WETLAND IN SOCIO-ECONOMIC AND GEOGRAPHICAL CONTEXTS: A STUDY OF HARIKE, ROPAR AND NANGAL WETLANDS

A thesis submitted to the Central University of Punjab

For the award of

DOCTOR OF PHILOSOPHY

In

Geography and Geology

BY

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August, 2019

DECLARATION

I declare that the thesis entitled **"WETLAND IN SOCIO-ECONOMIC AND GEOGRAPHICAL CONTEXTS: A STUDY OF HARIKE, ROPAR AND NANGAL WETLANDS"** has been prepared by me under the guidance of Dr. Kiran Kumai Singh, Assistant Professor, Centre for Geography and Geology, School of Environment and Earth Sciences, Central University of Punjab. No part of this thesis has formed the basis for the award of any degree or fellowship previously.

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ABSTRACT

WETLAND IN SOCIO-ECONOMIC AND GEOGRAPHICAL CONTEXTS: A STUDY OF HARIKE, ROPAR AND NANGAL WETLANDS

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Keywords:	Wetland, Land-use, Socio-economic, Threats, Conservation, Harike, Ropar and Nangal

Wetland ecosystem is regarded as one of most productive system of the earth surface due to its inclusive nature to supports a variety of flora and fauna. There are a number of functions and services provided by the wetland ecosystem which includes purification of water, protection from floods, groundwater replenishment, woods for fuel and commercial uses, fish resources, recreational and social services. Therefore, the study is an attempt to evaluate the socio-economic significance of wetland area and their relation with the livelihood activities of local people in Harike, Ropar and Nangal wetlands of Punjab. The economic value of the wetland products and services have been calculated from direct use value which employed different methods. The study also focused on the threat perceptions related to impact of human developmental activities inside the wetland boundaries. The people participation for the conservation and management of the wetland area has also been studied through their willingness to pay for such actions. The data desirable for the present study are collected from both secondary and primary sources. The secondary data for the study has been collected from published and unpublished resources such as from Department of Forest and Wildlife Preservation (Punjab), Department of Forest and Wildlife preservation (Firozpur), Department of Forest and Wildlife Preservation (Ropar), Harike Sanctuary Office, Punjab State for Science and Technology (PSCST), ENVIS, articles, research papers, newspapers, books and other internet resources. The Primary data has been collected through interview schedule of the

people of selected villages/towns falling within one kilometre buffer zone around the Harike, Ropar and Nangal wetlands. The collected data are analysed by using statistical methods like descriptive statistics, regression and probit model. The study came up with suitable recommendations for conservation of wetland.

(Gaurav Kumar) (Dr. Kiran Kumari Singh)

ACKNOWLEDGEMENT

I would like to express my gratitude to all, those who supported and helped me through this thesis work and made it very precious memorable experience. First of all, I would like to thank Almighty and my Parents who gave me this opportunity and faith.

First and foremost I wish to express my deep gratitude to my Ph.D. supervisor and teacher Dr. Kiran K. Singh, Assistant Professor, Centre for Geography and Geology, Central University of Punjab who consistently supported me for the research work and guide me at every stage during the research work. This thesis would not have been possible without her unwavering supportive, encouragement, patience, advice and guidance. I am very happy to express my sincere thanks to her.

I am immensely gratified to Dr. J. K. Parida, Assistant Professor in Centre for Economic Studies, Central University of Punjab for his unconditional guidance. I am highly obliged to Dr. L.T. Sasang Guite, Dr. Jitendra Kumar Pattnaik, Dr. K. Milankumar Sharma, Dr. Archana Bohra, Dr. Savita Ahlawat and Dr, Sunil Mittal (Dean of School) who assisted me in successful completion of this thesis.

My most sincere thanks to Prof. R.K Kohli, Vice Chancellor, Central University of Punjab for providing me research facilities to carry out my work. I am also extremely thankful to Prof. P. Rama Rao (Dean Academic Affair), Prof. V.K. Garg (DSW), Prof. Jagdeep Singh (Registrar) and Mr. Kanwal Pal Singh (Controller of Examination). It's my pleasure to acknowledge Assistant Librarian Dr. Bhupinder Singh Brar and whole Library staff, Mr. Puneet Kumar (Lab. Attendant) and staff members of Computer Centre and Administrative Block who provided necessary help during my work.

I am grateful to the contribution of my friend Amandeep Kaur who always scaled me in the high esteem and boosted my morale. I am extremely thankful to all respondents of this study, Department of Forest and Wildlife Preservation, Punjab, and my friends Mohidin Naiko, Halder Kumar, Deepak Chaudhary, Mandeep Singh, Khushmeet Singh, Amandeep Singh, Abhimanyu Jamwal,

Satinder Singh, Shiba, Prem Chand Kisku, Amrita and Ravi Krishan who never failed in cheering and providing moral support throughout my work.

On this occasion, I special thanks to my elder brothers and my sister Shinu Bansal for their aspirations for my success which always encouraged me to take tough decision of life.

Lastly, I am thankful to University Grants Commission for providing me financial assistance to doing this research.

(Gaurav Kumar)

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LIST OF ABBREVIATIONS

Sr. No.	Full Form	Abbreviation
1	International Water Management Institute	IWMI
2	Indian Space Research Organisation	ISRO
3	Ministry of Environment & Forests	MoEF
4	Soil Conservation Services	SCS
5	International Biosphere Programme	IBP
6	Space Application Centre	SAC
7	International Union of Conservation of Nature	IUCN
8	Kilometre	km
9	Right to Information	RTI
10	Green Houses Gases	GHG
11	Non-Governmental Organisation	NGO
12	Management of Aquatic Ecosystem through Community Husbandry	MACH
13	Ministry of Forest, Environment and Climate Change	MoEF & CC
14	National Wetland Conservation Programme	NWCP
15	International Waterfowl and Wetland Research Bureau	IWRB
16	World Wide Fund for Nature	WWF
17	Asian Wetland Bureau	AWB
18	National Wetland Inventory and Assessment	NWIA
19	Central Pollution Control Board	CPCB
20	Central Wetland Regulatory Authority	CWRA
21	Environmental Protection Act	EPA
22	Punjab State Council for Science and Technology	PSCST
23	Management Action Plan	MAP
24	National Lake Conservation Programme	NLCP
25	City Level Monitoring Committees	CLMCs
26	Urban Local Bodies	ULB
27	United Nations Educational, Scientific and Cultural Organisation	UNESCO

28	Ashoka Trust for Research in Ecology and the Environment	ARTEE
29	National Plan for Conservation of Aquatic Ecosystem	NPCA
30	National Action Plan for Climate Change	NAPCC
31	National Water Mission	NWM
32	Mahatma Gandhi National Rural Employment Guarantee Act	MANREGA
33	Mean Sea Level	MSL
34	Nangal Hydel Channel	NHC
35	Anandpur Sahib Hydel Channel	SYL
36	Quantum Geographic Information System	QGIS
37	Earth Resources Data Analysis System	ERDAS
38	Linear Imaging Self-scanning System	LISS
39	Salim Ali Centre for Ornithology and Natural History	SACON
40	Enhanced Thematic Mapper	ETM
41	Operational Land Imager	OLI
42	Thermal Infrared Sensor	TIRS
43	United State Geological Survey	USGS
44	Normalized Difference Water Index	NDWI
45	Near-infrared radiation	NIR
46	Joint Photographic Experts Group	JPEG
47	Other Backward Classes	OBC
48	Schedule Castes	SC
49	Bhakra Beas Management Board	BBMB
50	National Fertilizer Limited	NFL
51	Liquefied Petroleum Gas	LPG
52	Bombay Natural History Society	BNHS
53	Willingness to Pay	WTP
54	Punjab Pollution Control Board	PPCB
55	Ordinary Least Square	OLS

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Chapter 1: Introduction

Owing to its inclusive nature of encompassing diverse forms of biota and its adherence to various underlying ecosystem services or functions makes ‘wetlands’ one of the most vital and productive ecosystem that exists among other ecosystems. Due to its characteristic features as a natural pollutant filter, its role in water stabilization, flood control and protection, and groundwater replenishment, ‘wetlands’ are rightly considered as kidneys of the landscape as it filters the polluted water that it receives from both natural and man-made sources. As it encompasses a large variety of flora and fauna, it has a complex and large food chain which serves as another distinguishing feature of wetlands. The innate diversity of flora and fauna conveniently labels wetlands as an ‘ecological supermarket’ and ‘biodiversity hotspot’ which highlights the complexity, variety and availability of all possible elements on a natural sphere, rendering it different and unique as compared with other existing ecosystems, as a range of biota flourished in and around the wetland areas (Kundu et al, 2008; Paul et al; 2011). Not only the inclusive biota, but it also has a proximal connection with the inhabitants near the wetland areas, the latter who are labelled as wetlanders due to their overt habitation near the ecosystemic vicinity (Coles & Coles, 1989). There was a considerable metamorphosis in the realization of the significance of wetlands with the passage of time. In historical times, many great civilizations flourished alongside the wetlands as it was considered to fulfil the basic human requirements and needs (Barbier et al., 1997; International Water Management Institute, 2014), in spite of this, many countries view wetlands as wastelands due to the inaccessibility and difficulty of cultivation they face due to lack of technology. In addition to this, prehistoric people perceived wetlands as a breeding ground for different diseases and disasters that affected the humankind in that period (Mutagamba, 2012). But in due course of time, there was a considerable change in the way people perceived and realized the significance of wetlands with the expanding knowledge and values acting as a catalyst (Woodward & Wui, 2001). The value of wetlands is considerably influenced and dependent on several factors such as the location of the wetland, human population and habitation, climatic conditions and its contribution in terms of livelihood. For example, the value and function of a coastal wetland are different from inland or riverine wetland (Mitsch & Gosselink, 2000). Wetlands provide a range of products

that are either directly or indirectly linked to human livelihood, for example, many rural poor communities, particularly in Asia, are dependent on wetlands as it serves as a major source of their livelihood (Khan, 2011). The humankind, as well as different species of flora and fauna, are directly or indirectly dependent on wetland areas for their survival. Similarly, about 83 percent of Uganda's population is dependent, in various ways, on wetlands for livelihood purposes (Turyahabwe et al., 2013a & Turyahabwe et al., 2013b; Kakuru et al., 2013). The value of wetlands started growing mainly after the second half of the twentieth century due to the setup of the Ramsar Convention in the year 1971.

In terms of geographical occupancy, wetlands cover about seven percent areas of the earth surface, but in terms of its contribution, it provides about forty-five percent of ecosystem services to the world (Indian Space Research Organisation, 2011a). At the global level, surrounding inhabitants are largely dependent on the wetland for food and drinking water, such as Ga-Mampa wetland in South Africa which accounts for the large dependency of its surrounding people for the fulfilment of their basic needs and necessities. The significance and importance of wetlands range from purification and storage of water, groundwater replenishment, flood control, stabilization of shoreline and harbours, migrating effects of climate change by effective pollution regulation, etc. Apart from this, wetlands act as a source of social, economic, and cultural mobilization. Wetlands also promote tourism by creating a provision for various recreational activities, fishing, relaxation and pleasant weather (Folke 1990; Groot, 1992; Mwakubo & Obare, 2009; Government of Punjab, 2003). Thus, there can be a three-tier division of the different values provided by wetland ecosystem, as in, production inputs for market goods and services, consumer goods and production inputs related with eco-technologies (Gren et al., 1995). But in terms of economic valuation, the provisions of services and products by wetlands are classified into direct values and indirect values. Direct values are those in which the user or the consumer directly benefits from this form of the ecosystem by fulfilling its basic necessities through food, water, fisheries, agriculture, transport, recreational and tourism opportunities. On the other hand, indirect values, such as ecological or heritage values, provide no direct link to the consumers and the users cannot directly benefit from the services provided by the wetlands. But owing to its unhindered access to all, the wetlands tend to get over-exploited by humankind

through their various anthropogenic activities. It can be duly observed through historical studies that the over-dependence of communities has negatively affected wetlands and have led to the dire perversion of its functions and values (McCartney et al., 2006). Therefore, management and conservation of wetlands have become a pressing need of the day. But the existing bulk of research on wetlands was carried in the context of their hydrological regime, the biological regime, and its importance for providing habitats for migrated birds without the participation of local residents (Verma et al., 2001). On the other hand, activities such as commercial fishing, commercial farming, livestock, recreation, etc. have increased the estimated valuation of wetlands which in turn calls for a quantitative economic evaluation of the various products so that the level and range of dependency of its local residents over wetlands can be systematically accessed (McCartney et al., 2010). The major constraint in the economic valuation of products results from the lack of sufficient knowledge about the various functions of wetlands and the inherent complexity and interlinkages in the ecosystem relations (Jeena, 2002). Open accessibility and unhindered entry has posed a serious threat and has further instigated the relative devaluated status of wetlands. Thus, degradation of wetlands has initiated in the past, but the gradual emergence of technologies has exceeded the rate of degradation and have aggravated the situation to the worse. In spite of such consequences, wetlands still remain as the primary source of livelihood for the families residing in wetland areas. To cope up with such demands, it is essential to conserve and maintain the available resources to cater to the needs and interests of both present and future generations (Nabahungu & Visser, 2011). The rural communities, especially, are highly dependent on these resources because of its importance linked with historical, religious, social, economic, and food security (Morardet & Tchamba, 2005; Nabahungu & Visser, 2011). But due to high exploitation through excessive use in agriculture, construction of dams, industrial expansion, and other uses, the wetland areas have decreased at a higher rate, for instance, about 5000 sq. km have decreased in Asia due to over-intrusion and misuse of resources (Zedler & Kercher, 2005). Therefore, there is a dire need for policymakers to find the interrelation between the people in relation to wetlands or the values of wetland in the life of the consumers (McCartney et al., 2006). Irrespective of the formulation and application of different policies not much has improved since (Barbier et al., 1997). Thus, from an institutional point of view, the

economic valuation of the products and provisions of wetlands demands serious attention as it directly influences the politicians, planners, and decision-makers. Hence, the present study will be focused on the economic valuation of wetland goods and services along with the analysis of policies adopted by the state and central governments. The study will also throw light on the participation of communities in the management and conservation of wetlands and to access the impact of degradation of wetlands on people's livelihood, who live in the surrounding areas.

1.2. Historical Background of defining areas as Wetlands: The beginning of the twentieth century marked the initial phase of management and conservation of wetlands, with its main focus on wildlife, when a Migratory Bird Treaty Act was signed between USA and Canada in 1918 which ensured protection of migratory birds between the two countries. For conservation of birds and other wetland wildlife, bilateral treaties were signed by the USA with various countries such as Mexico in 1936, Japan in 1972, and with the Soviet Union in 1976. In addition to this, the U.S. Migratory Bird Hunting and Conservation Stamp Programme were started by the USA in 1930 especially for the conservation of ducks. Issuance of first duck stamp by the U. S. Fish and Wildlife Service was in 1934 which were purchased by many, including hunters, educators, and conservationists. Therefore, federal duck stamps contributed a lot in the conservation of wetlands as 98 cents out of one dollar was spent on the purchase of wetland land for the National Wildlife Refuge System. Consequently, in 1934 with the massive sale of duck stamps which generated 800 US dollars was further used for the purchase of over six million areas of wetland (Dahl & Allord, 1982). Therefore, there was a marked increase in the effort for the conservation of wetlands wildlife which had spread from North America to other parts of the world and which in turn led to a series of negotiations between various non-governmental organization and countries after the 1960s and eventually resulted in the Ramsar Wetlands Convention in 1971. At the initial stages, its primary focus was on the conservation and protection of the habitat of birds and later it shifted to cater to the livelihood needs of the poor sections of the society by ensuring sustainable development by providing them with necessary benefits from wetlands (International Water Management Institute, 2014). With the view of conservational and policy framework, there has been a need for the formulation of a proper definition. Wetlands, in general, can be defined as any natural or man-

made water system characterized by bog, marsh, fen, peat, or water land that are permanently or temporarily filled with water which can be of static or dynamic nature, fresh, brackish or salt water. Wetlands can also be defined as transitional zones that occupy an intermediate position between dry and open land. On the basis of their hydrology, geological, and ecological characteristics, wetlands can be divided into marine, estuarine (including mangrove and tidal wetlands), palustrine (marshy, swamps, and bogs) and riverine wetlands (Cowardin et al., 1979). Initially, before the twentieth century, there lacked an emergence of a full-fledged definition as people were unaware of the word 'wetland', the latter used these areas for making uplands or agricultural fields, or in the development of an extensive drainage system. The word 'wetland' surfaced itself in the later part of the 20th century when it was first referenced in the publication of 'Wetlands of the United States' in 1956 (Shaw & Fredine, 1956). Earlier, wetlands were natively known as marsh, bog, swampy, moor, and fen, the limitations of which are greatly prevalent in its earlier definitions. But, there has been more suitable, complete, multidisciplinary definitions adopted by various official and governmental offices as follows:

The US Fish and Wildlife Service defined 'wetland' as "*lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water level. For purposes of this classification, wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly un-drained hydric soil; and 3) the substrate is non-soil and is saturated with water or covered by shallow water level at some time during the growing season of each year"* (Cowardin et al., 1979).

The Ramsar Convention defined Wetlands as an," *area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres"*. In the year 2013, Article 2.1 further provides that wetlands '*may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands'*. In other words, wetlands can be defined as a part of the land covered with water almost throughout the year and the level of which fluctuates with seasons with little or very less water in the dry seasons and high water level during the

monsoons (Ministry of Environment and Forests (MoEF), 2007). Apart from this, Wetlands also constitute of areas, like in coastal islands or in marine water bodies, where the level of water ranges deeper than six meters.

The US Army Corp of Engineers and US Environmental Protection Agency defines wetlands as "*Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs, and similar areas*" (Environmental Laboratory, 1987). In comparison to other existing ecosystems, wetlands can be rightly defined as a multifunctional ecosystem.

While defining wetlands from an ecological standpoint, the Soil Conservation Service (SCS) of the U.S. Department of Agriculture, emphasizes three key attributes: 1) hydrology –the degree of flooding or soil saturation, 2) wetland vegetation (hydrophytes), and 3) hydric soils. A major characteristic feature of wetlands is that they must be thoroughly saturated with water for at least three months during the growing season so as to support vegetation. Accordingly, "*Wetlands are defined as areas that have a predominance of hydric soils and are Inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions".*

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. (U.S. Environmental Protection Agency (EPA) and Army Corps of Engineers (CE)).

The International biosphere Programme (IBP) defines wetlands *as "Part of the surrounding ecological structure and several stages in the succession from open water to dry land or vice versa, occurring at sites situated as a rule between the highest and lowest water level as long as the flooding or waterlogging of the soil as of substantial ecological significance"* (Praikh & Datye, 2003).

The various definitions of wetlands given by different scientists differ in relation to their concerned field and area of study; for example, plant scientists have plants as

their primary focus of study as compared to other aspects of wetlands, whereas, a hydrologist focuses more on classification of water, eventually shadowing other aspects of wetlands such as vegetation, crops, migratory birds, etc.

1.3 Classification of Wetlands: There have been different forms of categorization of the wetland system highlighting various aspects, such as, on the basis of its location, mode of occurrence, calculated size, and shape of the wetland areas. The first classification of Indian wetland was carried out by the Space Application Centre (SAC), Ahmedabad, by making a detailed inventory of Indian wetlands (Gopal & Sah, 1995).

Table 1.1: Wetland Classification System, 1992

Inland Wetlands		
	Natural	Lakes/ponds
		Ox-bow lakes/cut-off meanders
		Waterlogged (Seasonal)
		Playas
		Swamp/marsh
	Man-made	
		Reservoirs
		Tanks
		Waterlogged
		Abandoned quarries
		Ash pond/cooling ponds
Coastal Wetlands		
	Natural	Estuary
		Lagoon
		Creek
		Backwater (Kayal)
		Bay
		Tidal flat/ mud flat
		Sand/ Beach/Spit/Bar
		Coral Reef
		Rocky Coast
		Mangrove forest
		Saltmarsh/marsh vegetation
		Other vegetation
	Man-made	Salt pans
		Aquaculture ponds

Source: Gopal & Sah, 1995

In this directory, SAC adopted the International Union of Conservation of Nature (IUCN) definition “all submerged or water-saturated lands, natural or manmade, inland or coastal, permanent or temporary, static or dynamic, vegetated or non-

vegetated, which necessarily have a land-water interface, are defined as wetlands". The two major shortcomings faced in the context of Indian wetlands is the unavailability of any form of wetland classification and the lack of effort in filling the existing gap initiated by the standing committee on Bio-resources and Environment in 1991, the discussed proposal of which has been circulated among the 22 eminent scholars, academicians or managers for their valuable inputs. In 1992, the first classification of Indian wetland was finalized under the guidance of the Ministry of Environment and Forest that includes all wetlands, incorporation of all deep water habitats and impoundments such as reservoirs, ash ponds/ cooling ponds, and abandoned quarries (Gopal & Sah, 1995). The wetland has been classified into natural and man-made on the basis of its mode of occurrence and further classified into inland and coastal in relation to its location. The detailed classification of wetlands was discussed in above table 1.1.

Table 1.2: Wetland Classification System by ISRO, 2011

Wetland Code	Level I	Level II	Level III
1000	Inland Wetlands		
1100		Natural	
1101			Lake
1102			Oxbow/Cut-off meander
1103			High altitude wetland
1104			Riverine wetland
1105			Waterlogged
1106			River/stream
1200		Man-made	
1201			Reservoir/barrage
1202			Tank/pond
1203			Waterlogged
1204			Salt pan
2000	Coastal wetlands		
2100		Natural	
2101			Lagoon
2102			Creek
2103			Sand/beach
2104			Intertidal mud flat
2105			Salt marsh
2106			Mangrove
2107			Coral reef
2200		Man-made	
2201			Salt pan
2202			Aquaculture pond

Source: Indian Space Research Organisation, 2011a

In 2011, the ISRO formulated another classification of wetlands, in which 19 wetland classes were delineated by defining it into three hierarchical systems, i.e., inland or coastal, natural or man-made, and the third consists of different types of wetlands listed in a hierarchical order in each category. The detailed classification is tabulated above (table 1.2).

There is noticeable difference in the definitions used for delineation, such as the usage of IUCN definition for classification of wetlands in 1992 and the usage of Ramsar definition by the latest wetland inventory in 2011, which resulted in the decline in the number of different types of wetlands under different categories because of more detailed analysis in relation to the level and depth of the wetlands, for example, the exclusion of coastal wetland estuaries, Bay, Blackwater, tidal/mud flat and rocky coast in the recent wetland inventory of 2011.

1.4 Wetlands in India: Based on their location and geographical extent, natural wetlands in India varies from location to location, such as the glaciated wetlands that exists in the high altitude of Jammu and Kashmir or in the Himalayan region, as compared to desert wetlands that are situated in desert areas of Rajasthan or North-western region, which are quite different from the coastal and mangrove wetlands along the coastal lands both in Eastern and Western Ghats and so on. Apart from these natural wetlands, there exist various man-made wetlands in India, that support the growth of various flora and fauna (Sanjeev & Subramanian, 2003). These man-made wetlands were necessarily made for the fulfilment of human needs such as irrigation, electricity, flood control, fisheries, etc. Apart from these, several other water bodies like small ponds, lakes, reservoirs, and small tanks are also considered as a part of wetlands in India. Most of the wetlands in India exists alongside rivers or streams, such as Harike wetland on Sutlej and Beas Rivers. According to the Ministry of Environment and Forests (2007), an average of 4.1 million hectare areas of India lies under the 67,429 wetlands (excluding mangroves and paddy fields). Out of which, 1.5 million hectares come under natural wetlands (2,175 wetlands) and the rest 2.6 million hectares' areas come under man-made wetlands (65,254 man-made wetlands). According to the National Wetland Inventory and Assessment (2011), the total area covered by wetlands in India are about 15.260 million hectares, which accounts for over 4.63 percent of the total existing geographical region.

According to Indian Space Research Organization (ISRO) database, there exist over 7,57,060 wetlands in India (which includes both coastal and inland wetlands that were either man-made or natural wetlands and also included wetlands which were less than 2.25 sq. km (Table 1.3).

Table 1.3: Total Areas under Wetlands in India (Both Inland and Coastal) (Area in Hectare km)

Sr. No.	Wetland Code	Wetland Category	No. Of Wetlands	Total Wetland area	% of wetland area	Open Water	
						Post-Monsoon Area	Pre-Monsoon Area
1	1100	Inland wetlands (Natural)	45,658	66,23,067	43.40	41,00,766	31,15,701
2	1200	Inland wetlands (Man-made)	1,42,612	39,41,832	25.83	32,67,602	16,54,170
Total (Inland)			1,88,470	10,564,899	69.23	73,68,368	47,69,871
3	2100	Coastal Wetland (Natural)	10,204	37,03,971	24.27	9,30,663	7,50,339
4	2200	Coastal wetlands (Man-made)	2,829	4,36,145	2.86	3,01,767	2,81,010
Total (Coastal)			13,033	41,40,116	27.13	12,32,430	10,31,349
		Sub Total	2,01,503	147,05,015	96.63	86,007,98	58,01,220
5	3100	Wetlands (<2.25 ha)	555557	555557	3.64	-	-
Total			7,57,060	152,60,572	100	86,00,798	58,01,220

Source: Indian Space Research Organisation, 2011a

The two major types of wetlands found in India are inland and coastal wetlands, which are further subdivided on the basis of their mode of formation. Inland wetlands are classified into river/ stream, lake/ pond, and reservoir, whereas, coastal wetlands are classified into inter-tidal mudflat, lagoon, and creek. Among these, the river wetlands have a comparatively larger occupance covering over 5.26 million hectare areas that are 34.46 percent of the total wetland areas available in India, followed by reservoir wetlands of 2.48 million hectares (16.46%), intertidal mudflat wetlands cover 2.41 million hectares (15.82%), tank/pond wetlands include 1.31 million hectares and

remaining covers by lakes wetlands that are 0.71 million hectares (Indian Space Research Organization, 2011a).

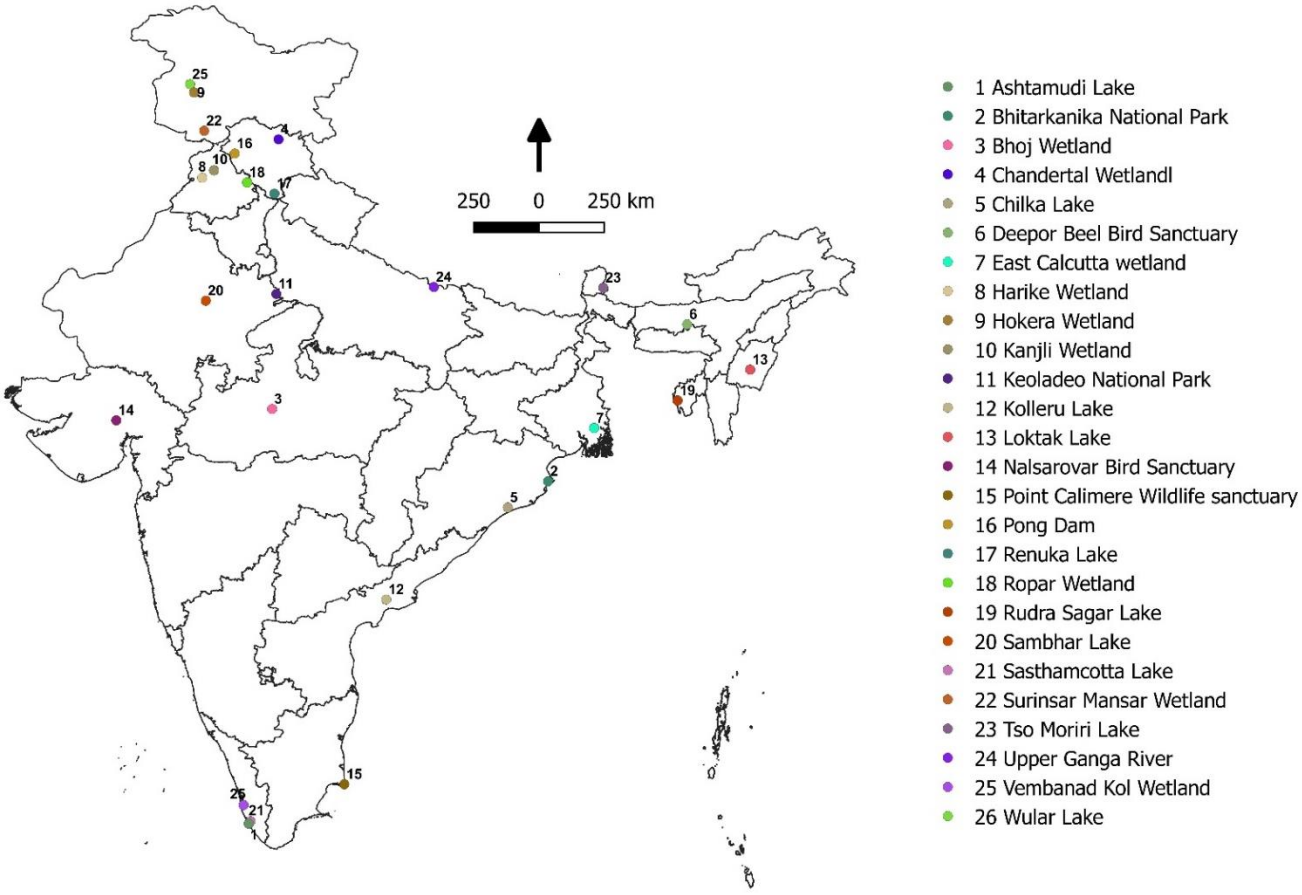
Table 1.4: Wetlands Areas in India (State-wise and Union territory)

Sr. No.	State	Wetland area (in hectare)	% of State geographical area
1	Lakshadweep	79586	96.12
2	Andaman & Nicobar Islands	152809	18.52
3	Daman & Diu	2070	18.46
4	Gujarat	3474950	17.56
5	Puducherry	6335	12.88
6	West Bengal	1107907	12.48
7	Assam	764372	9.74
8	Tamil Naidu	902534	6.92
9	Goa	21337	5.76
10	Andhra Pradesh	1447133	5.26
11	Uttar Pradesh	1242530	5.16
12	Odisha	690904	4.49
13	Bihar	403209	4.40
14	Dadra & Nagar Haveli	2070	4.25
15	Kerala	160590	4.13
16	Karnataka	643576	3.36
17	Maharashtra	1014522	3.30
18	Chandigarh	350	3.07
19	Manipur	63616	2.85
20	Madhya Pradesh	818166	2.65
21	Chhattisgarh	337966	2.50
22	Rajasthan	782314	2.29
23	Jharkhand	170051	2.13
24	Uttarakhand	103882	1.94
25	Arunachal Pradesh	155728	1.78
26	Himachal Pradesh	98496	1.77
27	Jammu & Kashmir	391501	1.76
28	Punjab	86283	1.71
29	Tripura	17542	1.59
30	Meghalaya	29987	1.34
31	Nagaland	21544	1.30
32	Sikkim	7477	1.05
33	Delhi	2771	0.93
34	Haryana	42478	0.86
35	Mizoram	13988	0.66

Source: Panigrahy et al., 2011

Areas under wetlands have undergone changes due to overt variations in the geographical and climatic conditions of that particular state or region. Lakshadweep marks the highest geographical extent of wetlands covering over 96.12 percent of the total geographical areas, followed by wetlands in Andaman and Nicobar covering a geographical extent of over 18.52 percent, followed by Daman and Diu with 18.46 percent and Gujarat covering about 17.56 percent of areas occupied by wetlands and Mizoram being the lowest with a geographical extent of 0.66 percent of areas under wetlands (Indian Space Research Organization, 2011a). The quantitative status occupancy of areas under the wetlands is different for different types of wetlands. For instance, in connection to inland natural wetlands, with a quantitative value of 4,369, Tamil Nadu has the highest number of wetland lakes, followed by Uttar Pradesh with 3,684 lakes, 1,327 lakes in West Bengal, 1,175 lakes in Assam and 514 lakes in Bihar. On the other hand, Uttar Pradesh has the highest number of Ox-bow lakes, i.e., 1,672, followed by 989 Ox-bow lakes in Bihar, 873 in Assam and 867 in West Bengal.

Map: 1.1 Location Map of Wetlands in India



Source: Created with the help of QGIS software

There is a considerable change in the categorization of ranking of areas under man-made inland wetlands as compared to natural inland wetlands, with Andhra Pradesh bagging the first rank with 4,527 reservoirs, followed by 2,005 reservoirs in Madhya Pradesh, 1,608 in Uttar Pradesh, 1,379 in Odisha and 1,213 reservoirs in Gujarat. In the categorization of smaller wetlands covering an area less than 2.25 hectares, West Bengal has the highest numbers with 1,38,707 wetlands, followed by 97,352 in Uttar Pradesh, 66,174 in Odisha and 44,952 in Madhya Pradesh (Indian Space Research Organization, 2011a).

1.5 Wetlands in Punjab: The wetlands in Punjab which accounts for rivers/ streams, reservoirs, and tanks range over 86283 hectare lands and account for less than 2 percent areas of the total geographical areas of the state. The remote sensing data collected by the Indian Space Research Organization (ISRO) at 1:50000 mapping scale found about 1,381 wetlands in Punjab (Indian Space Research Organisation, 2011b). According to Punjab Statistical Department (2002), 39 wetlands exist in Punjab, out of which, 33 are of natural origin and 6 are man-made. The areas of natural wetlands and man-made wetlands in Punjab accounted for 17,085 hectares and 5391 hectares respectively. Out of these 39 wetlands that exist in Punjab, three wetlands namely Harike wetland, Ropar wetland, and Kanjli wetland come under the categorization of international wetlands and are included in the Ramsar list, while Harike wetland was included in 1990, Ropar and Kanjli wetlands were included in the Ramsar list in 2002. There are two national wetlands, namely, the Nangal Lake and Ranjit Sagar Lake.

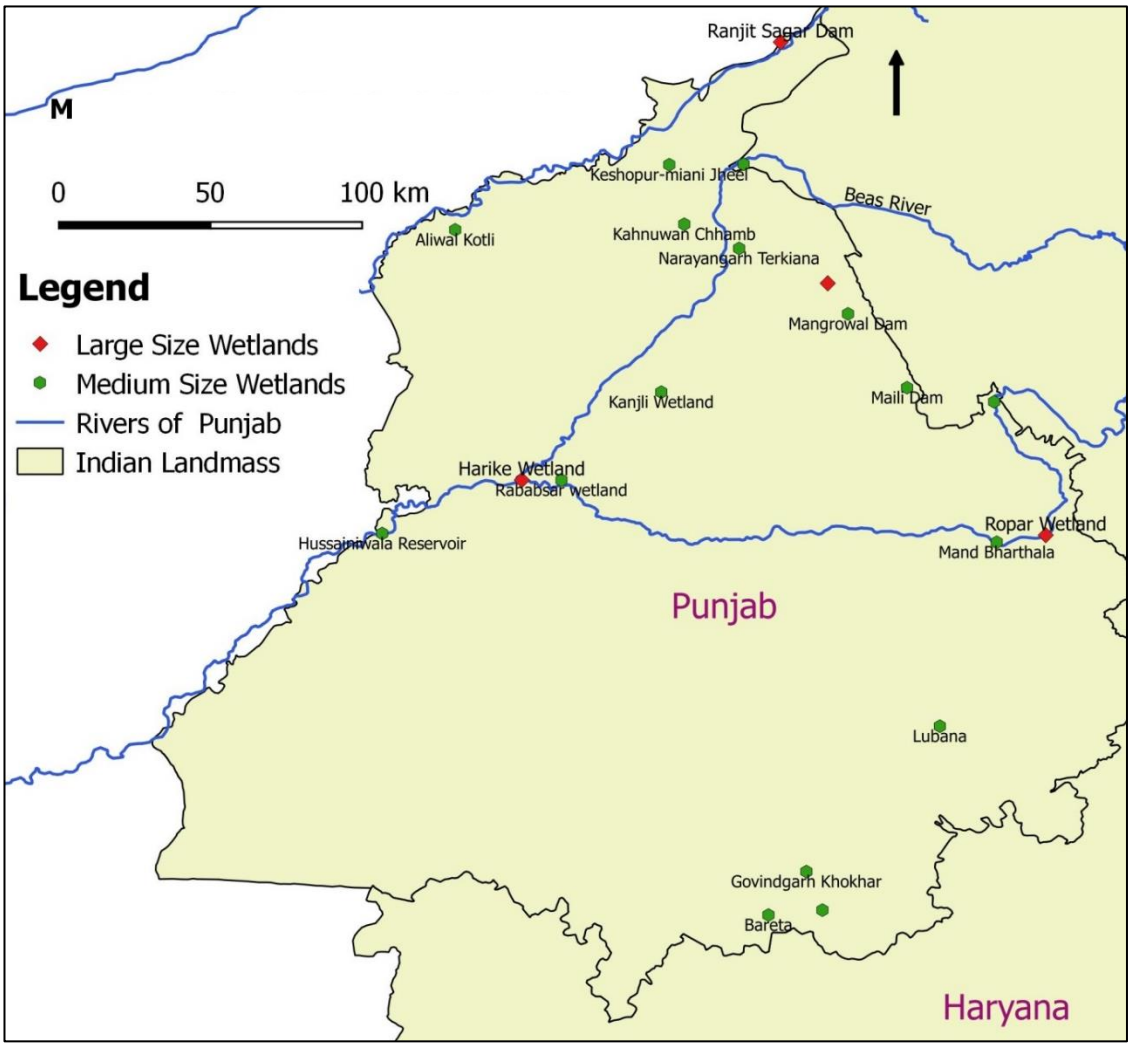
There survives a number of small and large sized wetlands spread over the districts of Punjab. As per total area under wetlands per district, Gurdaspur has the largest coverage of total area under wetlands with 16557 hectares and Fatehgarh Sahib having the lowest coverage with an area of 267 hectares. On the other hand, in terms of the percentage of total wetland areas vide the total area per district, Rupnagar has the largest coverage of the area, i.e., 8.75 percent (8950 hectares) under wetlands, and Gurdaspur with only 4.64 percent (16557 hectares) under wetlands. Kumar and Kaur (2018), categorized the wetlands of Punjab into three categories i.e. large size (more than 1000 hectare), medium size (2.25 hectare to 1000 hectare) and small size (less than 2.25 hectare). Location of large size and medium size wetlands is shown in map 1.2.

Table 1.5: Areas and Nature of Wetlands in Punjab (Natural and Man-made)

Sr. No.	Name of Wetland	Nearest town	District	Area (km^2)	Status
		A. Natural Wetlands			
1	Jastarwal Jheel	Jastarwal / Ajnala	Amritsar	0.55	Permanent
2	Aliwal Kotli	Aliwal / Ajnala	Amritsar	0.10	Permanent
3	Bareta	Bareta	Mansa	0.20	Seasonal
4	Kahnuwan Chhamb	Kahnuwan / Man Chopa / Chhawarian Banghar	Gurdaspur	1.28	Permanent
5	Keshopur – MianiJheel	Keshopur Miani Jhamela	Gurdaspur	4.08	Permanent
6	Mand Bharthala	Bharthala	Nawanshahr	0.61	Permanent
7	Narayangarh – Terkiana	Terkiana/ Dasuya	Hoshiarpur	0.82	Permanent
8	Sital Sagar	Mansar	Hoshiarpur	*	Permanent
9	Rababsar	Bharowana	Kapurthala	0.41	Temporary
10	Lobana	Patiala	Patiala	0.11	Temporary
11	Lahail Kalan	Lehail	Sangrur	0.20	Temporary
12	Gobindgarh Khokhar	Gobindgarh Khokhar	Sangrur	0.08	Temporary
		B. Manmade Wetlands			
1	Harike Lake	Harike	Tarn Taran, Kapurthala Ferozepur	41.0	Ramsar Site
2	Kanjli Lake	Kanjli	Kapurthala	0.44	Ramsar Site
3	Ropar Lake	Ropar	Ropar	13.65	Ramsar Site
4	Hussainiwala Reservoir	Ferozepur	Ferozepur	6.88	Nominated for recognition as National Wetland
5	Ranjit Sagar	Shahpur Kandi	Gurdaspur	32.64	National Wetland
6	Dholbaha Dam	Dholbaba	Hoshiarpur	13.2	Earth filled dam
7	Maili Dam	Maili	Hoshiarpur	0.72	-
8	Mangrowal Dam	Mangrowal	Hoshiarpur	0.70	-
9	Nangal Lake	Nangal	Ropar	4.0	National Wetland

Source: Ladhar, 2002

Map: 1.2 Locational Map of Wetlands in Punjab



Source: Kumar & Kaur, 2018

Issues related to Wetlands in Punjab: In connection with the advancement and culturing of sustainable development, wetlands are considered as a vital element of nature which has begun to face threats, thus undergoing rapid degradation with each passing day due to a number of factors. Anthropogenic pressure is one of the main factors responsible for the degradation of wetlands in India with a combing effect of increasing population, deforestation, agriculture activities and increasing amount of pollution from both point and non-point resources. Secondly, there has been a rapid conversion of wetlands into human settlements and agricultural fields as they are considered as a hindrance in the process of development and modernization. In addition to this, wetlands are falling prey to different natural variables as well, that eventually leads to their degradation. So, there are a number of problems that the wetlands face and undergo which leads to a gradual decrease in the number of

wetlands in India, particularly in Punjab (Foote et al., 1996; Nigah, 2007; Dandekar & Thakkar, 2011). The various reasons for their depletion and destruction are discussed below:

Pollution: There has been an alarming reduction and deterioration of the quality of water in the wetland areas as a consequence to the disposal of polluted and untreated water from industries, sewage inflow, and the inflow of insecticides and pesticides from the agricultural fields. These are further associated with the increase in the quantity of hyacinth which poses a serious threat to the wetland ecosystem as it instills a change in water chemistry, reduces the amount of light and oxygen, etc. The higher quantity of hyacinth also causes problems in fishing due to its complex root structure. According to a report, the quality of water in wetland areas are being subjected to degradation at a higher rate owing to the increase in the quantity of sewage in Kanjli wetland through the Kali Ben River (Mahal, 2017). Moreover, the illegal practice of drugs has made Kanjli wetland lose its importance as a place for recreation. Besides this, regular discharge of untreated and chemically affected water through the Budda Nalla into the Sutlej River counts as another reason responsible for the depletion of ecology in the Harike Wetland (Zutshi, 2015). Thus, there is a depletion in the quality of water in wetland areas with an increase in the quantity of discharge and inflow of sewage, pesticides, and fertilizers from the surrounding agricultural fields and towns (Dhiman, 2017).

According to a study, there has been an increase in the quantity and presence of heavy metals like lead (Pb), nickel (Ni), cadmium (Cd), Chromium (Cr), and Iron (Fe) in the Harike wetland (Brraich & Jangu, 2015). Similarly, the quality of water of Beas River is also affected due to the addition of polluted water from various source and non-source points like sewage, agricultural and industrial runoff, which ultimately degrades the quality of water at Harike wetland (Kumar et al., 2016). About 283.8 (mld) and 29.26 (mld) of polluted water are directly discharged into Sutlej and Beas Rivers from different towns situated on their banks (Table 1.6). The present use of wetlands as a ground for deposition of various solid and liquid wastes becomes a major threat. Wetlands are affected by landfilling in two ways, firstly by the declination of areas and secondly, by deteriorating the inherent quality of the wetland area. For instance, severe lack of areas in Badarpur area in Delhi led to the conversion of wetlands into landfilling for the disposal of wastages (Sinha, 2013). A similar case

can be witnessed in Bellanwalian-Attidiya bird sanctuary in Sri-Lanka which has been in constant threat due to the dumping of urban wastages in it (Jayawickreme, 2011). The drastic increase in the amount of pollution leads to various aquatic diseases which affect the skin, eye, gills, stomach, and intestine with plasmodia evident in the wetlands of Punjab (Singh & Kaur, 2012; Kaur, 2014; Kaur et al., 2017). Thus, these factors have substantially reduced the quality and quantity of water in wetland areas of Harike, Ropar, and Nangal wetlands in the past decades.

Table 1.6: Towns discharging sewage into Sutlej and Beas River

S.No.	Town	Waste-water (mld)	Through Tributary/ river
1	Ludhiana	148.00	Budha Nullah/Sutlej
2	Jalandhar	68.00	East Bein/Sutlej
3	Moga	14.00	Moga Drainage/ Sutlej
4	Hoshiarpur	12.00	East Bein/Sutlej
5	Kapurthala	9.00	West Bein/Sutlej
6	Anandpur Sahib	1.10	Sutlej
7	Ferozepur	8.00	Sutlej
8	Nangal Township	1.20	Sutlej
9	Naya Nangal	2.20	Sutlej
10	Phagwara	12.00	East Bein/Sutlej
11	Phillaur	2.10	Sutlej
12	Ropar	3.30	Sutlej
13	Nawanshahr	1.47	East Bein/Sutlej
14	Sultanpur Lodhi	1.43	West Bein/Sutlej
15	Pathankot	18.73	Beas
16	Mukerian	0.06	Beas
17	Talwara	2.10	Beas
18	Tanda	2.08	Beas
19	Dasuya	2.28	Beas
20	Beas	2.51	Beas
21	Harike	1.50	Beas

Source: Department of Forest and Wildlife Preservation, Firozpur

Siltation: Several factors like excessive livestock grazing, removal of grass and vegetative structure both by natural and anthropogenic activities have increased the volume of siltation carried out by the rivers at a higher rate, which in turn affects the wetland system as the water capacity of wetland areas declined due to shrinkage of areas. According to a recent study, due to siltation, the lake areas of Harike wetland has reduced from 41 sq. km. to 28 sq. km. The study estimated that yearly, owing to heavy siltation, about 0.2 to 0.4 sq. km. areas of the lake are converted into dry lands.

The water holding capacity of Harike Lake decreased from 8381 hectare meter in 1952 to 1820 hectare meter in 1990 (Ladhar, 2002). According to a study, within a span of 13 years, there is about 30 percent reduction of areas of Harike wetland (100.31 sq. km. areas in 1990 to 71.08 sq. km. in 2003) due to decrease of water inflow at the Harike Wetland (Jain et al., 2008). According to the recent findings, there has been a decrease in storage water capacity of 67,900 acres' feet in 1952 to 35,670 acres' feet in 1980 and 14,740 acres' feet in 1990 in the Harike wetland (Department of Forest and Wildlife Preservation (Wildlife), Firozpur). There has been a 78.28 percent reduction in the capacity of water storage of Harike Lake from 1952 to 1990 due to high amounts of siltation. As compared to Harike wetland, the degradation due to siltation is much higher in Ropar and Nangal wetlands as they are located in the Kandi belt or lower Shiwalik hills. This problem of siltation is evident from the statement given by an executive engineer, working in Ropar Head Works Division, that water is not properly supplied in the Bist Doab Canal due to excessive concentration of siltation. Lack of proper governance is the main factor for the problem to still persist, which is noticeable in the case in 1996, where the project of 33 lakhs regarding the clearance of silt from Ropar wetland was approved by the Government of Punjab, for which the funds have not been released yet. To resolve the problem of siltation, integrated development plans were adopted for the period of 2005-06 to 2011-12 (RTI, Ropar Headworks Division).

Encroachment: Increasing use of wetlands for agricultural, residential, and for urbanization purposes is highly responsible for the scenario of floods in the region, as witnessed in the case of Jammu and Kashmir, where the flood vulnerability scenario in the Jhelum basin has worsened in the last few decades due to the lack of protection provided by wetlands that used to sponge the region against flooding have been converted into concrete landscapes covering the entire Kashmir Valley. Therefore, most of the wetlands are fighting a losing battle for their survival. In a similar context, catchment areas of Bharatpur wetland in Rajasthan has declined due to excessive use of wetland areas for agricultural purposes, and use of wetland water for irrigation has led to drying up of wetlands leading to further degradation. The local government claims that they have no surplus water for wetlands (Sharma, 2005). Likewise, in the Punjab region, many wetlands like Bhupinder Sagar, Chhangali Chhamb and Rahon de Chhamb have lost their ecological importance due to the

reclamation process. The wetland areas are encroached for various purposes like road development, residential uses, religious and agricultural practices; out of which agricultural activities are majorly accountable and responsible for the decline of wetland areas. About 97.04 hectare areas encroached by local residents for agricultural activities fall under irrigation/canal department. Out of this, 50.54 hectare areas encroached by Bhadahupur Village, 44.17 hectares by Alampura Village and 2.33 hectare by Katli Village (RTI, Ropar Headworks Division). According to a study, 729 hectare areas of Harike wetland encroached by people for agricultural uses, which further increased to 1056 hectare areas in 2018 (Ladhar, 2002; Forest Officer (Wildlife), Firozpur). In present times, remote sensing techniques play a crucial role in identifying and detecting the various changes in ecosystems in terms of space and time (Bhaskar et al., 2010). Mabwoga & Thukral, 2014 analysed the Landsat Thematic Mapper and Enhanced Thematic Mapper Plus data for the years of 1989, 2000 and 2010, and found that over 13 percent of Harike wetland areas declined from 1989 to 2010. In Nangal wetland areas, some minor areas have been encroached by people that are used as Kitchen gardens, seasonal huts and dumping of cattle dungs, garbage and stocking fodder (Dept. of Forest and Wildlife Preservation, Punjab).

Flora and Fauna: The biota of the wetland areas have been severely affected due to various anthropogenic activities including the destruction of habitation, pollution from point and non-point sources. The mixing of heavy metal in wetland areas has drastically deteriorated the water quality of wetland areas, which directly or indirectly affects the flora and fauna in that area (Brraich & Jangu, 2015). A study of Harike wetland found high concentration of heavy metals, like Chromium 0.12 ppm, Manganese 0.02 ppm, lead 0.53 ppm, Cadmium 0.01, Nickel 0.01 ppm, Copper 0.26 ppm, Zinc 0.69 ppm, Cobalt 0.007 ppm, above permissible limit that can be dangerous for the aquatic life in wetlands (Brraich & jangu, 2015). In addition, to which, illegal poaching and fishing have reduced the numbers of wildlife in the Harike Wildlife Sanctuary (Ladhar, 2002; Tiwana et al., 2008). The Wildlife Department Firozpur gives a report on the numbers of challan and cases filed in Harike wetland .i.e. 38=2010, 22= 2011, 20=2012, 13=2013, 15=2014, 12=2015, 5=2016 and 6 cases and challan in 2017. This shows how wildlife in wetland areas disturbed by human beings (RTI, 2018). A study by Singh and Kaur (2012), examined the impact of heavy metals in the Ramsar listed wetland namely Harike, Ropar and Kanjli and

found that fishes are highly infected in Kanjli Wetland (71.1%) in comparison to 60.8 percent in Harike Wetland and 28.7 percent in Ropar Wetland (Singh & Kaur, 2012). By destroying their habitat places through the clearance of the elephant grass in Ropar wetland, the migratory birds are forced to look for new places for habitation (The Tribune, 2017). According to the report of Asian Bird Census 2017, the number of migratory birds visiting Ropar wetland reduced from 3114 in 2016 to 2302 in 2017 due to high-level disturbance like fishing, boating, and clearance of vegetation (Vasudeva, 2017). Similarly, in Harike Wetland, the number of migratory birds has dropped down to 11.8 percent from 1,05,890 in 2016 to 93, 385 in 2017 (The Times of India, 2017).

Weed Intensification: The wetlands of Punjab have been suffering from an excessive accumulation of unnecessary aquatic weeds like water hyacinth. The overgrowth of hyacinth inversely affected the ecology of Harike wetland areas (Ladhar, 2002; Tiwana et al., 2008). About 1, 42, 29, 935 Indian Rupee has been expended in 2005-2010 for clearance of weeds, silt, jalas and maintains of in Ropar wetland (RTI). The excessive growth of weed affects the inflow of water in the wetland areas. In addition to this, insufficient knowledge of local communities aggravates the existing problems as they are unaware of the problems of wetlands (Verma et al., 1998). Lack of cooperation also becomes a major obstacle in the sustainable development of wetlands. The climatic changes also affect the wetland ecology such as eventual drying up of smaller wetlands due to changes in climatic conditions. Apart from these, fluctuation of water in wetlands are responsible for releasing of GHG that further affects the wetlands and are blameworthy for the greenhouse effect.

1.6 Knowledge Gap: The existing literature reveals that earlier, in the 19th century, most people considered wetlands as disease-prone areas, despite the fact that most of the important civilizations such as Indus civilization had flourished around the wetland areas. There was a gradual metamorphosis in the perception and attitude of the people which led to the initiation for management and conservation of wetlands. The process of sustainable development of wetlands began after the Ramsar Convention in 1971. A number of research has already been carried out in the context of its physical and biological importance, but quite limited works has been ventured in terms of its socio-economic importance, especially in the context of Punjab. Therefore, in order to fulfil the existing knowledge gap, it becomes necessary to know

the socio-economic significance of wetlands and assess the negative impact of degradation of wetlands on local inhabitants. In addition to this, the study had also adopted an interdisciplinary approach by involving the geographical, social, and economic aspects in relation to wetlands and people and, it also aims to analyse the various conservation and management programmes adopted by the Non-Governmental Organisations (NGOs) and government for the sustainable development of wetlands.

1.7 Statement of Problem: As the knowledge gap reveals that major studies on wetlands have been done in the context of its biological, ecological, hydrological aspects. Because major research related to wetland areas have been done by the researchers belong to the fields of ecology, ornithology, and hydrology. Moreover, Ramsar convention also focused on the study related to the conservation of wetland areas to improve the habitats for migratory birds. It has been observed that an important section of wetland areas remain under research i.e. the valuation of services and functions provided by wetlands and what is the opinion of stakeholder who lives around the wetland areas. Even, the Ramsar Convention's focused on how wetlands are significant for people. The Ramsar Convention Secretariat released a report in 2018 entitled "'Global Wetland Outlook: State of the World's wetlands and their services to people" by focusing on the contribution of wetlands to achieving the Sustainable Development Goals (SDGs). Therefore, the present study would be concentrated on the economic evaluation of services and function provided by the wetland areas as well as people's perception about the wetlands. In this way, people's interaction can be understood and management plans can be achieved.

1.8 Research Questions:

1. What types of livelihood are provided by Harike, Ropar and Nangal wetlands of Punjab?
2. How are wetlands degraded by the users and what are the impacts of wetland degradation on local people living around it?

1.9 Objectives

1. To prepare map of spatial extent of Harike, Ropar and Nangal wetlands for year 2003 and 2017 and study the change.
2. To assess the socio-economic significance of Harike, Ropar and Nangal wetlands of Punjab.

3. To study and analyse the impact of human developmental activities on Harike, Ropar and Nangal wetlands.
4. To analyse management and conservation policies of state and central government and role of NGOs and the local community in wetland management activities.
5. To suggest recommendations for conservation and management of wetland

1.10 Chapter Organization:

- Chapter 1: Introduction
- Chapter 2: Review of Literature
- Chapter 3: Material, Method and Area of Study
- Chapter 4: Result & Discussion
- Chapter 5: Conclusion and Recommendation

Chapter 2: Review of Literature

Aptly regarded as the kidneys of the landscape and a biodiversity hotspot, 'Wetland' is one of the precious natural resources that exist on the earth surface. The flourishment of Indus civilization in ancient times effectively traces and highlights the value of wetlands. Tracing the lineage, almost all the towns and cities were established near or along the ponds, lakes, rivers, etc. In present times, there has been a gradual change in perception and attitude towards the way people view wetlands, in retrospect, people were unaware of the value of wetlands and perceived it as a breeding ground for mosquitoes for the elimination of which the Government of United States had provided financial funds under US swamp land Acts of 1855. The process of destruction of wetlands can be divided in three phases, i.e., due to colonial settlements (1600- 1800), agricultural developments (1800- 1900), and technical innovations and developments. In the first phase, permanent colonial American settlements can be held accountable for the destruction of wetlands. Secondly, agricultural developments such as the construction of dams, development of drainage systems, and governmental policies related to various developments in agriculture and irrigation schemes were mainly responsible for wetland losses (Dahl & Allord, 1982). Thirdly, authors have discussed the directly proportionate relationship between changes in culture and values with the decrease in numbers and areas of wetlands.

On the other hand, wetlands provide a variety of ecological, socio-economic, entertainment, cultural, religious and livelihood advantages and benefits. These services can be distinctly divided into several groups such as provisioning services like food, wood, flowers, etc., regulating services like supply of water, treatment of wastes, in addition to which it also provides various cultural and amenity services such as recreational, artistic, provision of historical information, etc. and services for essential life-support and livelihood such as provision of habitat for flora and fauna (Indian Space Research Organisation, 2011a). Some of the primary significance of wetlands are discussed below:

- Wetlands occupy an advantageous position if seen through a historical and religious point of view. For example, because of the existence of the Dong Han

Dynasty in 223 AD, Xixi Yangtz is considered a famous wetland delta in China. In addition to this, Tang dynasty also flourished alongside the Xixi Yangtz wetland in 618 AD. Due to the development of temples in the past, this wetland acquired a spiritual and religious significance (Verschuuren, 2014). Similarly, the historical significance of Ropar wetland is marked due to the signature of treaties between Maharana Ranjit Singh and Lord William Bentick as an indication of the political dynamics of Punjab. Damage of archaeological sites within and around wetlands and loss of organic artefacts are associated with the degradation of wetland areas (Nicholas, 1992). Wetlands in Punjab also have their own specific religious importance such as Kanjli wetland due to its association with Shri Guru Nanak Dev Ji. Apart from its religious significance, wetlands have greater economic significance as evident in the case of Naganon district of Assam where the livelihood of a bulk of people depend on wetlands for fishing, agriculture, sericulture, and for the rearing of ducks, goats, and cattle (Sarma & Saikia, 2010). Among other significations, wetlands are bestowed with higher importance in terms of tourism and provision for livelihood. In rural areas, it also serves as a ground for bathing of cattle in the summer season.

- Due to its capacity to store rainwater, it can be considered as a site for rainwater harvesting. The water that gets stored in wetlands is further used for the supply of water for various irrigational, industrial, and domestic use. For example, most of the water supplied in Mumbai are supplied through wetlands like Tansa lake, Tulsi lake, Vihar lake, etc. (Sinha, 2013). For irrigational purposes, wetlands play a primary role as the supplier of water such as, in the case of, Sirhind canal, Firozpur feeder, and Rajasthan feeder from the Ropar and Harike wetlands of Punjab. Wetlands also act as a water purification system. As most of the wetlands are found near the rivers or streams, they play a dual role in terms of mitigation of floods by diverting the extra flow of rivers into wetland areas and also maintains the flow of rivers by adding water to the river during dry seasons. (Tiwana et al., 2008). The role of wetlands shifts on the basis of its distribution and location, for example, in coastal regions, the mangroves creates a protective shield against the speedy waves of cyclones. Among various other

advantages, wetlands also act as a carbon sink where the dependency of absorption of carbon is directly related to the amount of vegetation in that particular wetland.

- Wetlands also serve as a habitat for different species and forms of biota, along with supporting various threatened and vulnerable species. Due to seasonal migration, wetlands have also attained the stature of international importance.

2.1 Services related to Wetlands: The functions attributed to wetlands can be divided into four main categories such as regulation activities which includes ecological processes for a supportive healthy environment, secondly, as a carrier of supporting activities that aim to provide a space for human settlement and for agricultural purposes, and thirdly in relation to its production functions including provision for food, water, raw materials like clay and wood, and lastly, its function as a provider of information through research, education, various aesthetic and spiritual values related to wetlands (Groot, 1992; Turner et al, 2000; Schuyt, 2005; Millennium Ecosystem Assessment, 2005). Wetlands play a vital role to shield against floods especially in upstream countries like the USA where construction of wetlands has reduced the damage of about $17 million each year, along with the mainstream of River Charles. For mapping of coastal wetlands, Sundarban delta uses ERS-1 SAR black and white data images of 1992 and 1993 that is able to penetrate cloud covers, conversely, IRS-1B LISS data is also used for evaluation of ERS-1 SAR data. (Dwivedi et al, 1999). Coastal wetlands help in the maintenance of the world's freshwater storage by preventing the intrusion of saline water into fresh water (Stuip et al., 2002). The management policies and the feasibility of such policies in real life was the main area of focus of the study undertaken by Cools et al. (2013). Due to inadequate measurement of the services and products catered by the wetlands, insufficient knowledge, and high complexity of the wetland ecosystem, ramifies to mismanagement of wetlands particularly under the river basin management plan. To burden on it, the outcome of the research project is not appropriately implemented by the policymakers. According to a study, analytical analysis is necessary for a proper management plan, which can be divided into quantitative analysis (involves models, statistics, etc.), qualitative analysis (mainly involves local stakeholder and is focused on the depth

knowledge of every aspect) and lastly to study the role of external variables (such as population, climate change etc.). The authors of the above study focused on issues such as to investigate the primary issue responsible for the constant decrease of areas under wetland covers, irrespective of its ecological significance, and analysis of the social gaps that exists between the local communities and the governmental policies as one of the main factors for the degradation of wetland ecosystem (Gopal, 1982; Gopal, 1991). Therefore, there is an urgent need to make people aware of the importance of wetlands and instil such ideas among other basic ideas that are cultivated since birth, the conservation and management of which is essentially necessary for us. The resulting monetary outputs from wetlands, in turn, contributes to its management by the action of benefits (Franco & Luiselli, 2014).

2.1.1 Socio-economic significance: **Stuip et al. (2002)** take into account case studies of different wetland ecosystems of developing countries to analyze their contribution in terms of socio-economic benefits, which can be divided into use value and non-use value (Ramachandra et al., 2005; Ramachandra et al., 2011). On the basis of their functions and benefits, use value can be divided into direct use values such as food, transportation, agriculture, and non-direct use value like protecting from floods, groundwater recharging. Protection of biodiversity, ecological maintenance, cultural and heritage are described under the non-use value of wetlands. Values of wetlands differ from stakeholders to stakeholders, for instance, if one stakeholder perceives it as a form of developmental process, the other might perceive it as a form of livelihood providing food and environmental security. Debroy & Jauaraman (2012) focused mainly on the role of Pichavaram mangroves on the livelihood of fisher-folk in Tamil Nadu. In terms of economic return, mangroves including its product and services were estimated to be 2, 00,000 $ to 9, 00,000 $ per ha/year. But sadly, different anthropogenic activities in coastal areas affect fisher-folk by damaging the coral reefs, mangroves, wetlands, swamps, etc. In order to study the economic capability of wetland areas, it is utterly vital to estimate the importance and value of wetland areas and its contribution to humankind. The economic valuation of wetlands is controlled by several factors such as its location, size, types, and biophysical properties such as recharge of groundwater and treatment of water. A close relationship exists between wetlands, their ecosystem

services and the prospective economic valuation of ecosystem services (Whiteoak & Binney, 2012). Verschuren (2014) has revealed the social implication of wetlands in the context of their religious and spiritual importance. For example, In the religious context, Manasarovar Lake in Himalayan region of Tibetan Autonomous province is being worshipped by the people of India, Nepal, and Tibet as it is believed that bathing and drinking of its water cleanses and relieves a person from all his sins.

Lambert (2003) stated that the valuation of natural products is necessary for the management and conservation of wetlands. Nonga et al. (2010) stated that the study of the surrounding environment, land use practices of peoples and a possible threat to wetlands are equally necessary to know the socio-economic importance of wetlands. People that live around the wetland areas are dependent mainly on agriculture activities for the sustenance of their livelihood. Due to its scenic beauty, the spiritual and religious significance of wetlands attracts a number of tourists, tourist camps and hotel companies which open a range of employment opportunities for local inhabitants. In addition to this, wetlands are used for a number of other purposes such as grazing of animals, water supplies for drinking and domestic use, medicinal use, wildlife purpose, fire woods etc. But wetland areas are negatively affected due to overexploitation of wetland areas by dumping waste materials, overuse of water for irrigation purposes and rapid construction of settlements. Demnati et al. (2012) stated that three activities like agricultural production, livestock and salt pan production are highly dependent economically on wetlands in the arid region. About 80 percent of the population in the arid region is economically dependent on agricultural production, such as feeding of livestock and for the purpose of grazing, except in dry seasons. During the dry months, salt pan production is the main source of income in arid areas whose economic contribution is higher than both agriculture and livestock production. Authors have stated that up to 2003, governmental agencies had a monopoly over salt pans in Chott Merouane of Algeria. But in present times, its involvement has declined to 25 percent and the remaining 75 percent are held by private companies that overuse and exploit these salt pans and are responsible for the degradation of wetland areas.

According to Lamsal et al. (2015a), the rural communities are more dependent on wetlands for various purposes as compared to urban residents, as the poor

communities in developing world are more reliant on wetlands for their livelihood as compared to the communities of the developed world. The biological and environmental ecosystems are very essential in the case of sustainable livelihood as these ecosystems affect the numbers, species, and quality of flora and fauna. But on the other hand, higher growth of population and its allied activities affects the productivity of wetlands. Authors also specified that higher priority to food security and reduction of poverty also affects the conservation and management of wetlands, because people fail to understand its value; which alarms for a need for greater participation of local communities rather than higher authorities, as the former understand the situation much better than the latter. Odine et al. (2011) have analyzed that wetlands are a warehouse of a number of products like medicinal plants, handcrafted materials, provision for water and food, etc. People residing in the surrounding as well as in the faraway areas are dependent over wetlands for their day to day requirements and needs, but are exploited by local people due to lack of sufficient knowledge, mismanagement, and poor planning by the government. Farber et al. (2002) stressed the meaning of valuation as simply an expression of an object or for a particular action. They elaborated the meaning of valuation and categorized into two: intrinsic and instrumental value. The intrinsic values are defined as those in which the valuation of any object can be decided according to its level to integrate with the ecosystem rather than solely for human satisfaction. On the other hand, instrumental value mainly deals and gives its preference to the satisfaction of human beings, and is anthropocentric in nature. The increasing difference between the utility and return of products in the natural ecosystem is becoming the main source of conflict. There are different benefits that are derived from the products and services provided by wetlands in terms of its valuation such as travel cost, replacement cost, factor income, avoided cost etc. Bockstael et al. (1995) & Brander et al. (2013) also shed light on the economic valuation of ecosystem products and services which are necessary for the stability or sustainable use of natural products. Carlsson et al. (2003) focused mainly on the designing of wetlands area that affects the provision of services and the number of benefits that are derived from them. For instance, the design of pavements and walking tracks, plantation of trees and level and depth of water affects the frequency of visitation of

both birds and people. The primary concern of the authors lies in the reduction of the amount of nitrogen in the wetland areas in a sustainable and cost-effective way. In this article, authors have observed that the valuation of products not only depended on the magnitudes but also on the fragility of the products.

2.2 Threats to wetlands: Destruction of wetlands in India puts a negative impact on the livelihood of 74 percent human populations in rural areas who are directly or indirectly dependent on wetlands for food, irrigation, drinking water, transportation, etc. Ladhar (2002) revealed that residents of wetlands are worried about shrinking of wetlands which will pose a great threat to their livelihood dependence on fish farming and wetland crops such as Nelumbium and Trapa. It affects the ecological system of wetlands with the continued cultivation of mono-crops. Sustenance of livelihood is responsible for the conversion of wetlands into dry lands as people are unaware of wetland crops and its economic importance. Present day practice of using modern techniques of agriculture can also be held accountable for the disappearance of wetlands due to lack of passage of water to the wetlands. Ramachandra (2001) & Ramachandra et al. (2015) stated that about half of wetlands in Bangalore city of Karnataka state has been lost due to unplanned urbanization, coupled with the spatial expansion of cities at the cost of wetland areas. Several factors like population explosion, industrial activities have negatively affected the environment of wetlands due to increasing pollution from both point and non-point sources. Rana et al. (2009) focus on how the growth of population and its developmental activities are responsible for the relative decline in the numbers of trees and shrubs in wetland areas of the tropical region in Bangladesh, leading to loss of animal habitat and extinction of species and number of animals. Thus, the ecological and biological characteristics are interlinked with the socio-economic functions of the wetland. Out of the several economic profits and benefits provided by wetlands, sand mining and woods plucking are one of the many which act as a source of income for the local communities. Tulu & Desta (2015) laid emphasis on the negative impact of human activities on wetlands. The authors in the article, explains how the nature of human exploitation has changed from the subsistence to commercial. The government policies associated with the development of industrial and agriculture are mainly responsible for the degradation or

loss of wetland areas, for instance, conversion of wetland water into canal for irrigation purposes. For the conservation and management of wetlands, the focus has to be laid on ‘down to top’ policies, which demands an initiation of local level planning at the basic step. Antos et al. (2007) shed light on the negative impact of urban expansion over the wetland areas which leads to degradation or encroachment of wetlands in three ways; encroachment for urban expansion increased flow activities and increased numbers of human activities such as recreation, infrastructure building etc. In urban spaces, many visit the wetland areas for recreation, pure entertainment purpose, relaxation or to relink with nature, the ramifications of which can be both positive and negative. The negative form of recreational activities has been responsible for habitat loss, and in a positive way, can raise the level of awareness and values of wetlands. Faulkner (2004) mainly focusses on urban expansion and the status of forest wetlands in U.S.A in which he notices a gap between the population growth and land development has been widening greatly with an increase in the level and progress of urbanization. Major researches in India has been on the ecological and limnological aspects of wetlands and have marginally focused on the socio-economic implications of wetlands that affect the management strategies related to wetlands in India.

The area under wetlands is decreasing day by day due to the continuous expansion of urban areas both within and in the surrounding areas. Similarly, infrastructure developmental activities such as encroachment of the wetlands areas for the construction of a multi-storey complex have been accountable for the disappearance of Ambuja wetland in West Bengal (Mukherji & Nayak, 2015).

2.2.1 Decreasing Area: According to Prasad, 16 percent of people in India are dependent on wetlands that cover only 2.42 percent area vide the total area in India. Prasad et al. (2002) divided the loss of wetlands areas based on their intensity into acute loss and chronic loss. In acute loss wetlands, areas are filled up with soil and chronic areas are characterized by gradual removal of forest areas due to soil erosion and sedimentation of wetlands. The amount of open water drastically decreases in wetlands from the post-monsoon period to the pre-monsoon period. In the case of a river, the amount of open water in a reservoir decreases at a higher rate in comparison to Ox-bow Lake, sandy and marshy lakes (Indian Space Research Organisation,

2011a). Remote sensing plays a significant role in the monitoring of wetlands in terms of their land use pattern, drainage, and physiography (Verma et al., 1998; Kumar & Pandey, 2003). By using remote sensing data, several scholars have studied the land use, land cover and area under wetlands in different periods of time. Kotoky et al. (2012) makes a land use/ land cover study of Dhansiri river channel with the help of remote sensing data and topographical sheets, the result of which shows the decline of forest and crops from 1975 to 2008 and areas under settlements have increased from 1975 to 2008 due to urbanization and the explosive growth of population. Prabaharan et al. (2010) with the help of remote sensing data analyses land use and land cover changes in the coastal areas of Tamil Nadu, in which he used toposheets as a base layer and made a land use map with the help of IRS and Landsat data. Results have found that severe form of urbanization and population explosion have led to a decrease in the areas under grass and shrubs from 1998 to 2008. In the same line, a study undertaken by Verma et al. (1998) shows that the Ropar wetland of Punjab is highly affected by human interference due to the high fertility of the soil that is used for paddy cultivation. Thermal changes in the temperature of the water are also responsible for rampant water pollution in Ropar wetlands as hot waters from Ropar thermal plant is discharged into the Lake for coolant process. On the basis of its physiographic characteristic, wetlands are mostly found in depression places which leads to, in many developing countries, the use wetland as a dumping ground for both solid and liquid wastes (Zedler & Kercher, 2005). The fish scale can be used for mapping of pollution in wetlands with respect to fish fauna. Buda Nallah and Kala Sanghain are sources of polluted water in Harike wetland that affect both the quantity and quality of water resources (Brraich & Jangu, 2013).

2.2.2 Impact on Bio-diversity: Wetlands being a habitation place for different forms of biota, the decrease in the quality and quantity of wetlands equally affects the biodiversity. Habitat plays an important role in terms of breeding and in the maintenance of biodiversity, but several anthropogenic activities such as deforestation, urbanization, mining, and firing of grass for agriculture space destroy the habitat at the Kallar Kahar Lake in Punjab. Destruction of habitats impacts the biodiversity both in terms of breeding and in their numbers (Rias et al., 2010).

2.2.3 Degradation by Human Activities: Various studies that were conducted to analyze the impact of wetlands on its surrounding areas particularly focussing on drainage, have reached multiple conclusions. A study taken up by Zedler & Kercher (2005) concluded that the construction of drainage for irrigational purposes is responsible for the disappearance of wetlands on a global scale as well as at national, regional and local level. Similarly, Stuip et al. (2002) revealed that uses of wetlands for water supply for irrigational purposes are responsible for the degradation of 56-65 percent of wetlands in Europe, 27 percent in Asia and 6 percent in North America till 1985. In developing countries, several factors like deforestation, storage of water in dams, and displacement of people ramify into the loss of areas and functions which further affects the wetland ecosystem (Galbraith et al., 2005). Frequent use of fertile floodplains for agricultural purposes eventually leads to dire loss of wetlands. Similarly, the invention of recent technology for digging of canals and construction of the walls around major rivers are also responsible for the degradation of wetlands; for example, the conversion of Dutch peat land into agricultural fields in the 11th century was marked by dikes on its boundaries (Frequent use of highly fertile floodplains for agricultural purposes eventually leads to loss of wetlands. In the same way, the invention of technology for the digging of canals and construction of the walls around major rivers are also responsible for the degradation of wetlands (Verhoeven & Setter, 2010). According to Ellis et al. (2000), wetlands are mainly known as wildlife habitats and, for conservation and preservation of archaeological remains, is presently under serious threat due to the construction of artificial drainage system from wetlands. The insufficiency in policies related to wetlands leads to further degradation and depletion of wetlands in India. Under the rules for wetland conservation and management, 2010, wetlands with areas more than 500 hectares and below 2500 meters are selected for conservation and protection of wetlands; smaller wetlands with areas less than 500 hectares are excluded which leads to loss of a huge number of natural wetlands in the last decade, due to conversion of these wetlands into sites of dumping of wastages. Another systematic lack points to a concentrated focus on the wetland's conservation and management rules on the protection of habitats of birds, prevention of pollution, and industrial set ups in the wetland territories. According to the studies on the water

crisis in wetland areas, the main source of water feeding in wetlands is due to the construction of dams over the rivers (Dandekar & Thakkar, 2011). A study taken up by Mironga (2005) to analyze the effects of farming practices on wetlands of Kisii district in Kenya, highlighted the lack of awareness among the farmers regarding the various negative impacts of farming practices in wetlands, due to their sole intention and interest to cultivate economic benefits out of wetlands. Ehrenfeld (2000) has evaluated the impact of urban growth on the size and number of wetlands, both within as well as in the surrounding areas. The nature of urban wetlands is different as compared to the non-urban wetlands in terms of its hydrology, habitat patches, species, and geomorphology. In urban areas, wetlands are used for several activities that not only puts an impact on its size and quantity, but also on the activities of the species associated with it, for instance, the quantity of water in a wetland would affect its species habitation and growth as habitat plays an important role in the evolution and the growth of several species. The gaps between the urban, suburban and rural wetlands have decreased due to several developmental activities.

2.3 Impacts of wetland: Wetlands play a vital role in restoration and as regulatory factor for the ecosystem. But, it impacts on human and biology of surroundings cannot be ignored. Rey et al. (2011) elaborated the condition of Florida's environment where high mosquito populations have always been a part. The stable water areas are favourable for reproduction of mosquitos (Clements, 1992). Mosquito-transmitted diseases have played a major role in human history. The impact of high saltmarsh mosquito numbers on the health of locals and visitors cannot be ignored. In case of Florida, Coastal wetland management had done many efforts from 1920s for mosquito control in terms of dredging ditching and filling, and impounding without effecting the environment. By keeping in mind, the importance of wetlands as habitat of aquatic life, high use of pesticides use to control mosquito have been minimized. Even in early 1980s, the planning of wetland area in Florida goes side by side with mosquito control practices. In this way, it is important to make efforts to keep in mind local public health issues along with importance of wetlands so that management practices can be implemented to reduce the problems created by wetland areas. Wetlands are habitats of many types of flora and fauna. The water characteristics of wetlands determine the

types of species within it. There are many species which are found in wetlands water and may be different from local biology. A salt marshy areas adjacent to Mar Menor saline lagoon have many different species due to is hydrology. Rogel et. al. (2007), studied the soil salinity and characteristics of ground water from 1991 to 2004 by evaluation the values of nitrogen, organic carbon, phosphorus, ammonium and nitrates. The results of these values show that the due to increased flooding, the soil salinity has dropped during the study period. The soil characteristics have changed due to flooding by wetland/lagoon areas and with those environmental changes, *Phragmites australis Sarcocornia fruticosa,* and *Juncus maritimus* species have expanded in local areas of wetlands. This pattern of vegetation was completely different from the previous zonation of vegetation. The moisture and salinity in soil has increased due to wetland so the cover of *Limonium delicatulum* has decreased. Abundant vegetation cover adjacent to wetland led to deposition of organic debris due to colonization of this habitat by perennial species.

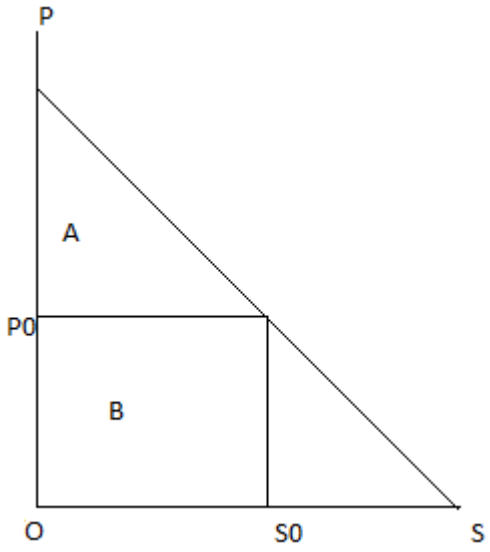
Except the changing pattern of biodiversity of the surroundings, wetlands also become the cause of intense flooding. Increased flood risks of surrounding areas promote human migration because flooding risks are associated with the location of wetlands nearby coastal areas. Increase in water level in deltaic landscape causes submergence of coastal areas. Twilley et al. (2016) identified the various causes of flooding in coastal areas and sinking of river deltas beneath seas-level is significant threat for social systems and natural landscapes. This type of sinking of river deltas and flooding in coastal wetlands is the combined effect of anthropogenic activities and changes in sediments supply to those areas. The study on Mississippi River Deltaic Plain (MRDP) provides various examples of the functions and feedbacks regarding river management and its impacts on human. Changes in salt marsh vegetation patterns along with reduced sediment input and increase in salinity also coincide with an increase in wind fetch in Terrebonne Bay. The authors argued that the balance of water relative to land of this delta provides much clearer understanding of increased flood risk from tropical cyclones rather than just estimates of areal land loss. These type of activities affect human settlements shifting also.

2.4 Modes of wetland conservation: The conservation of wetlands initially began in 1934, with the issuance of duck stamps by the United States of America. With the sale of these duck stamps, the Government of U.S. A. successfully purchased 2.1 million hectares of land solely for the purpose of wetlands (Mitsch & Gosselink, 1986). This effort for the conservation and management of wetlands spread across the globe and stimulated many countries to take a step towards its conservation. The initiation was taken up on 2nd February 1971, with a convention of wetland signed in Ramsar which came to be known as the Ramsar Convention of Wetlands. It is an intergovernmental treaty that provides a framework or platform for the conservation and management of wetlands with progressive national action and international cooperation. Unlike the earliest policymakers who solely focus on the aspect of drainage of wetland areas, the concept and nature of conservation and management of wetlands changed with time. The earliest attempt of the government for its conservation encouraged the conversion of wetland areas for agricultural purposes (Larson & Kusler, 1979). The slow metamorphosis was marked with the gradual shift in focus from the drainage of wetland areas to making a habitat for wildlife hunters in the first half of the twentieth century. In the present times, the theme and mode of conservation have shifted to the protection of wildlife and conservation of wetlands from various anthropogenic activities like intensive land use changes, pollution, infrastructural development, and hydrological alteration. Precise attention and focus towards the identification and ecological conservation of wetland areas were started almost after the second half of the twentieth century. Before this, wetland areas were treated as transitional habitats or areas of different stages from terrestrial to aquatic land (Mitsch & Gosselink, 1986; Pattern et al., 1990). The Ramsar Convention initiated the orientation towards the making of a wetland inventory. The first inventory of Indian wetlands was published in 1990 by the Ministry of Environment and Forests. An inventory of wetlands is essential for the evaluation of various wetland resources, their functions, values, diversity as well as the variations and the qualitative and quantitative influence of human activities over the wetland areas. Various institutions establish control over wetlands as wetlands functions as a warehouse for different kinds of goods and services which accounts for a clear demarcation for each product and services provided. Therefore, lack of

coordination between these departments will hinder in the management of wetlands, likewise, developmental plans of one institution may affect the management of other institutions; for instance, the plan for reclamation of land for agricultural purposes taken by the agricultural department may affect the management plans of the fishery department. In addition to this, there is a necessity for the maintenance of historical records in order to document the number of resources that are provided by wetlands. These historical records are then used by various departments for the proper management of wetland resources (Torell et al., 2001). These historical records are then used by various departments for the proper management of wetland resources (Torell et al., 2001). The shifting of priorities are greater culprits responsible for the degradation of wetlands, for instance, concentrating solely on the benefits of industrial development would influence both the ecological structure as well as a local dependency of people. In order to overcome such problem, authors have introduced a group model building that comprised of local participants. In this model, only technical support is provided to each local participant for the accurate collection of data. The GMB is helpful for the success of any policy at a local level with complete awareness and knowledge about that particular problem. Systematic Dynamic is another system that deals in line with the management policies and which works in several steps according to its required needs (Chen et al., 2014). Rajasekar et al. (2007) analyse the management and measures taken for conservation of Keshopur wetland in Gurdaspur which was started by the forest department in 1998, 2003 and 2005 but failed due to political causes. Therefore, in 2006, wildlife division was created which focused on the bottom-up approach with the active participation of the local participants that led to the development of the Keshopur Chhamb Community Reserve in 2007. The main objective was aimed at the conservation and management of vulnerable ecosystem of wetlands. The Keshopur Chhamb Community Reserve was divided into five zones and each zone was controlled by the Panchayat. But this programme was not successfully executed due to lack of infrastructure facilities, communication barriers, financial problems etc. Therefore, the economic valuation of wetlands became necessary as self-generating of funds from wetlands served better from the management and conservation point of view. Rahman & Begum (2011) focused on the management of

wetlands through diversification of people dependency by generating new employment opportunities in the area. Therefore, the Government of Bangladesh initiated a community-based project MACH (Management of Aquatic Ecosystem through Community Husbandry) for management and conservation of wetlands under the diversification of livelihood opportunities. Poultry farming, fish nursery, livestock rearing are the example of some livelihood opportunities that lower the dependency level of people over the wetland areas. Ganjali et al. (2014) shed light on the values of the culture that play an important role in the development of any nation, in which the authors focused on the promotion of ecotourism mainly in the context of conservation and management of wetlands. In the view of which, the authors emphasized the study of strengths and weaknesses of wetland areas which are necessary for effective development and promotion of tourism. The development of tourism offers both opportunities as well as threats to the culture, beliefs and natural environment. Howarth & Farber (2002) emphasized on the economic values of the products and services provided by the ecosystem, such as market values, which are not covered under the institutional arrangement. The valuation of ecosystem products and services are essential for the successful execution of various management and conservational policies, which in turn develops a spirit of sustainable use and consumption of natural products.

Figure 2.1: Heuristic Model of Economic Valuation



In this figure, S shows the numbers of products provided by wetlands and P shows the price. The P_0 and S_0 show the level of human satisfied at P_0 price human beings are ready to purchase S_0 goods.

Hettiarachchi et al. (2014) focus on the significance of Ramsar institution that took an initiative for the management and conservation of wetlands at a global level. The idea of the whole article revolves around the sustainable use of urban wetlands; which becomes evident in 2012 when the Ramsar Convention exclusively focussed on the conservation and management of urban wetlands under resolution XI. Authors revealed three major drawbacks that affect the management and conservation policies such as the complex relationship between society and ecological process, political pressure and absence of environmental justice especially in the case of urban areas. The study taken up by Reed et al. (2014) focused on the issue of process and structure of management action plans which rendered sole collection of knowledge as futile, and demanded greater exchange of knowledge between both the consumer group that involves those who use these services such as the local communities and the policymakers who developed these management plans. The knowledge exchange process is also beneficial for the making of an interview schedule, as the number of experts and the practical knowledge about a specific object is helpful will help in refining a definitive question. In addition to this, knowledge exchange is also helpful in minimizing research expenditure. Management and Conservational policies related to wetlands are controlled by the Ministry of Forest, Environment and Climate Change (MoEF & CC). In addition to this, management strategies in India were adopted mainly after 1990, with the establishment of the National Wetland Conservation Programme (NWCP) in 1985. In 2006, the National Environment Policy was adopted by the Government of India that also discusses the lack of a formal system for the management of wetlands in India (Bassi et al., 2014).

2.5 Policy Framework of Indian Wetlands conservation: The research related to the making of wetland inventory started in 1960 by the Government of India. Post-independence, there was an initiation for the conservation and protection of wildlife, forest, estuaries, mangroves and other wilderness that came under the Indian Board for Wildlife, chaired by the Prime Minister of India. A Tiwari Committee was established

in 1980 for the protection of the environment and on the recommendation of the committee, the Department of Environment was established by the Government of India in November 1980. The Department of Environment had set up a wetland research group in the year 1980 which was chaired by Prof. C. K. Varshney and identified about 1193 wetlands that covered about 39, 04543 hectare areas. Out of this, only limited wetland sites such as Keoladeo Ghana National Park, Point Cali mere, Chilika Lake and Sundarbans delta are covered for the conservation and management purposes (Scott, 1989). In the year, 1985, Department of Environment was replaced with the Ministry of Environment and Forest that worked for the planning, promotion, and coordination between the department for management and conservation of protected areas.

According to WWF, 'the *first step of any conservation programmes is to understand what exists'*. The first step towards the compilation of information about the wetland areas was initiated by the International Union for Conservation of Nature and Natural Resources (IUCN), International Waterfowl and Wetland Research Bureau (IWRB) in 1985 with the financial support of World Wide Fund for Nature (WWF). After this, a directory related to wetlands of India was prepared by the Ministry of Environment and Forests in 1990 based on a survey carried out in 1972 (Ministry of Environment and Forests (MoEF), 1990). The directory recorded 67420 wetlands in India that covered about 40, 40,087 hectare areas. Out of these, 14, 50,861 hectares lies under the 2167 natural wetlands and 25, 89.266 hectare areas under 65,253 man-made wetlands (Ministry of Environment and Forests (MoEF), 1990; World Wild Fund for Nature, 1993). But, this served as an incomplete directory of wetlands, as it excluded many inland and coastal wetlands due to lack of data. In a year, 1993, the Directory of Indian Wetlands was reproduced by the WWF and Asian Wetland Bureau (AWB), in which new information related to wetland areas were added which previously didn't exist in the Asian Wetland Directory. The limitation of such a directory was the inclusion of several wetlands with insufficient information in the Directory of Indian Wetlands. Besides this, it gives much preference to fauna and flora or waterfowl in the selection of wetlands. For detailed knowledge of Indian wetland areas, remote sensing data of LISS I/II data of the year 1992/1993 had been used for the first time by Space Application Centre

(SAC), Ahmedabad in 1992. The information about several wetland areas was added in the inventory which was located in inaccessible and remote areas, which didn't give much space for field visits. The mapping of wetland areas had been mostly done on 1:250000 scale under the Nation-wide Wetland Mapping Project. Although, for some states like Punjab, Haryana, Himachal Pradesh, Sikkim, Tripura, Manipur, Nagaland, Assam, Arunachal Pradesh, Meghalaya, Goa, West Bengal mapping has been done on 1:50000 scale (Garg et al., 1998). The major shortcoming in this inventory is that it includes all the water bodies and water masses in the wetland category and makes a complete exclusion of rivers (Garg et al., 1998). In order to increase the accuracy of wetland inventory, a second scientific inventory of wetlands has been done by SAC in 2007 under the project of National Wetland Inventory and Assessment (NWIA) sponsored by the Ministry of Environment, Forest and Climate Change (Panigrahy et al., 2011).

2.5.1 Nodal agencies that deal with the management and conservation of wetland;

2.5.1.1 Ramsar Convention, 1971: The Ramsar Convention is an international treaty, which provides a framework for national action and international cooperation for the conservation and sustainable use of wetlands and its resources. The history of Ramsar convention can be traced back to 1960 when several countries and non-governmental organizations were worried about the degradation and loss of wetlands habitats and its consequent effects on migratory birds. The Ramsar Convention was signed in 1971 at the Iranian city of Ramsar and it came into force in 1975 (Ramsar, 1971). Its primary focus, in its initial phases, was on the conservation and protection of the habitat of birds and it later shifted to provide various benefits of wetlands to the lower sections of the society in line with sustainable development (International Water Management Institute, 2014). In 1982, the Government of India signed the Ramsar Convention on wetlands for the conservation of wetlands and biodiversity, at the global level and presently, 26 wetlands sites in India has been selected for Ramsar wetlands (Ramsar Convention Secretariat, 2010).

2.5.1.2 The Ministry of Environment, Forest and Climate Change (MoEF& CC): It is a nodal agency in the administrative structure of the Central Government, dedicated for effective planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. The main objectives of the MoEF & CC are conservation and survey of biodiversity and wildlife, prevention and control of water, soil and other pollutions, afforestation, protection of the environment and to ensure the welfare of animals. The ministry is responsible to formulate plans and various regulating strategies for the protection of wetlands in India. The degradation of wetlands which forms a major part of water resources has become the thrust interest of the ministry. Ministry has coalitions with the Central Pollution Control Board (CPCB), river management authorities and research institutions as well as universities to regulate water pollution (Ministry of Environment and Forests (MoEF), 2007).

- **Central Wetland Regulatory Authority (CWRA),** is an authoritative body of the Ministry of Environment and Forests. The main aim of this body is to look into the issues of wetlands and promote wetland protection, conservation, management, policies etc.

2.5.2 Wetland Management and Conservation in India: There has been no specific rule and policy as such for the conservation and management of wetlands. The Ministry of Environment, Forest and Climate Change sees to the proper management and conservation of wetlands in the country, which can be accounted for a major influence of a number of legalization acts like Indian Fishery Act 1857, Indian Forest Act 1927, Forest (Conservation) Act 1980, Water Act 1974, Wildlife Act 1972, Environmental Protection Act 1986, Air (Prevention and Control of Pollution) Act 1974, Coastal Regulation Act 1991, on the wetlands in India (Bassi et al., 2014; Ministry of Environment and Forests (MoEF), 2009). Besides this, the management and conservation of wetland areas are supported by several other policies like the National Forest Policy 1988, National Conservation Strategy and Policy Statement on Environment and Development 1992, National Environment Policy 2006 and National Biodiversity Action Plan 2008 (Ministry of Environment and Forests (MoEF), 2013). The

present study mainly concentrates on those policies/plans which were established or implemented after the foundation of the Ramsar Convention in 1971.

2.5.2.1 Wildlife Protection Act, 1972: This act is indirectly linked with the protection of flora and fauna (of wetlands), as it includes the Biodiversity Hotspots and National Parks and Wildlife Sanctuaries. This act was implemented with a major objective of protecting the wildlife of the country from smuggling, poaching and illegal trade (Ministry of Environment, Forest and Climate Change (MoEF & CC), 2016a). The management of wetland areas and marshes areas are covered under Act 44 of 1991. The Act was amended in 2002 and later re-amended in 2006 with some additions of other acts related to tiger conservation act etc. and a special steering committee was established. National Wildlife Action Plan was formulated in the year 1982 in the meeting of the Indian Board of Wildlife and was adopted in 1983. The conservation of biodiversity was its primary focus. Similarly, the year 1988 witnessed the formulation of the National Forest Policy to stress on conservation (Department of Environment, Forests and Wildlife, 1988). In the preferment of Wildlife Plans, in February 2016, presented a draft of the National Wildlife Action Plan (2002-2016) in the form of a new draft of the National Wildlife Action Plan (2017-2031) that had been formulated to ensure a systematic forward planning of the wildlife and forest resources (Ministry of Environment, Forest and Climate Change (MoEF & CC), 2016b). Section IV of the draft, fully concentrates on the wetlands, primarily dealing with its importance, problems, issues, and conservation of the wetlands of the nation. By highlighting the biological, ecological and economic significance of the wetlands, the draft speaks to adopt certain management plans like the climate change adaptation and disaster risk reduction. In addition to which, it suggests to engage some management authorities or training institutions to overcome the exceeding concern of wetlands.

The government ensures the conservation of the wetlands under the Wildlife Protection Act but fails to understand the real issue of lack of proper functioning at the ground level. It focuses on the protection of flora and fauna by labelling those areas as ‘protected’. The conservation of the wetland areas is solely under the Wildlife Act, but only if it supports the endangered species of flora and fauna and the habitats of endangered wildlife (Panini, 1998).

2.5.2.2 Environmental Protection Act (EPA), 1986: The first draft of this act was conceived after the participation of India in the United Nations Conference on Human Environment in Stockholm in 1972. The main objective behind the introduction of the Environmental Protection Act was to control the rapid decline of the environmental quality due to an increase in the amount of pollution, exceeding the number of chemicals in the food chain and thus, aggravating the risk of environmental threats at national as well as at the global level. Therefore, EPA deals with the protection and improvement of the environment by setting relative parameters in order to counter the effects of pollution (Ministry of Environment, Forest and Climate Change (MoEF & CC), 2016c). The various aspects of the Environmental Protection Act are defined as follows;

a) “environment” which includes water, air and land and the inter-relationships and interactions that exist among them, with humankind, other living creatures, plants, micro-organisms, and property;
b) “environmental pollutants” comprise of different solid, liquid or gaseous substances that are present in impermissible amounts which tends to be injurious to the natural environment;
c) “environmental pollution” which indicates the presence of environmental pollutants in the immediate environment;
d) “handling”, in relation to any substance, its mode of manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer, etc.;
e) “hazardous substances” are inclusive of any substance or preparation of which, owing to its chemical or physio-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plants, micro-organisms, property or the environment;
f) “Prescribed” refers to the prescription of rules under this act (MoEF).

Encompassing a range of pollution issues of land, water, and air, this act came into effect from 19th November 1986. As wetlands can be subcategorized under water pollution so it aims towards the protection of water from wetlands. This act is responsible for the formulation of rules so as to prevent environmental pollution and to ensure proper coordination among the state and central governmental bodies for

achieving its necessary target. The EPA standardizes the limit for the presence of any substance in air, land, and water. Violation of the standardization rules by any person, public or private firms will be strictly penalized, the management of the act is taken care by the Ministry of Environment and Forests (MoEF) which has also set up a National Committee on wetlands, mangroves and coral reefs that are further subdivided into Wetlands/ Lakes Committee, and Mangroves and Coral Reefs Committee.

2.5.2.3 National Wetland Conservation Programme (1985-86): It is the first conservational programme that is directly linked with the conservation and management of wetland areas. The status of conservation and management of wetland areas has been accessed from the coverage of wetland numbers and areas under the NWCP. In its initial stages, only 23 wetland sites were covered under the NWCP, of the Ministry of Environment and Forests, with not much change in the numbers up to the year 2003. The NWCP shows a remarkable expansion from the year 2003 to 2006 with the numbers of wetland sites increasing from 27 in 2003 to 94 in 2006 (Ministry of Environment and Forests (MoEF), 2007), with further revision of the programme on 12th June 2009. The coverage areas and numbers of wetlands had increased from 94 in 2006 to 115 in 2009 that required serious conservation and management actions (Ministry of Environment and Forests (MoEF), 2009) in about twenty-four states and two Union Territories of India. In the case of Punjab, three Ramsar wetland sites, i.e. Harike, Ropar and Kanjli, and two national wetlands, i.e. Nangal and Ranjit Sagar have been selected for the conservation and management purposes. Out of which, four wetland sites namely Harike, Ropar, Kanjli and Nangal are managed and conserved by the Punjab State Council for Science and Technology (PSCST) and the conservation and management scheme of Ranjit Sagar wetland is taken by Ranjit Sagar Dam Design Organization under the department of irrigation (Punjab State Council for Science and Technology, 2010, 2011).

The enlisted objectives of this programme are protected and prevent further degradation of wetlands from a number of activities like encroachment, siltation, catchment erosion, weed infestation and agricultural wastage that are discharged into the wetland areas (Garg, 2015). The primary aim of this programme includes the formulation of policies for the conservation and management of wetland areas, to select

the wetland areas according to their priority of conservation, to monitor the programme and formulation of wetland inventory. NWCP is coordinated both by the central and the state governments whose principal role is to issue guidelines, provide financial aids, and evaluate the entire project or wetland sites covered under this programme. Complete financial assistance is provided by the Government of India for the Management Action Plan (MAP) and research projects, which ranges for 3-5 years and is submitted by the state government to the central government. Small and medium-sized wetland areas with areas less than 100 hectares are not covered under the NWCP. Similarly, small and medium-sized wetlands are excluded from the list and description of the MAP and are financially deprived as governmental funds are based on the area and size of wetland (Ministry of Environment and Forests (MoEF), 2009). The list and description of MAP for wetlands is not available on the site of NWCP, in addition to which, financial support is given only for certain activities like survey and mapping, fencing of catchment areas, plantation, treatment of catchment areas, controlling of weed intensification, pollution control, livelihood support, infrastructure development, and awareness etc. The release and funding of financial sources are quite complicated as wetlands are protected areas which are managed by other departments. The main function of the central government lies in the provision of financial assistance and evaluation of various conservational and management action plans whereas, the state/ union territories are responsible for proper implementation of these plans. In the case of Punjab, funds for 1113.34547 lakh rupees' have been released up till 1st February 2017 under NWCP by the Government of India. The details of the funds in accordance to the wetland sites are discussed below table 2.1:

Table 2.1: Details of financial aids released under the NWCP

Sl. No.	Name of Wetland	Fund release till 1.02.2017 (in lakhs)
1.	Harike Wetland	493.06447
2.	Ropar Wetland	271.645
3.	Kanjli Wetland	167.541
4.	Nangal Wetland	181.095

Source: NWCP, 2017

NWCP covers only a limited share of wetland areas as the selection criteria for the conservation and management of wetlands are as same as that of the Ramsar selection criteria, which are discussed below:

1. Criteria 1. If it contains a rare or unique example of a natural or near-natural wetland type.
2. Criteria 2. If wetland areas support endangered or ecologically threatened species.
3. Criteria 3. If the wetland areas support a population of plants or animal species that maintain the biological diversity of the region.
4. Criteria 4. If the wetland areas support endangered species of plants/animals that are at a critical stage of their life cycle.
5. Criteria 5. If the wetland is able to support 20000 or more water birds.
6. Criteria 6. If it a consistently supports 1% of the total population of any one species or its sub-species.
7. Criteria 7. If the wetland areas are able to support those species or population of fishes that are associated and contribute to the benefits of the wetland ecosystem and biodiversity at a global level.
8. Criteria 8. If the wetland areas provide an abundant space for fishes for their food, water resources, the path of migration, nursery etc.
9. Criteria 9. If the wetlands are able to cater to the possibilities of eco-tourism, recreational activities, research and educational facilities, water and food resources, cultural heritage and their conservation etc.

Drawbacks of NWCP:

1. Due to the sole selection of only Ramsar wetland sites under this programme threatens several small and medium-sized wetlands.

2. The whole process of fund release and approval of the government is questionable as it provides financial aids on the basis of the size and area occupancy of the wetland rather than the problem itself.

3. The provision of funds to the state governments becomes a complex affair if granted on the basis of protected or non-protected areas, for instance, if the

wetland area is estimated greater than the protected area, then funds will be released under the NWCP, or else it will be released under some other programme like the Integrated Development of Wildlife Habitats or under the Project Tiger and Project Elephant etc.

4. NWCP has mentioned that both the central and the state governments are accountable for the conservation and management of wetlands under this programme. But there is no clear demarcation and mentioning of the committee who will seek and look into the conservation and management activities, in particular.
5. There is a complete exclusion of the participation of local stakeholders and the non-governmental organizations under this programme. The participation of the local stakeholders should be indispensable to the process of decision making. The combination of both traditional and scientific technologies is necessary for obtaining long-term conservation plans (Ministry of Environment and Forests (MoEF), 2007).
6. Besides this, lack of interest of both the central government and the state government on proper implementation of conservation plans and the review of existing legal and institutional issues poses a major setback. (Panini, 1998; Ramachandran & Aithal, 2016).

In the year 2013, NWCP was merged into National Plan for Conservation of Aquatic Ecosystem. All the wetlands that are identified under the NWCP were now covered under the NPCA. The financial funding pattern for the conservation and management of wetlands was changed from 100 percent to 70:30 percent (90:10 for North-eastern and Himalayan states) in the year 2013-14 (Ministry of Environment, Forest and Climate Change (MoEF & CC), 2014; Simha, 2016).

2.5.2.4 National Lake Conservation Programme (2001): Lakes is one of the important elements of the ecosystem which provides a range of benefits in terms of various ecological services. But due to the high amount of pollution, siltation, encroachments, etc., these services and values are under severe threat. The conservation and management of water bodies depend not only on the nature and tendency of the problem but also on the level in which it affects in terms of physical,

chemical, hydrological and biological. NLCP was initiated in the year 2001, for the conservation and management of lakes primarily in the urban areas. Earlier, the lakes and water bodies were covered under the National Wetland Conservation Programme from the year 1983 to 1989, which was developed by the government for special lakes in order to protect them against the nature of activities in the urban and semi-urban areas which includes discharge of wastages in the lakes. The pre-survey that has been carried out for the protection of lakes, identified 62 lakes in total (Ministry of Environment and Forests (MoEF), 2008). They have been given a choice for amendment and revision of priority by the State Government within 5 years of time. In addition to it, the involvement of multiple agencies in the management of lakes is further accountable for the degradation and over-exploitation of lakes (Gopal et al., 2010). Further degradation occurs due to the carelessness in decisions of different management bodies such as a municipality, who permit for the disposal of solid and liquid wastes in the same water body from which domestic water is supplied; as in the case of Dal Lake in Srinagar and Upper Lake in Bhopal. As a reply to which, the National Lake Conservation Programme was adopted in the year 2001 that focussed on various activities like; de-siltation, removal of weeds, development of front lake areas, fencing of lake areas, checking of water qualities, control of pollution from point and non-point sources, sewage treatment plants and public awareness programme that has been covered under NLCP. The beginning stages marked a cent percent grant provision by the Government of India for the conservation of lakes in urban and semi-urban areas (Reddy & Char, 2006). The funding arrangement of NLCP has been changed in the year 2002, in which the share of the Central Government was reduced from 100 percent to 70 percent and the remaining 30 percent funding was done by the State Govt. The bodies of the lake conservation authority have been developed in several states with various names such as the Lake Development Authority in Karnataka in the year 2002, Lake Conservation Authority in Madhya Pradesh in 2004, Loktak Lake Development Authority in Manipur, Chilka Development Authority in Odisha, Lake and Waterways Development Authority in J & K. The Ministry of Environment, Forests and Climate Change has given directions to all states to constitute a City Level Monitoring Committees (CLMCs) for all rivers and lakes that is

to be chaired by the District Collector including the administrative head of the Urban Local Bodies (ULB), representatives of the implementing agencies, NGOs and other prominent social workers. In addition to this, there is an utmost need and necessity for the awareness and knowledge related to the conservation of water bodies from a management point of view. The Indian Institution of Technology, Roorkee started a course on “Conservation of Rivers and lakes: through Alternative Hydro Energy Centre” that is sponsored by the MoEF (Alternative Hydro Energy Centre, Indian Institute of Technology, Roorkee, 2010). There is no specific legal framework that deals directly with the management and conservation of lakes, wetlands and aquatic ecosystems which are covered under several Acts such as the Wildlife Act, 1972, the Forest Conservation Act, 1980 related with the biodiversity and natural resources and the Water Prevention & Control of Pollution Act, 1974 which concerns itself towards effective prohibition of dumping of wastages in the water. As a concern of fulfilling their duties, various state governments have developed their legal framework for the conservation, and management of lakes, wetlands, and rivers in their respective territories as ‘land’ and ‘water’ account as state subjects.

Delimitations:

Only perennial lakes have been covered under the NLCP, other types of wetlands, those are under non-perennial lakes, are conveniently ignored by the government. Lakes exceeding an area of 10 hectares and depth more than 3 meters is the only criteria for a wetland and lake to get selected for conservation, as an exception, lakes comprising of the area more than 3 hectares and having any social and religious importance to take into consideration for selection. There are several loopholes that are present in each regulatory plan designed for wetlands and these loopholes serve as an advantage and incur profits for the industrialists, as in the case of the Coastal Regulation Zone Notification.

2.5.2.5 National Environment Policy, 2006: The National Environment policy is an extension of the existing policies that looks into the issue of environmental protection, and formulates on the recommendation and in the view of earlier policies. The National Environmental Policy is developed to extend its coverage and fill in the existing gaps

in previous policies**. "***The Dominant theme of policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation than from degradation of the resource"* (Ministry of Environment and Forests (MoEF), 2006). The objective of the National Environmental Policy is to focus on the conservation and intra-generational equity of environmental resources relevant to all sections of the society in line with their form of livelihoods. It carries out its objective by focussing on environmental conservation through multi-stakeholders such as participation of local communities, public agencies as well as for various research institutions. Along with the conservation of environment, some of the other objectives of the National Environmental Policy includes good governance and to promote optimum use of environmental resources, in addition to which, certain aspects like priority to the surrounding inhabitants, right to development, economic efficiency, equity, legal labiality, decentralization of power, integration of social and natural science for policy formulation, environmental standard and precautionary measure etc. has been discussed. In actual sense, such things are not applied at the ground level as evident in the case of Harike wetland, which despite being a Ramsar site there is no proper boundary demarcation, lack of plantations and revenue records of the lands acquired by the local people etc. as it is not feasible. This policy is focused on the empowerment (in terms of funds, actions, and capabilities) of local bodies such as panchayats or municipalities (Ministry of Environment and Forests (MoEF), 2006). The relation between the services and its impact on the wetland areas have been discussed in the National Environmental Policy, 2006. According to which, several wetlands are undergoing stress as it is being constantly exploited and is used for dumping of various solid and liquid wastes as it is perceived to have little economic value as compared to other water bodies. But in reality, the dependency of the surrounding inhabitants has increased the economic value of wetlands from the ground level. Sadly, despite being home for various biota, there is an effective failure in realizing the quantitative and qualitative view of wetlands. The policy highlights the need to set up a legally enforceable regulatory mechanism that will promote the conservation and management

of wetlands with the proper participation of local communities and relevant stakeholders. Therefore, on the basis of suggestions of National Environmental Policy, a legal structure named *Wetland Conservation and Management Rules, 2010* was developed by the Ministry of Environment and Forest.

2.5.2.6 Wetland Conservation and Management Rules, 2010: The wetland conservation and management rules, 2010 was developed on the basis of recommendations given by the National Forest Policy, 2006. The National Forest Policy mentioned the need to set up a regulated authority that seeks towards the maintenance of ecological character, identification of new wetlands and primarily focus on the development of a national wetland inventory (Bassi et al., 2014; Ministry of Environment and Forests (MoEF), 2012; Ministry of Environment, Forest and Climate Change (MoEF & CC), 2016d; National River Conservation Directorate, 2017). The Central Wetland Regulatory Authority was constituted as per the provision under rule 5 of Wetland Conservation and Management Rules, 2010 and consists of a Secretary (MoEF), a representative of the Ministry of Tourism, Water Resources, Agriculture, Social Justice, Chairman (CPCB), Joint Secretary or Advisor (MoEF) and four experts from the field of ornithology, limnology, ecology and hydrology who are nominated by the central government for a tenure of three years, the nomination process of which is not entirely transparent which further shows the lack of confidence and seriousness in the part of the government in relation to the conservation and management of wetland areas (Dandekar & Thakkar, 2011; Bassi et al., 2014). The wetlands controlled under these rules include the Ramsar wetlands, UNESCO heritage sites (wetland), protected areas such as national park, wildlife sanctuary, reserved forests, and marine parks, complex ecosystem wetlands with an elevation of 2500 meters and an area of 5 square kilometres or above, wetlands below 2500 meters with an area of 5 square km or higher areas, and also incorporates any wetland that is identified or suggested by the Central Wetland Regulatory Authority (Wetland Conservation and Management Rules, 2010; Dandekar & Thakkar, 2011).

Reclamation of wetland areas, setting up of new industries, storage, dumping and handling of hazardous substances, permanent construction and untreated disposal of any liquid and solid wastes etc. are restricted under these rules. The Harike wetland is

the part of Sutlej River which has turned into a dumping site of the industrialized city of Ludhiana, the effluents from which has turned the water black with impurities, and has become a breeding place for different diseases which causes harm to the surrounding biodiversity and people. The activities such as extraction and use of water, disposal of treated effluents, unsustainable grazing, collection of biotic and abiotic resources, boating, dredging, agriculture, horticulture, repairing of existing structure and the facilities are prohibited and requires prior permission from the state government as it aims to preserve the ecological character of the wetland areas. Conversely, activities related to recreational, religious, livestock, etc. are allowed with respect to the essential rights of the communities over the wetland areas.

In order to identify new wetland areas, a brief document has been prepared by the state government within a year of the formulation of rules and details of wetland areas, in terms of their geographical location, size and entailing threats etc.; which will succeed with the investigation of the matter by the committee, the result of which would decide if that area be labelled as 'protected' or not. Any dissatisfaction with the decision of the Central Wetland Authority can be then appealed to the National Green Tribunal within six months. The National Green Tribunal is not functional at this stage (Dandekar & Thakkar, 2011).

Drawback or limitation of conservation and management rules, 2010:

1. The major drawback is the sole focus of the wetland conservation and management rules on the conservation and management of wetlands by prohibiting and regulating certain activities, by blatantly ignoring the rights of people over the wetland areas. In other words, the dependency of people over the wetland areas for water security, livelihood, grazing etc. has been conveniently ignored and overlooked during the formulation of the rules. The worldwide conservation and management policies recognize the importance of protecting livelihood dependency and promotion of democratic system or structure for the management (Ashoka Trust for Research in Ecology and the Environment (ARTEE), 2010; Dandekar & Thakkar, 2011), the adoption of which is evident in the case of the Forest Department of India with its announcement of the Forest Rights Act, but the same is completely overlooked in

the case of the management and conservation rules, 2010 (Ashoka Trust for Research in Ecology and the Environment (ARTEE), 2010). The same is also mentioned in the draft in the year of 2008, 2009, and 2010 regarding the roles of wetland in connection with the dependence of livelihood of the rural communities and the consequent effects of the declining services of the wetland ecosystems. For example, more than 50000 people are dependent over Dal Lake in Jammu & Kashmir for the sustenance of their livelihood (Khan et al., 2014). About 90 percent population depends over mangroves wetlands in the East Godavari Delta, Andhra Pradesh, India (Dahdouh-Guebas et al., 2006). Thus, there is a dire need for both the state and central governments to understand the real meaning of conservation and manage the involvement of the local communities that are dependent over these wetland areas.

2. The draft formulated in the year 2008, mentioned different types of wetlands which need proper management and conservation; which categorized wetlands into three types: A type, B type, and C Type. Category A wetland includes Ramsar sites, World or National heritage areas, transboundary wetlands, wetlands that have more or equal to 1000 hectares in arid, 5000 hectares in semi-arid, 10000 hectares in humid and 100000 hectares in humid region and including those wetland areas that are a source of water for 'A' class cities. Category B wetland includes state heritage areas and also includes wetlands that are a source of water for B class cities and Category C wetland includes those wetlands that are selected under A and B categories or is the source of water for 100 residents or fulfilled the needs of local people. But in the final notification rules in 2010, only class A wetlands are given preference in terms of management and conservation. The selection of wetlands for management and protection activities was far better mentioned in the draft of the year 2008. In addition to which, socially and culturally significant wetlands are identified for conservation activities under the draft year 2008. But, the final notification rules of the year 2010 marks an exclusion of such rights for the protection of smaller wetlands (Dandekar & Thakkar, 2011; Ministry of Environment and Forests (MoEF), 2008).
3. In the draft of the year 2008 as well as in 2009, there has been mentioning of the initiation for the constitution of regulatory committees at different levels, i.e., district

level, state level, and central level so as to properly cater to the representation and participation of native people. But, in the final notification in the year 2010, no such space has been allotted to the district and state level committees (Ministry of Environment and Forests (MoEF), 2008; Ashoka Trust for Research in Ecology and the Environment (ATREE), 2010; Dandekar & Thakkar, 2011). The second section of the draft mentioned about the local bodies like the municipalities and panchayats, which were omitted in the rules in the year 2010. Unlike the draft, in the year 2008, the final notification of the management and conservation rules, 2010, doesn't mention any form of public consultation. Public consultation is a process that seeks the opinions of the locally affected people and their concerns about the ecological and economic, that will be brought to the notice of the regulatory authority for further action (Ministry of Environment and Forests (MoEF), 2008). There is a need to have a management committee with at least 50 percent quota for the local and non-expert members that are routinely connected with the wetland areas (Dandekar & Thakkar, 2011). Even, in the 2016 draft (management and conservation rules, 2016), the participation of the local people has been completely ignored in the constitution of the state level committee.

4. The prohibited activities that are mentioned in the rule, 2010 have not successfully applied in the context of wetlands. For example, as per the rules, Ramsar sites have been selected for the management and conservation, but according to a field survey, disposal of liquid and solid wastages still continue in the wetland areas. In addition to which, ARTEE's wetland conservation team mentioned that there is a need for a separate notification that only delineates on the prohibited activities for better conservation and greater profits.
5. The identification of new wetland areas is limited as per the rules 2010 as it primarily focusses on Ramsar sites, heritage sites, etc.; and the lack of proper space for local level government further aggravates the problem. ARTEE group of wetland research team proposed a need to add democratically elected members of various panchayat/assembly/parliament members in various committee (Ashoka Trust for Research in Ecology and the Environment (ATREE), 2010). The National Environmental Policy, 2006 was reviewed by both the experts as well as the

members of parliament and focusses on the participation of several local bodies such as the municipalities and panchayats, local communities and stakeholders that are directly or indirectly dependent over its resources (Ministry of Environment & Forests (MoEF), 2006).

6. The whole foundation of management and conservation rules falls apart due to overlapping; as wetland areas that fall under the National Parks and Wildlife Sanctuaries shall be regulated by the provision of Wildlife Act, 1972 which mainly focusses on the conservation of fauna or flora species. The protected or notified forest areas is managed under the Forest Act and Environmental Protection Act and other areas that are covered in these shall be regulated under the Environmental Protection Act which further questions the whole setup of allotting a wetland area under a different act. According to ARTEE, there is a need to develop or constitute a separate wetland act that strives towards complete analysis of all possible issues and aspects of wetland areas.

2.5.2.7 National Plan for Conservation of Aquatic Ecosystem (NPCA), 2013: The National Plan for Conservation of Aquatic System is developed to fulfil the needs of a separate body for the conservation and management of lakes and wetlands that are different from the aspects of rivers conservation. There are two different programmes for the conservation and management of wetlands and lakes that have been already developed by the government, i.e. National Lake Conservation Programme (NLCP) and National Wetland Conservation Programme (NWCP). These two programs separately seek towards the conservation and management of the same. For instance, NLCP focuses on the conservation and management of lakes in the urban and semi-urban areas, whereas NWCP focuses on the wetland areas mainly the Ramsar or large-sized wetland sites. In the year 2013, with the aim for integration and to promote a multi-disciplinary approach, the Union Cabinet of India merged two different forms into a single plan that came to be known as NPCA. The approaches of management and conservation plans have changed from a sectorial level to the mainstreaming aquatic ecosystem (Ministry of Environment, Forest and Climate Change (MoEF & CC), 2016e).

The main objectives of NPCA include the development of policies guidelines; advancement of eco-restoration efforts with the help of integrated management, development of a national inventory for the aquatic ecosystem, participation, and support of local stakeholders for various management purpose etc. Both the central and the state level committee has been established under the NPCA. Formulation of policies and financial aids related to conservation come under the central level committee whereas the implementation of conservation and management plans comes under the duties of the state level committee.

Delimitation of NPCA:

The coastal and mangroves wetland areas are excluded from the NPCA, and the number of wetlands and lakes identified is the same as covered under the NLCP and NWCP. There has been no noticeable change in the selection criteria for wetlands and lakes. The NPCA talks about the setup of a State Wetland Authority, but in the case of Punjab, there has been no specific wetland authority to address its issues. There has been no evidence of the participation of local people and integrated approaches in the case of NPCA.

2.5.2.8 Wetland Management and Conservation Rules, 2016 (Draft): The Ministry of Environment, Forest and Climate Change proposed a new draft of Wetland (Conservation and Management) Rules, 2016 that shows the ineffectiveness of Management and Conservation Rules, 2010 (Nagaranjan, 2016; India Environment Portal, 2016). The pending petitions against the Wetland Management and Conservation Rules, 2010 at the National Green Tribunal are also responsible for the announcement of new draft rules i.e. Wetland (Conservation and Management) Rules, 2016 as dated 31 March 2016. Several organizations such as Bombay Natural History Society, WWF India, Legal Initiative for Forests and Environment, International Rivers, INTACH, Yamuna Jiye Abhiyan and South Asian Network on Dams Rivers and people have sent their representatives and submitted objections regarding the new Rules. Ritwick Dutta, an environmental lawyer and member of the Legal Initiative for Forests and Environment said, “It makes very little sense to grant states, which have so far not been adhering to the Rules that are

already in place, all the power to notify wetlands" (Nagaranjan, 2016). The new draft rules have some advantages as well as shortcomings as discussed below:

- The proposal of draft 2016, regarding the setup of a State Level Wetland Authority in the place of Central Wetland Regulatory Authority that dealt with the concerns related to wetland conservation, regulation, and management. The participation of the local bodies, NGO, communities has been ignored in this case. All the power related to enforcement of the rules, acts, regulations, and implementation has been given to the State Wetland Authority.
- The draft did not mention the timespan required for the identification and selection of wetlands. As mentioned in the earlier notification, the state government shall prepare within a year of the commencement of rules (Nagarajan, 2016; India Environment Portal, 2016).
- The coastal areas that were overlooked in the rules 2010, has been mentioned in the draft of the year 2016 for the management and conservation activities.
- The reclamation of wetlands and conversion of wetland areas to non-wetlands are mentioned only under the prohibited category. Other activities such as setting up of industries, disposal of solid and liquid wastages and permanent construction that are prohibited in the earlier notification of Rules, 2010 have been deleted in the new draft rules, 2016 (General Knowledge Today Blog, 2016). Only those activities are mentioned which contribute to the maintenance of ecological integrity.
- The new draft rule, 2016 doesn't mention about the correspondent authority that is entitled to give prior permission for the approval of these kind of activities in the wetland areas. The list of activities that needs prior permission from the state government is mentioned in the earlier rules, 2010.
- The new rules have omitted certain wetland areas that were covered in the earlier rules, for example, the UNESCO heritage world site and high altitude wetland areas have been overlooked and certainly omitted.
- The right to appeal against the rules, that have given in earlier rules, are also omitted in the new draft.

2.5.2.9 Wetlands (Conservation and Management) Rules, 2017: Wetlands (Conservation and Management) Rules, 2017 was introduced by the MOEF & CC on 26 September 2017, which worked under the Environment Protection Act, 1986. This act replaces the Central Wetland Authority with the State or Union Territory Level Authority. At the national level, a working committee has been established. The committee has the power of recommendation and advises the government for suitable policies and programs for the management and conservation of areas by promoting 'wise use of wetland' and 'zone of influence'. 'Wise use of wetland' delineates the conservation of wetland ecosystem, with sustainable development and 'zone of influence' focuses on the list of activities operating in the catchment zone of wetland areas. The notified list covers the central, state, union territories and Ramsar listed wetlands. This rule shall not be applied over the wetland areas that are covered under any other act like the Wildlife Protection Act 1972, India Forest Act 1927, Forest (Conservation) Act 1980 and Coastal Regulation Zone Notification 2011 as it creates confusion regarding the coverage of wetland areas under this rule, because many Ramsar sites are covered under the Wildlife Protection Act 1972 and so on. According to this, the list of wetlands will be prepared within three months and notification within six months. According to the Conservation and Management Rules 2017, the demarcation of wetland boundary and zone of influence is necessary with the notification of Wetlands within a year.

2.5.2.10 National Water Mission (NWM): National Water Mission is one of the subdivisions of the National Action Plan for Climate Change (NAPCC). The basic objective of National Water Mission is "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management". The open accessibility of water resource data and impact of climate change over the water resources in public field, conservation, and management of water through stakeholders' participation, concentrating on the overexploited or the most vulnerable areas, has three major goals (out of fives) under the NWM. The NWM wetland mainly focuses on the conservation of water bodies excluding the wetland areas with the active participation of state, local bodies, and stakeholders. It also gives an idea as to how the public scheme is used for

the conservation of water bodies; for instance, the participation of a local stakeholder under the Mahatma Gandhi National Rural Employment Guarantee Act (MANREGA) scheme for the conservation and management of water.

The identification and inventory of wetland areas with 'unique features' are covered and aimed as the first goal of NWM i.e. accessibility of all data in the public domain. The third goal of the National Water Mission includes the conservation and management of wetland areas and "focused attention on vulnerable areas including over-exploited areas". According to NAPCC, formulation and implementation of a regulatory system to ensure wise use of wetland areas at the national, the state and district level, environmental impact assessment of development project over the wetland areas and the relation between the afforestation and wetland areas are the major or highlighted areas. But, there are no recommended strategies under the NWM (National Water Mission, 2011). Water is one of the most important elements of wetland areas, but it seems that the conservation and management of wetland areas are not properly understood by the Ministry of Water Resources. NWM mentions the fact that the management and conservation of wetland areas are controlled by the Ministry of Environment and Forest in their existing schemes or programs (National Water Mission, 2011). Water is an essential part of the wetland ecosystem that affects all other wetland ecosystems. But, sadly, wetlands have no space in the National Water Policy of India which is mainly concerned about the provision and issues on the availability of water to all human beings rather the proper management of water bodies includes wetland areas (Ministry of Water Resources (MoWR), 2002, Ministry of Water Resources (MoWR), 2012).

2.5.2.11 Eco-sensitive zone: The Eco-sensitive zones are defined as transitional zones from areas of highly protected areas to non-protected areas. The National Board for Wildlife takes decisions about the declaration of eco-sensitive zones around the National Park and Wildlife Sanctuaries. The decision or discussion on the eco-sensitive zones is discussed in the 21st meeting of National Board for Wildlife under the theme of Wildlife Conservation Strategy 2002. It was decided that "lands falling within the 10km of boundaries of National Parks and Wildlife Sanctuaries should be notified as eco-fragile zones under the section 3 (V) of the Environmental (Protection) Act and

Rule Sub (VIII) & (X) of the Environmental (Protection) Rules". A letter was moved by the Additional Director General of Forests on 6th February 2002 to all the chief wardens of the state and the union territories. The same states have raised a concern regarding the impact on eco-sensitive areas due to various developmental activities. So, the proposal about the formation of an eco-sensitive has been re-examined in the second meeting of the Indian Board for Wildlife that was held on 17th March 2005 and decided that the "*delineation of eco-sensitive zones would have to be site specific and relate to regulation, rather than prohibition, of specific activities*". The decision was circulated among all state governments for compliance vide letter dated 27th March 2005, to which they waited for a reply in vain.

Then, a writ petition no. 460/2004 was filed by the Goa Foundation in the Hon'ble Supreme Court with the concern of eco-sensitive zones. On 4th December 2006, the Hon'ble Supreme Court decided that the period of 4 weeks should be given to all the states and union territories to send a proposal to the Ministry of Environmental and Forests. But, the proposal was moved by only six states namely Haryana, Gujarat, Mizoram, Meghalaya, Assam and Goa, and the remaining states didn't forward the proposal. In this context, a writ has been filed by the Shri Anand Arya and Anr Vs. Union of India about the non-declaration of the eco-sensitive zone around the protected areas in Uttar Pradesh and the Hon'ble Supreme Court gave them the decision and approval for the construction of a park near the Okhla Bird Sanctuary.

As a result of which, MoEF had set up a committee under the chairmanship of Shri Pronab Sen for identifying the parameters for an ecologically sensitive zone. The extension of ecosystem varies from area to area on the basis of the requirement for that specific area. The inventory for different land use pattern is necessary around or within 10 kms of the protected areas in order to avoid the negative impact on protected species and habitat areas. Therefore, a committee has been formed, comprising of the wildlife warden of the concerned area, an official from the respective states/ union territories, an official from the revenue department of the area concerned. The suggestions of which could be the following:

(I) In reference to protected areas, as to how much areas have been declared under the eco-sensitive zones.

(II) The relative needs of the areas that also acts as a shock absorber.

(III) To propose the finest techniques for the management of eco-sensitive zones.

(IV) To recommend broad-based thematic activities to be included in the Master Plan of the region.

The final notification for the creation of an eco-sensitive zone around the protected areas such as National Parks, Wildlife Sanctuaries has been issued on 9th February 2011, by Shri Prakriti Srivastava (deputy inspector general (WL)), to all states/union territories with necessary guidelines that are to be followed.

Activities that are allowed in the eco-sensitive zones may be of three types, i.e., prohibited, regulated and permitted. The list of activities is discussed in the following table:

Table 2.2: List of activities permitted, regulated and prohibited under the Eco-sensitive zones

Sl. No.	Activity	Prohibited	Regulated	Permitted	Remarks
1.	Commercial Mining	Y			Regulation will not prohibit the digging of the earth for construction or repair of houses and for the manufacture of country tiles or bricks for housing for personal consumption
2.	Felling of tree		Y		With permission from the appropriate authority
3.	Setting of sawmills	Y			
4.	Setting of industries causing pollution (water, air, soil and noise etc.	Y			

5.	Establishment of hotels and resorts		Y		As per the approved master plan, which takes care of habitats allowing no restriction on movement of wild animals
6.	Commercial use of firewood	Y			For hotels and other business-related establishment
7.	Drastic change in agricultural systems		Y		
8.	Commercial use of natural water resources including ground water harvesting		Y		As per approved master plan, which takes care of habitats allowing no restriction on movement of wild animals
9.	Establishment of major hydroelectric projects	Y			
10.	Erection of electrical cables		Y		Promote underground cabling
11.	Ongoing agriculture and horticulture practices by local communities			Y	However, excessive expansion of some of these activities should be regulated as per the master plan
12.	Rainwater harvesting			Y	Should be actively promoted
13.	Fencing of premises of hotels and lodges		Y		
14.	Organic farming			Y	Should be actively promoted
15.	Use of polythene bags by shopkeepers		Y		
16.	Use of renewable energy sources			Y	Should be actively promoted

17.	Widening of roads		Y		This should be done with the proper environmental impact assessment (EIA) and mitigation measures
18.	Movement of vehicular traffic at night		Y		For commercial purpose
19.	Introduction of exotic species		Y		
20.	Use or production of any hazardous substances	Y			
21.	Understanding activities related to tourism like over-flying the National Park area by any aircraft, hot-air balloons	Y			
22.	Protection of hill slopes and river banks		Y		As per the master plan
23.	Discharge of effluents and solid waste in natural water bodies or terrestrial areas	Y			
24.	Air and vehicular pollution		Y		
25.	Sign boards and hoardings		Y		As per the master plan
26.	Adoption of green technology for all activities			Y	Should be actively promoted

Source: Ministry of Environment and Forests, 2011

a) The precise description and mark of physical boundaries delineating actual geographical conditions over the toposheets are to identify a potentially

qualifying eco-sensitive zone and identify the name and geographical coordination of the village that falls within the buffer zone.

b) An inventory of the existing legal status of rights, entitlements, privileges, and obligations of the local communities.
c) The detailed description of the endemic species, habitats, species, and richness in terms of their biodiversity importance. In addition to this, details regarding the cultural and aesthetic values and land-use pattern may be necessary.
d) The resources that are significant in an eco-sensitive zone from an economic and livelihood point of view.
e) An inventory of activities that are regulated, prohibited and permitted in an eco-sensitive zone.
f) A list of the protected areas for a declaration of an eco-sensitive zone.

The list of prohibited activities is well defined under the Eco-sensitive zone, which depends on the committee as to how they implement these rules and regulations. The inefficiency of the State and Union Territories is reflected in their lack of interest in the case of demarcation or sending off a proposal in regard with the creation of eco-sensitive zones around National Parks and Wildlife Sanctuaries. Though the letter for the demarcation of eco-sensitive zones was initiated in the year 2002, it was finalized in the year 2011. The final notification for eco-sensitive zones was successfully issued owing to the active participation of the public and the Public Interest Litigation in the Hon'ble Supreme Court of India. But there are still some states that have not submitted their proposal to the MoEF until the year 2011, which shows the state's irresponsibility towards the serious issues of water, soil, and wildlife.

2.6 Local participation and their role in the management of wetlands: The significance of local participation has been accessed from its popularity, as maximum of the programs, policies and the plans are focused on the active participation of local stakeholders in the management and conservation of the wetland areas. The close relationship between the wetland areas and people, necessitates the participation of the local inhabitants for the conservation of surrounding areas as they are closely aware of the situations, problems, and way of management from several years (Badola et al., 2012). For example, the Keoladeo National park was initially managed by the

local people in the 18th century, as their livelihoods closely linked with the areas. The rights of the local people were withdrawn after the conversion of the area as a National Park in the year 1980 (Vijayan, 1991). Even when livestock is the main source for the livelihood of surrounding villages, people's dependency of wetland areas dropped to only 5 percent after the declaration of areas as a National Park area (Azeez et al., 1992). The impact of the banning of livestock grazing has more impact on the lower income group than the middle and the higher income group. The banning of grazing of livestock is responsible for rapid growth of grasses that is responsible for fires in the sanctuary areas. Therefore, after knowing the role or importance of local people in the management of areas, permission for the limited livestock has been given for a limited season (Azeez et al., 1992).

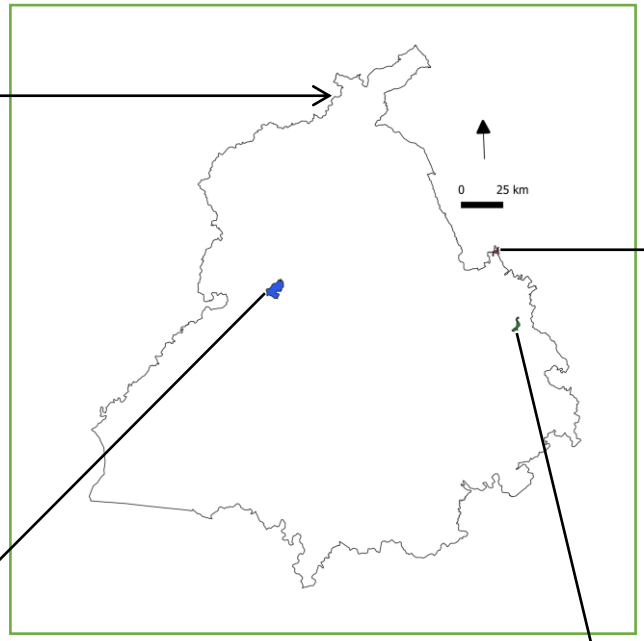
Chapter 3: Material, Method and Area of Study

This chapter discusses the data sources and detailed methods used in the study to achieve the objectives. The chapter also explains the details of the areas of study, the rationale of a selection of sample villages and sample size, Indicators used for the economic evaluation of wetlands and various statistical models used in the study.

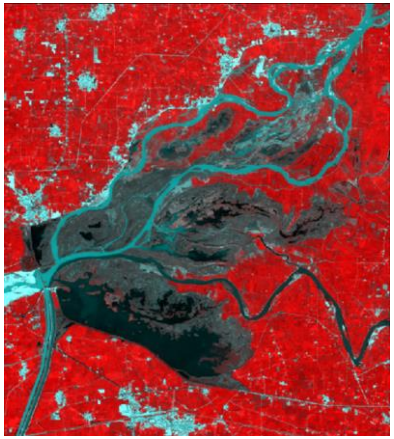
3.1 Selection of Study Area: The multi-sampling techniques have been used for the selection of study areas. First of all, at the Macro level, the Punjab state has been selected to analyze or evaluate the socio-economic significance of wetland for surrounding areas. The people of surrounding areas have been dependent over wetland areas for several reasons likes agriculture, fishing, tourism, religious, and water for drinking purpose. The major distribution of the wetland occurs in the central region of Punjab (Majha and Malwa regions) that count for about 76.5 percent of total wetland areas. Moreover, all the three internationally important Ramsar listed wetland namely Harike, Ropar and Kanjli and one international important Nangal wetland are located in the central region. Therefore, at Meso level, Malwa, Doaba and Majha regions of Punjab have been selected for the study areas on the basis of wetland distributions (Indian Space Research Organisation, 2011a). Lastly, at the micro-level, two international wetlands (Harike and Ropar) and one national wetland (Nangal) have been selected to study the socio-economic significance of these wetlands in the life and economic activities of people living around these wetlands (Map 3.1).

3.1.1 Harike Wetland: Harike wetland locally known as Hari Ka Patten means the place of God, was came into existence in 1952 after the construction of reservoirs at the confluence point of River Sutlej and Beas. It is one of the largest man-made wetland of northern India that falls in the territory of three districts .i.e. Firozpur, Tarntaran, and Kapurthala (Moza & Mishra, 2008; Ladhar, 2002; Tiwana et al., 2008). In the terms of its geographical location, it is placed between 31º 09’41” North to 31º13’11” North Latitude to 74º 56’49” East to 75º03’07” East longitude. For the first time, about 141 sq. km area of the Harike lake has been declared as a ‘closed area’ by the Punjab Government in 1971 after seeking the potential of the area for breeding and resting of native as well as migratory birds.

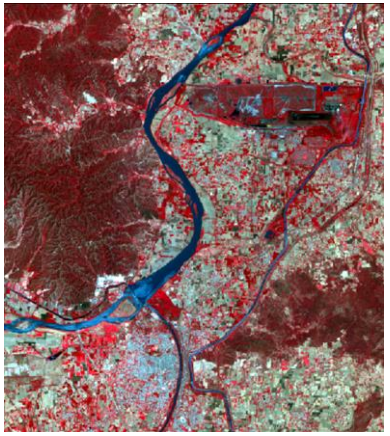
Map 3.1: Area of Study (LISS IV Satellite Data)



Nangal Wetland



Harike Wetland



Ropar Wetland

In the year 1982, for the protection of migratory birds, the Government of Punjab declared 41 sq. km area of Harike Lake as a wildlife sanctuary for the 10 years. As, Harike wetland provides a most appropriate environment for the resting, breeding and staging of the migratory birds, the MoEF selected it for the nomination of Ramsar wetland. It was selected under the Ramsar convention wetland sites in 1990, owing to their ecological perspective. The final notification of Harike Wildlife Sanctuary was issued under section 26-A, subsection (1) of Wildlife Protection Act, 1972 and the areas under wildlife sanctuary increased to 86 sq. km. in 1992 and notification extended the sanctuary period for ten years (Department of Forests and Wildlife Preservation, 1999). Many endangered, rare and vulnerable species come from different countries like Siberia, Europe, Kazakhstan and other counties are supported by the Harike wetland. Besides this, many International Union of Conservation of Nature (IUCN) red-listed species is supported by the Harike wetland area (WWF, 2008; Ladhar, 1994; Ladhar, 2002). The fishing was allowed in a Harike wetland, after the implementation of the wildlife act, 1972 fishing was banned primarily in the bird sanctuary areas by the Government of India in the year 2000.

A study on changing land use cover shows that the water body area decreased by 4.4% (388 ha), wetland I by 3.2% (277 ha) and wetland II by 5.4% (469 ha) whereas barren and agricultural land areas increased by 4.5% (394 ha) and 8.5% (739 ha) from 1989 to 2010 (Mabwoga & Thukral, 2014). The shrinking of Harike wetland is mainly associated with human activities such as the use of surrounding land for the agricultural purpose and changing of deep-rooted vegetation cover with the small rooted vegetation covers. Therefore, expansion of agricultural activities is liable for both the diminishing size of the wetland as well as slightly shifting of river route (Mabwoga & Thukral, 2014). Also to this, anthropogenic pressure has also been responsible for the ecological imbalance in Harike wetland and it needs conservative plans for their optimum use, but finds problems due to the insufficient database (Chopra et al., 2001). The major pollution in the Harike wetland is brought through by Sutlej River than the Beas River, therefore the less pollution was founded at the conferencing point.

3.1.1.1 Climate and rainfall: The districts has been characterized as hot and dry, a small rainy season and healthy winter climatic conditions with total four seasons (i.e. spring, summer, autumn, and winter). The rise of temperature starts with beginning

of the spring season and reaches to the maximum temperature at the end of it (i.e. about 47^0 C at the end of June). The drop in temperature starts with the beginning of the rainy season mostly at the end of July and starting of August month. But the feel of temperature is higher in the month of July and August due to the existence of a higher amount of humidity. After this, the autumn season started that is characterized by a healthy climatic condition with suitable temperature and maximum fall down in the temperature seen at the end of December and start of January.

Table 3.1: Average Monthly Rainfall of Ferozepur district

Month	Average Rainfall (mm)	1991 to 1995 (%)	1996 to 2000 (%)
January	20.3	45	34
February	38.1	37	23
March	30.5	34	37
April	20.3	52	19
May	20.3	23	24
June	61	130	70
July	228.6	326	237
August	188	365	237
September	86.4	172	57
October	5.1	6	34
November	12.7	10	6
December	20.3	16	-

Source: India Water Portal; District Administrative Ferozepur

3.1.1.2 Physiographic Division: The Ferozepur district falls in the Indo-genetic plains are characterised by normal slope, about 2 feet from North-east to South-west direction. Mainly two types of soil are found in the district i.e. alluvial (69%) and desert soil (31%). On the basis of soil nature, the district has been divided into three plains that are hittar plains lies on the South-west direction where alluvial dark and grey clay found; rohi and mukhi plains lie on the South-eastern direction that is characterized by light and sandy soil.

3.1.1.3 Population Growth: The number of population and its growth plays an important role in the use of natural resources. From the below table, it has been depicted that the numbers of the population in selected villages and town increased at a higher rate in comparison to the overall growth rate of Punjab state. It has been clearly implicit that natural resources of the Harike wetland are under pressure due to the higher population growth because the land resources have their own limitation. Therefore, it has become necessary to study the role of Harike wetland for the livelihood and socio-economic implication for the local people.

Table 3.2: Population Profile of Selected Villages and Town around Harike Wetland

Village/town	Population 2001	Population 2011	Area in Hectare 2011	Population Growth in % (2001 to 2011)
Makhu	65530	77378	-	18.08
Harike	6972	8662	952	24.23
Chamba Kalan	2631	2998	1187	13.94
Kiriyan	917	1478	980	61.17
Dhun	1772	2234	1004	26.07
Kambo Dhaiwala	951	1319	746	38.69
Rasulpur	880	1514	196	72.04

Sources: Economic & Statistical Organisation, 2015, Census of India, 2011a & Census of India, 2011b

3.1.2 Ropar Wetland: Ropar wetland is located in Eastern parts of Punjab with a geographical extension from 30°58’50” North-31°03’10” North latitude and 76°29’56" East-76° 31’ 59” East longitude at an elevation of 275 meters above the mean sea level (Verma et al., 1998). The Ropar Wetland came in existence in 1882 with the construction of a small reservoir on the right side of Sutlej for providing water supply through the Sirhind Canal (RTI, Ropar Headworks Division). The area under the Ropar Wetland increased in 1952 by the construction of a headwork on the Sutlej River for providing a water supply through the Bist Doab Canal. As a result, at present, water from the Sutlej River is supplied from Ropar headworks through Sirhind Canal and Bist Doab canal. The water depth in the Ropar reservoirs ranged between half meters to six meters, as the depth of water is greater in the central part and shallow in the outer area of reservoirs. However, the wetland area suffered from the excessive amount of siltation, as it surrounded by the Shivalik foothills. The conservation measure mainly started after the initiative of the Government of Punjab in the year 1996-97, but always lacked financial support. The wetland is an important breeding place for the Hog deer, Smooth Indian Otter, Sambar deer and several reptiles. About 150 species of local as well as migratory birds and 35 fish species are supported by the wetland area. The use of wetland resources plays a significant impact on the livelihood of locals. The site has been selected as the Ramsar site in the year 2002. After, this conservation measure were adopted by the concerned authority to maintain the ecological importance of areas. A beautiful tourist complex was also developed by the Punjab State Tourism Development Board on the banks

of Ropar wetland, however, it has been turned closed due to some administrative reasons. At, present Ropar wetland has been influenced by several anthropogenic activities like infrastructure activities, industrial development, agricultural expansion, residential uses and other uses.

3.1.2.1 Physiographic Division: On the basis of physiographic division, the areas have been divided into four zones .i.e. Shiwalik hills, Kandi/Sirowal formations, alluvial plains and the intermontane valley of Sutlej River. The Shiwalik hills area the interconnection between the main Himalayan ranges and the Indo-Gangetic plains. Next to Shiwalik hills, an inter-montane valley that extends from Nangal in the North to Ropar in a Southeast direction. The following areas are Kandi belt i.e. categorized as a transitional area lies in the foothill zone of the hilly areas. The next to Kandi areas, plains areas founded in the Southern direction. The district has been drained mainly by the Sutlej River that enters in the district near the Nangal in the North and flows towards the South-east direction. After this, the river meanders towards the South and South-west direction and enters into plains areas.

3.1.2.2 Climate, rainfall, and soil: On the basis of temperature, the year has been divided into four seasons; winter, summer, autumn, and spring. The winter season starts from the mid of November to the end of February; spring season lies between March and June; summer season starts from mid-June to end of September and lastly the autumn season from last September to mid-November. The rages of temperature vary from 4^0 C in winter to 45^0 C in summer. The district receives about 776 mm annual rainfall, mainly contributed by the Southwest monsoon that contributed to about 78 percent of total rainfall (June to September). The pattern of rainfall changed with its direction that its decrease normally with the direction from North-eastern to South direction.

Mainly two types of soil found in the district i.e. reddish and tropical brown lies in the North-eastern and rest of parts respectively. The Ropar and Anandpur Sahib Block is mainly characterized by the reddish soil. The texture of soil varies from loam to silt clay except along the Chaos and Sutlej River, where some sandy patch may be found.

3.1.2.3 Population Growth: The population growth and natural resources have an adverse relationship with each other, as, the demand for the use of resources has increased with the increasing the number of the population. Similarly, the condition

has happened in the Ropar wetland, where pressure over the wetland resources has increased with the growing population. As, the area under the wetland are greatly affected by increasing the demand for infrastructure activities like roads; encroachment of wetland areas for agricultural activities; drying of wetland areas due to increasing the demand of water supply and other many reasons.

Table 3.3: Profile of Population Growth for the selected Village of Ropar Wetland

Village/town	Population 2001	Population 2011	Area in Hectare 2011	Population Growth (2001 to 2011) %
Alampura	425	506	121	19.05
Bahardurpur	433	425	68	-1.84
Chak Dhera	431	461	282	6.96
Dakala	590	646	89	9.49
Garh Bagga	1593	1698	1553	6.59
Katli	495	541	229	9.29
Laudi Majra	1040	1032	101	-0.76
Patail	641	661	90	3.12
Rupnagar	132938	144600	37534	8.77
Tabba Tiaprian	1242	1445	657	16.34

Sources: Economic & Statistical Organization, 2015 & Census of India, 2011c

3.1.2.4 Socio-economic Significance: The strategic location of Ropar wetland area provides an opportunity for the development of socio-economic activities. The location of Ropar wetland linked with the history of the Sikh ruler; territories were demarcated between the ruler of Sikh Maharaja Ranjit Singh and Lord William Bentinck in October 1831 over the banks of Sutlej River. For the attraction of tourist, a tourist Bungalow named as Pinccasia Tourist Complex opened in 1975 inside the wetland areas. A boat club was operated in the Ropar wetland area that was now closed by the Punjab Government. In spite of this, Ropar city is well known for archaeological museum related to Harappa civilization that was open for public in 1998.

3.1.3 Nangal wetland: Nangal Wetland is situated in the North-eastern part of Punjab, is surrounded by the Shivalik hills. It came into existence in 1961 by constructing a 6 km long artificial lake over the Sutlej River. The reservoirs are mainly used for storing the extra water of Sutlej River so that extra water of Bhakhra dam is

released into this lake. Besides this, it provides a fresh water supply to the state of Punjab, Haryana and Rajasthan. It has constructed over 1184 feet Mean Sea Level (MSL) and depth of water in it varies from 24 meters to 41 meters. It comprises the areas of Government forest land of Bhabour Sahib, Talwara, Dhabeta, Hambewal, Khera Bagh, Swamipur Bagh. Nangal Lake works like a sponge during the time of the rainy season and provides protection from the flash floods. In another way, during the time of drought condition, it provides water to tackle the drought conditions. The water from the Nangal Dam diverted into two Hydel Channels .i.e. Nangal Hydel Channel (NHC) and Anandpur Sahib Hydel Channel (SYL). In the terms of its geographical location wetland is situated at 31º22' N to 31º37' North latitude to 76º23' E to 76º38' East longitude (Singh, 2011). A variety of flora and fauna in Nangal Wetland is supported by the riverine and lacustrine system. As a result, in 2008, Ministry of Environment and Forest declared Nangal wetland as a National wetland of India that spread over the 400-hectare areas. After one year, Government of Punjab declared Nangal Wetland as Wildlife Sanctuary in August 2009 that covers 715.83-acres area. It is the home of numbers of migratory as well as resident birds mainly in the winter season due to the availability of suitable breeding and feeding facilities around the wetland (Brraich & Jangu, 2015). There are an estimated 56 species of terrestrial birds and 30 species of water birds are recorded. The Nangal wetland has a great scope in the terms of its socio-economic development because a number of people visit the Bhakra Dam stayed at the Nangal. The scenic beauty of wetland also attracts a number of tourists that visit the wetland for several purposes such as for bird watching, religious, educational and research purpose etc.

3.1.3.1 Climatic Conditions: The climatic condition of the areas mainly controlled by temperature and rainfall of the areas. The whole year has been divided into four seasons mainly based on the temperature of areas. The rages of temperature vary from 4^0 C in winter to 46^0 C in summer. The coldest temperature is found in the month of December and January and hottest in the month of May and June.

3.1.3.2 Rainfall: The most of rainfall in the Nangal areas occurred in the months of July, August and September. A less amount of rainfall occurred in the winter season mainly in the months of December and January. The Nangal areas experienced average 876.6 mm rainfall in the last 15 years.

3.1.3.3 Population Growth: The population is one of the supreme key factors that play a dynamic role in the conservation as well as depletions of natural resources.

The 95 percent area of the Nangal Wetland submerged under the water. The increasing the number of human being affected the wetland area dual way; firstly affected the wetland area by increasing pressure over wetland resources by the action of increasing demand for food, infrastructure development and others. Secondly affects the functions of wetland ecosystem through the decreasing of areas under wetland.

Table 3.4: Profile of Population Growth for the selected Village of Nangal Wetland

Village/town	Population 2001	Population 2011	Area in Hectare 2011	Population Growth in % (2001 to 2011)
Bhabhaur	3102	3263	569.00	5.19
Swamipur	785	901	252.00	14.77
Khera Bagh	305	367	38.00	20.32
Talwara	993	1118	230.00	12.58
Nangal		48497		

Source: Census of India, 2011c

3.2 Steps for selection of sample size and surveyed areas around the wetlands:

After the selection of wetland sites, the next step was to select the villages where the survey has been carried out to study the socio-economic values of the wetland area. The following steps are used for the selection of villages:

1. A buffer zone of one kilometre has been marked around the boundary of Harike, Ropar and Nangal wetlands with the help of Quantum Geographic Information System (QGIS) software.
2. The areas fall within one km buffer zone and at least one area in each direction around the wetland.
3. Areas within buffer zone having more than 50 households (for Harike, Nangal and Ropar wetland) have been taken for a sample because the variation in the populations of three wetlands was different according to their direction and physiography of the region around the wetlands.
4. The separate criteria have been used for the selection of respondents in both rural and urban that are described in the following tables;

Table 3.5: Percentage of Households selected for the Survey in Rural and Urban Areas

	Number of Households	Percentage of Households select for Survey
Rural	Less than 500	5 percent
	501-1000	4 percent
	More than 1000	3 percent
Urban	Less than 5000	1 percent
	5000-10000	.5 percent
	More than 10000	.25 percent

Note: The method is used by several scholars in random sampling techniques

The details of selected villages and town which have been selected for the survey are discussed below with respect to the wetland sites.

Justification for 1Km buffer zone: Idea to create a buffer zone and to calculate the economic valuation of wetland area within the buffer zone has been adopted from the work of Barbier et al., 1997 and Boral et al., 2016. The one-kilometre buffer zone around the wetland area has been selected after doing a pilot survey around the wetland area. The impact of wetland area may extend far beyond the one-kilometre distance. However, the tendency of impact may decline after the one-kilometre buffer zone such as dependency for livestock grazing, use of wetland area for agricultural activities, tourists, and livestock grazing as was observed in village Laudi Mazra during pilot survey.

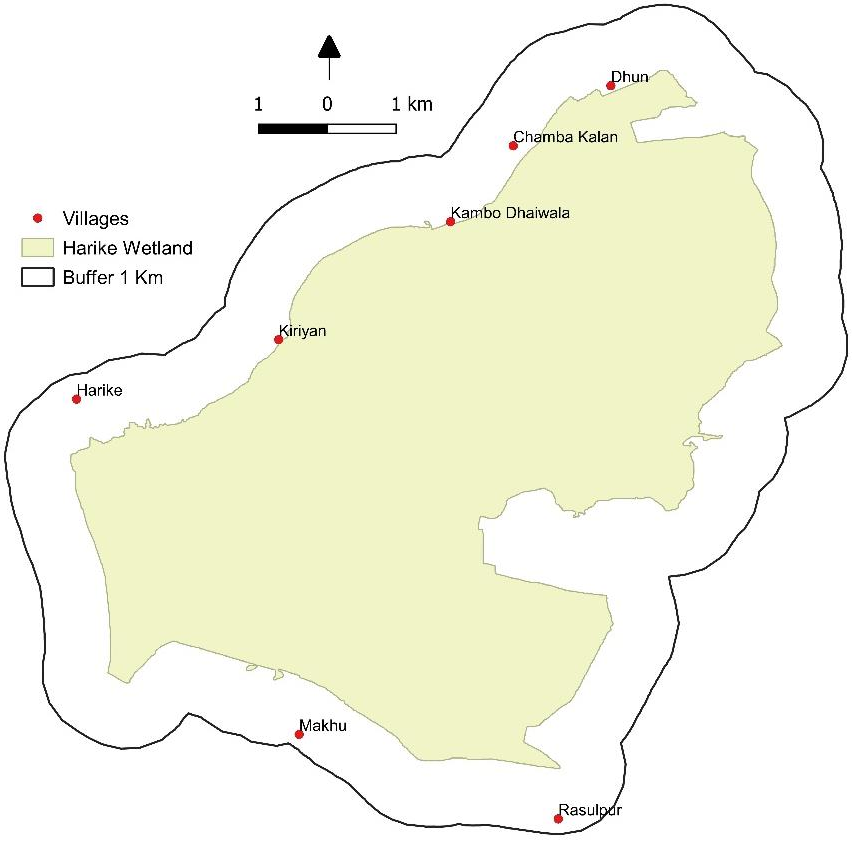
3.2.1 Sample of Harike Wetland: There are 13 villages and one town lies within the buffer zone of 1 km around the Harike Wetland. Out of these, one town namely Makhu and six villages namely Harike, Dhun, Chamba Kalan, Kambo Dhaiwala, Rasulpur and Kiryan (Kirian) were selected for the survey on the basis of the numbers of population and location with respect to the wetland area. The selected villages were mostly located in North, West and South direction of wetland. In the East direction, only one village was lies there but the population of that village was very less so no village was selected from this direction. The list of selected surveyed areas and their sample size were given in the following table.

Table 3.6: Sample Size for the Surveying around the Harike Wetland

Village/town	Population (2011)	Household (2011)	Area	Direction	Sample Size
Makhu	77378	14177	Urban	South	40
Harike	8662	1620	Rural	North-West	48
Chamba Kalan	2998	503	Rural	North	25
Kiriyan	1478	259	Rural	North-West	13
Dhun	2234	363	Rural	North	18
Kambo Dhaiwala	1319	206	Rural	West	10
Rasulpur	1514	329	Rural	East	16
Total Sample Size of Harike Wetland= 170					

Sources: Economic & Statistical Organisation, 2015, Census of India, 2011a & Census of India, 2011b

Map 3.2: Buffer zone around the Harike Wetland



3.2.2 Sample of Ropar Wetland: For the selection of sample size and surveyed areas around the Ropar wetland, a buffer zone of one kilometre had been demarcated around the wetland. There were 20 villages fall within the 1 km buffer zone around. But, on the basis of population and direction, one city and nine villages had been

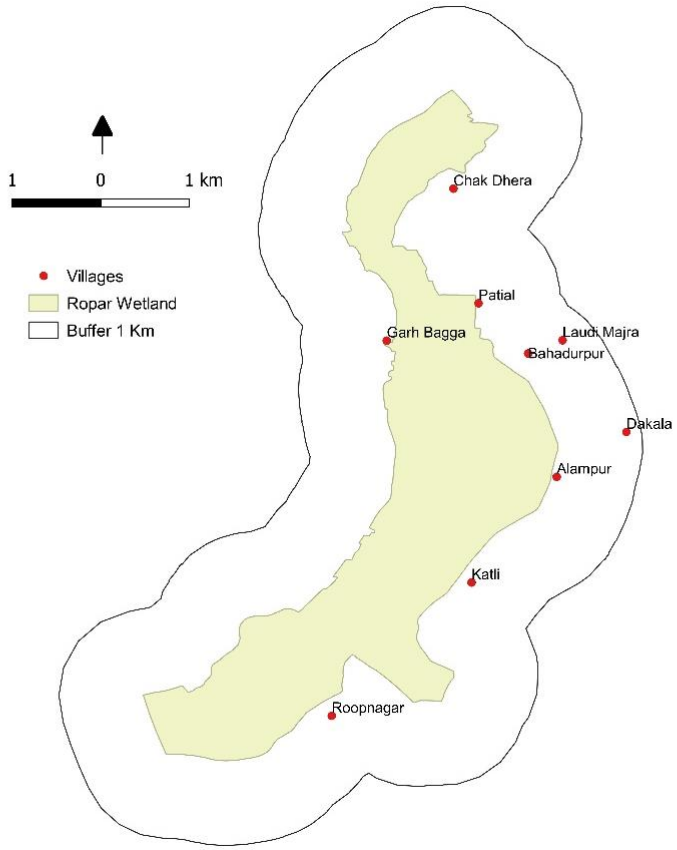
selected to study the socio-economic importance of the wetland area. The list of selected surveyed area and their sample size has been given in the following table;

Table 3.7: Sample Size for the Surveying around the Ropar Wetland

Village/town	Population (2011)	Household No. (2011)	Area	Direction	Sample Size
Rupnagar	144600	28270	Urban	South-East	71
Chak Dhera	461	91	Rural	North	5
Laudi Majra	1032	209	Rural	North	10
Bahardurpur	425	83	Rural	East	4
Dakala	646	115	Rural	East	6
Garh Bagga	1698	351	Rural	West	18
Tabba Tiaprian	1445	268	Rural	North-West	13
Patail	661	149	Rural	East	7
Katli	541	116	Rural	South-East	6
Alampura	506	94	Rural	East	5
Total Sample Size of Ropar wetland= 145					

Sources: Economic & Statistical Organization, 2015 & Census of India, 2011c

Map 3.3: Buffer zone around Ropar Wetland



3.2.3 Sample of Nangal Wetland: There were 9 villages were fall within 1 km buffer zone of Nangal wetland. For the Survey, one town namely Nangal and four villages namely Swamipur Bagh, Khera Bagh, Talwara and Bhabahor Sahib were selected

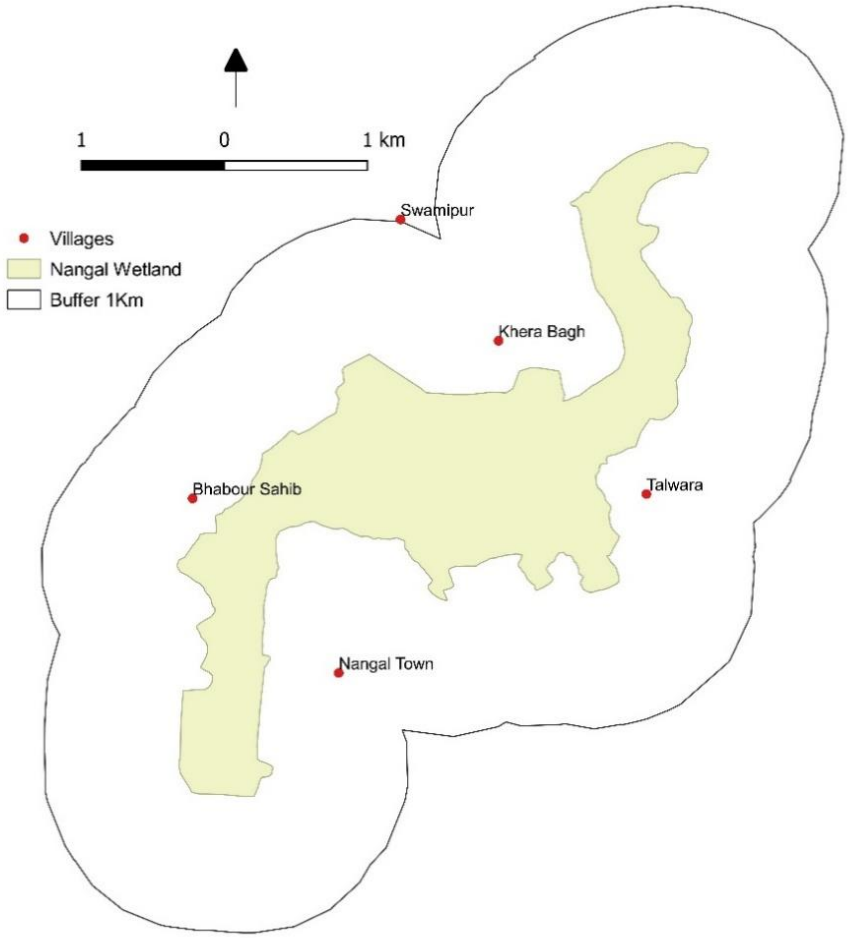
for the surveying. The selected villages and their direction of the location were as; Swamipur and Khera Bagh in the North direction, Bhabahor Sahib in West direction, Nangal in South direction and Talwara in the East.

Table 3.8: Sample Size for the Surveying around the Nangal Wetland

Village/town	Population (2011)	Household (2011)	Area	Direction	Sample Size
Bhabhaur Sahib	3263	703	Rural	West	35
Swamipur	901	178	Rural	North-West	9
Khera Bagh	367	78	Rural	North-West	4
Talwara	1118	227	Rural	East	11
Nangal	48497	10738	Urban	South-East	27
Total Sample Size of Nangal wetland=86					

Source: Census of India, 2011c

Map 3.4: Buffer zone around Nangal Wetland



3.3 Preparation of Interview Schedule: The interview schedule had been prepared for the fulfilment of the objective of the study area. The interview schedule covered both closed and open-ended questions. The interview schedule was divided into a subsection on the basis of the objective of the study. The respondents for the survey were selected on the basis of stratified random sampling. The sample had covered mainly those respondents who live around the wetland area. On the basis of livelihood, respondents had been chosen mainly from different sectors such as agriculture, fishing, livestock and tourism etc. The size of the sample for the interview schedule was about 401.

3.4 Data Sources and Methodology: The present research is exploratory in nature. Descriptive research is designed to obtain pertinent and precise information concerning the current status of phenomena and, whatever possible, to draw a valid general conclusion from the facts discovered (Koul, 2009). The data for this study was generated from secondary as well as primary sources. The secondary sources were concentrated on existing plans, demarcation and boundary related data of selected wetlands. The primary data consists of field survey which was associated to conduct a survey within a 1km buffer zone of rural and urban areas of Harike, Ropar and Nangal wetlands.

3.4.1 Secondary Sources: The secondary data are those in which information is collected by someone else and used by another scholar to meet their needs of research. This means that first-hand information is not generated through secondary data. Secondary data provide us with a base or strong literature to do research. For example, the study related to wetlands and its contribution to farmers livelihood, but before to know about the wetland contribution to farmer's livelihood, it is important to know about the function and areas of wetland. The secondary data had been collected from the various journals (Elsevier, Springer, Sustainability, Taylor & Francis etc.); newspapers (The Tribune, Hindustan Times, The Hindu etc.); reports published by various agencies and government organisations (SACON (Salim Ali Centre for Ornithology and Natural History), MoEF & CC, WWF, Space Application Centre (SAC), Hyderabad, Wetland International, PSCST etc.). The unpublished reports related to the selected wetland area had been collected from the Department of Forest and Wildlife Preservation (Wildlife), Ferozepur and Rupnagar. Besides this, some relevant data had been collected by the visiting of Department of Forest

and Wildlife Preservation, Mohali and Punjab State Council for Science and Technology, Chandigarh. Moreover, some data related to wetlands was also collected from the regional office of Harike, Ropar and Nangal wetlands.

3.4.2 Remote Sensing & GIS: Mapping from remote sensing data was done using Earth Resources Data Analysis System (Erdas) Imagine, ArcGIS and QGIS software. First of all, the base map had been prepared with the help of topographical sheets. The geo-referencing of topographical sheets had been done with the help of QGIS software and boundaries of specific wetland areas had been generated by the digitization of topographical maps.

Table 3.9: Image Characteristics of Landsat 7 ETM+ and Landsat 8 OLI and TIRS

Sensor	Bands		Spatial Resolution (m)
Landsat 7	Band 1	Blue	30
	Band 2	Green	30
	Band 3	Red	30
	Band 4	NIR	30
	Band 5	SWIR-1	30
	Band 6	TIR	60*30
	Band 7	SWIR-2	30
	Band 8	Pan	15
Landsat 8	Band 1	Ultra-Blue (Coastal /Aerosol	30
	Band 2	Blue	30
	Band 3	Green	30
	Band 4	Red	30
	Band 5	NIR	30
	Band 6	SWIR 1	30
	Band 7	SWIR 2	30
	Band 8	Panchromatic	15
	Band 9	Cirrus	30
	Band 10	Thermal Infrared (TIRS)1	100*(30)
	Band 11	Thermal Infrared (TIRS) 2	100*(30)

Source: United State Geological Survey (USGS)

The satellite images of Landsat 07 Enhanced Thematic Mapper (ETM) having 7 bands for 2003 and Landsat 08 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) having 11 bands for 2017 was used to detect a change in land use of Harike, Ropar and Nangal Wetlands. The satellite data for the study area were accessed through the Earth Explorer of United State Geological Survey (USGS). Image characteristics are given in table 3.9.

Table3.10: Landsat 7 ETM+ and Landsat 8 OLI/TIRS used in the study

Sensor	Path	Row	Acquisition date
Landsat 8 OLI/TIRS	148	38	19 March 2017
Landsat 7 ETM	148	38	05 March 2003
Landsat 8 OLI/TIRS	147	38	12 March 2017
Landsat 7 ETM	147	39	10 February 2003

Source: United State Geological Survey (USGS)

3.4.2.1 Image Subset or Mask Layer: The study areas have been extracted from satellite imageries with the help of subset tool in Erdas Imagine.

3.4.2.2 Image Classification: For the Image classification of selected wetland area, vector data had been generated for each class and with the help of QGIS software land use of each wetland had been prepared.

3.4.2.3 Change Detection: In order to extract information about the surface water of Harike Wetland, Landsat 7 image of the year 2003 and Landsat 8 image of the year 2017 is used (Fig). The Normalized Difference Water Index (NDWI) is a widely used method to delineate open water features. The NDWI makes use of visible green light and reflected near-infrared radiation (NIR) to enhance the presence of waterbody. The NDWI is expressed as follows (McFeeters 1996):

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

The method of NDWI was designed by McFeeters in 1996 to detect surface waters in wetland environments and to allow for the measurement of surface water extent. It was calculated in the spatial analyst tool of Arc GIS software. The result is presented in gray-scale as well as a color-coded image.

3.4.2.4 Map Composition: Final maps were composed with the help of the QGIS software by using the tool of a new print layout and exported into Joint Photographic

Experts Group (JPEG) format. The features like scale, north arrow, the title of map and legend added to map for classified and understanding of the map.

3.4.3 Primary Sources: The primary data is first-hand information that was collected by researcher through fieldwork. Thus, primary data was collected mainly through interview schedule and group discussion. In order to enhance the quality of research data, personal observation method was also used. The primary data collected in a few phases, for example in the first phase tentative interview schedule was prepared and in this phase pre-testing of the interview schedule was done with a short survey in the field. Therefore, on the basis of the collected information, a well-designed pre-tested interview schedule was prepared. Before undertaking the main survey, pre-testing of the tentative interview schedule had been done by selecting of about 30 respondents to know the validity of the interview schedule. Therefore after the testing of the interview schedule, the final schedule was prepared by making a correction in it with the removal of unwanted questions and adding some relevant question that ensures the reliability of data. The interview schedule had been prepared in both Punjabi and English languages and the data for the study had been collected by the researcher by asking questions from respondents in local Punjabi language. In addition to this, information related to the particular wetland was collected from the local office of the government department also. The households for the survey were selected on the basis of the population of each village. The step used for selection of surveyed areas and sample size from each village and towns are listed above. The numbers of total household selected from the study areas were 401.

3.4.4 Field Observation: The observational method had been used mainly to know the behavioural aspects of the respondent through personal observation rather than solely dependent on the response of respondents. Through, the observational method accesses the information that was only concerned with the present situation rather than the past. The observational method was qualitative in nature because it provided us with real information rather than the willingness of the respondent.

3.5 Data Analysis and Interpretation: The analyses of the collected information from the different sources have been organized into their representative categories so as to come up with logical results. In dealing with the qualitative analysis based on the data collected from the different sources, an effort was made to carefully

understand and interpret the information to use it together with the quantitative data. Data were tabulated by using 'Likert Scale' for the responses to make them quantitative.

3.5.1 Use of 'Likert Scale': The data been saved by using Microsoft excel after converting it into 'Likert scale' values. The responses have been divided into three categories mainly by giving them ranging from 1 to 3. This was done to make calculations easy and to calculate correlation, mean and standard deviation from the qualitative data also. Tabulation of data and various responses in percentages was done after doing this.

3.5.2 Model 1 Specifications: After converting the whole qualitative data into quantitative values by using 'Likert Scale', data has been tabulated in Excel spreadsheets. To calculate the Economic Value of wetlands, calculations have been done in Excel spreadsheets. To calculate the economic value of each wetland, direct use value and expenditure were calculated and indirect use value was only explained by observation during the field survey (Tables 3.11). This could be possible the limitation of the study.

Table 3.11: Indicators used for Economic Evaluation of Wetlands

Value	Indicators	Data Sources
Direct Use Value	Fish Agriculture Production Livestock Tourism Restaurant	Collected during Field Survey and Secondary Sources
Expenditure	Government	Data Collected from government offices
Indirect Use Value	Religious Recreational Aesthetic Habitat Conservation Species Conservation Flood and Landslide Control Groundwater Recharge	Collected during Field Survey through interview schedule

Total Economic Value has extracted from Direct Use value (Except direct Water value) + Expenditure of government for the maintenance of wetland areas. The Valuation has done for the year 2017; Government Data, Remote Sensing data and field survey has been conducted in the year 2017.

Table 3.12: Indicators for the Direct Use value of Harike Wetland

Indicators	Parameters	Data sources for Valuation
Agriculture	✓ Wetland area used for agriculture (Illegal) in acres. ✓ Average annual income from agriculture.	• Total agricultural land extracted from google earth pro database. • Average annual income (per acre) on the basis of production and expenditure occurred.
Fish	✓ Total price money was given to the government under contract for fishing (per annum). ✓ Annual Income by contractor through fishing.	• Annual income by the contractor after deducting the contract amount payable to the government.
Livestock	✓ Percentage of respondent household depends upon wetland for grazing. ✓ Average annual income from livestock.	• Percentage of respondent households who are directly dependent upon wetlands for grazing purposes, which means the livestock is directly depended upon wetland, is taken for direct value of the wetland for livestock. The number of total households (dependent on wetlands for livestock) of every village is estimated from the sample. Then, the number of household come after calculation is multiplied by the average annual income from livestock. • Average milk production of a year is multiplied by Rs. 32 (average milk selling price per litre around Harike Wetland) minus average annual expenditure on livestock.
Tourism	✓ Number of passes issued to visitors per year. ✓ Travel cost.	• Daily visitors book to get data of yearly number of visitors. • Distance from the place of origin of visitors multiply by travel cost.
Restaurant	✓ Annual income of restaurants.	• Average monthly income of restaurants, food points *(dhabas*) and tea stalls, is used which indicates the value of expenditure done by people on food and accommodation etc.

Table 3.13: Indicators for the Direct Use value of Ropar Wetland

Indicators	Parameters	Data sources for Valuation
Agriculture	✓ Wetland area used for agriculture (Illegal) in acres. ✓ Average annual income from agriculture.	• Total agricultural land extracted from google earth pro database. • Average annual income (per acre) on the basis of production and expenditure occurred.
Fish	✓ Total price money was given to the government under contract for fishing (per annum). ✓ Annual Income by contractor through fishing.	• Annual income by the contractor after deducting the contract amount payable to the government.
Livestock	✓ Percentage of respondent household depends upon wetland for grazing. ✓ Average annual income from livestock.	• Percentage of respondent households who are directly dependent upon wetlands for grazing purposes, which means the livestock is directly depended upon wetland, is taken for direct value of the wetland for livestock. The number of total households (dependent on wetlands for livestock) of every village is estimated from the sample. Then, the number of household come after calculation is multiplied by the average annual income from livestock. • Average milk production of a year is multiplied by Rs. 32 (average milk selling price per litre around Ropar Wetland) minus average annual expenditure on livestock.
Sand Mining	✓ No. of respondents involves in sand mining and their annual income.	• Average annual income of respondents by the selling of sand per hoarse cart in the market.
Plantation	✓ Wetland area used for plantation (Illegal) in acres. ✓ Average annual income from plantation.	• Total agricultural land extracted from LISS IV data. • Average annual income (per acre) on the basis of an average of a tree planted per acres.
Kayaking	✓ Annual income from training.	• No. of students comes for training
Restaurant	✓ Annual income of restaurants.	• Average monthly income of restaurants, food points *(dhabas*) and tea stalls, is used which indicates the value of expenditure done by people on food and accommodation etc.

Table 3.14: Indicators for the Direct Use value of Nangal Wetland

Indicators	Parameters	Data sources for Valuation
Agriculture	✓ ----------	• ----------.
Fish	✓ Total price money was given to the government under contract for fishing (per annum). ✓ Annual Income by contractor through fishing.	• Annual income by the contractor after deducting the contract amount payable to the government.
Livestock	✓ Percentage of respondent household depends upon wetland for grazing. ✓ Average annual income from livestock.	• Percentage of respondent households who are directly dependent upon wetlands for grazing purposes, which means the livestock is directly depended upon wetland, is taken for direct value of the wetland for livestock. The number of total households (dependent on wetlands for livestock) of every village is estimated from the sample. Then, the number of household come after calculation is multiplied by the average annual income from livestock. • Average milk production of a year is multiplied by Rs. 32 (average milk selling price per litre around Nangal Wetland) minus average annual expenditure on livestock.
Sand Mining	✓ No. of respondents involves in sand mining and their annual income.	• Average annual income of respondents by the selling of sand in the market.
Restaurant	✓ Annual income of restaurants.	• Average monthly income of restaurants, food points *(dhabas*) and tea stalls, is used which indicates the value of expenditure done by people on food and accommodation etc.

3.5.3 Model 2: Three-Dimensional Matrix for Threats to wetland: A three-dimensional matrix analysis has been made with 10 indicators of threats to the wetland area. These indicators are the perception of the people living around the wetland area. People perceive that these are the major causes of the degradation of wetland area which could be treated as threats to the wetland area. The high score values of the index indicate the more probability of threat to the wetland of that indicator to affect the wetland area as per people's perception. To calculate the matrix, 10 indicators are taken and each indicator has been assigned a weightage

as per their priority to be a threat as identified by the respondents. The ranking has been given to the percentage of the response of the people saying 'Yes' to the indicator of being a threat. The index obtained from the analysis of primary data is multiplied by weightage to evaluate a score for the corresponding villages (Table 3.15).

Table 3.15: Indicators and Weightages for 3 dimensional Matrixes

Sr. No.	Indicators of threats	Weightage (Total 10)	(% of respondents saying 'Yes')	Rank
1	Agricultural drains to wetland	2	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
2	Industrial effluent drained to wetland	2	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
3	Sediment accumulation and suspension	1	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
4	Excessive water extraction for urban use, agriculture and industry	1	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
5	Overgrazing	0.5	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
6	Weeds/hyacinth/other aquatic plant	1	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
7	Increased human activity within the wetland	0.5	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
8	Poor water quality	1	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
9	Encroachment of wetland by human activities	0.5	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
10	Household waste dumped to wetland/around wetland	0.5	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4

3.5.4 Model 3: Three Dimensional matrix analysis of conservation and Management

A three-dimensional matrix analysis of management has been made with 7 indicators of management related observation of local people to wetlands area. The high score values of the index indicate the more implementation of management indicator to wetland as per the people observation. To calculate the matrix, 7 indicators are taken and each indicator has assigned a weightage as per their priority to be more significant for management. The ranking has been given to the percentage of the response of the people saying 'Yes' to the indicator of happening on the ground reality. The index obtained from the analysis of primary data is multiplied by weightage to evaluate a score for the corresponding villages (Table 3.16).

Table 3.16: Indicators and Weightages for 3-dimensional Matrixes

Sr. No.	Indicators of conservation and management	Weightage (Total 10)	(% of respondents saying 'Yes')	Rank
1	Demarcation/fencing around wetland	2	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
2	Waste treatment measures near the wetland	2	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
3	Removal of weeds/hyacinth/other aquatic plant	2	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
4	Removal of silt	1	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
5	restriction on Increased human activity within wetland	1.5	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
6	Outreach and Education Action/awareness camp	1	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4
7	Participatory planning/involvement of local community/NGOs	0.5	Less than 25 %	1
			25-50%	2
			50-75%	3
			75-100 %	4

3.5.5 Model 4-Probit Model: The probit regression methods are the best choice for the analysis of data when the dependent variable is binary means that value assigned 1 if the event occurs and 0 otherwise (Dougherty, 2011). But, in the study, the probit model has been used to estimate the willingness to pay of respondents for the conservation and management of wetlands, livestock grazing and services of water supply. It was introduced in 1934 by the Chester Bliss. Since there was no problem of endogenous in the data, therefore uses the simple probit model in the study to know the willingness to pay of respondents. The equation of a simple probit model is expressed as:

$$Y_{1i}^{*} = \beta X_{1i} + u_i$$

Where $i = 1,2.....N$ $\beta X = \beta_1 + \beta_2 X_1 + \beta_3 X_2 + \beta_4 X_3 + \beta_5 X_4 + \beta_6 X_5 + \beta_7 X_6$ and u_i means error. We do not observe instead we have information on

$$Y_{1i} = \begin{cases} 0 & Y_{1i}^{*} < 0 \\ 1 & Y_{1i}^{*} \geq 0 \end{cases}$$

3.5.6 Model 5: Microeconomic theory suggests that willingness to pay should change across individuals having various differing socio-demographic characteristics, residential characteristics and others (Casey et al., 2006). The specification of the model is as follows:

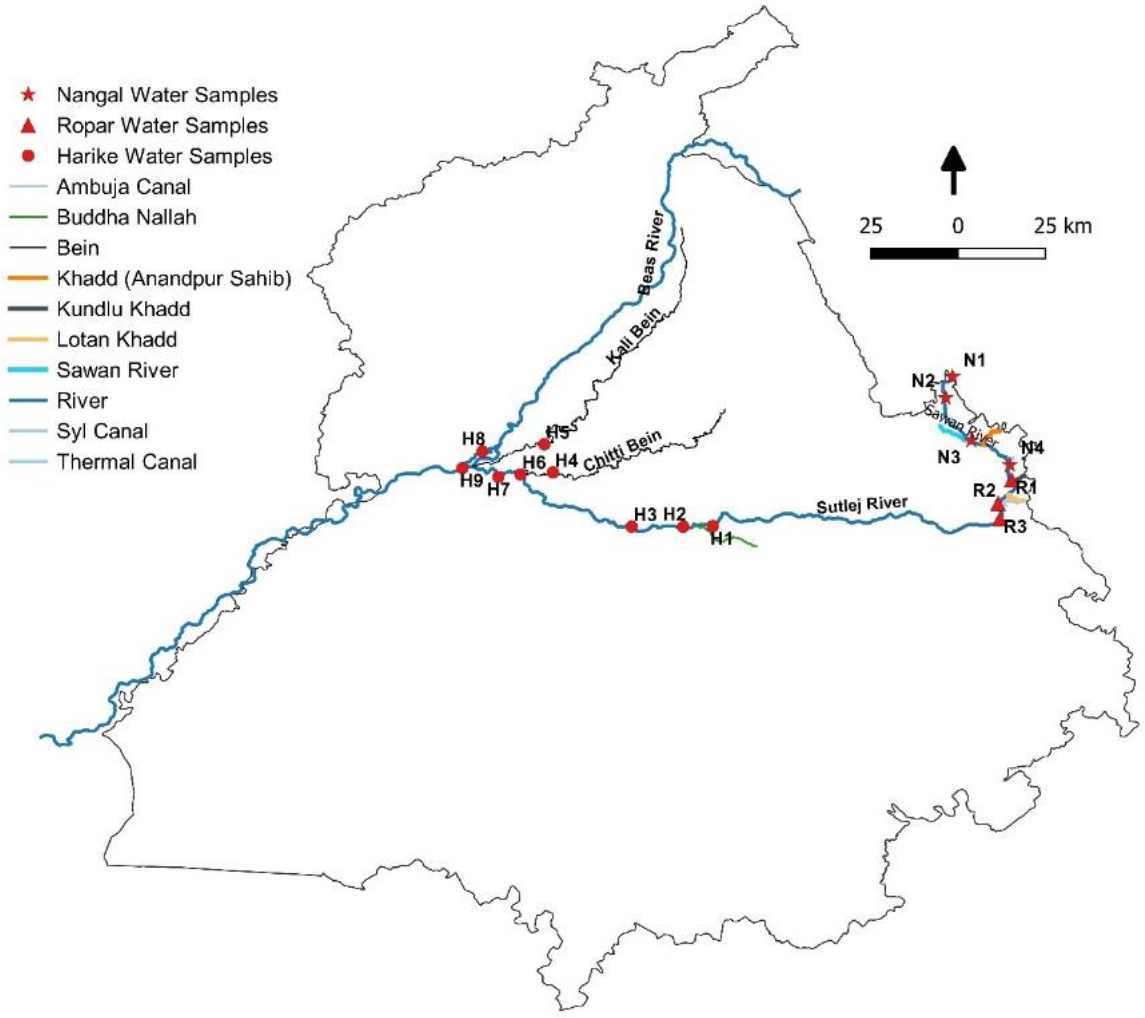
$$\text{Aesthetic}_j = \alpha_0 + \beta_1 X_1 + \varepsilon \text{.....} \quad \text{(i)}$$

Where X_1…….X_7 indicate seven explanatory variables (X_1=religion, X_2= caste, X_3= Age, X_4= occupation, X_5= education, X_6= family member and X_7= family income) and j represents aesthetic use of wetland area. The estimation method of the model is linear regression. This model is important to study the use of wetland area for aesthetic uses.

3.5.7 Physical Analysis of Water: Water samples were collected from 16 sites along the River Sutlej and Beas in November 2018. Out of total samples, twelve numbers of water samples were collected from Sutlej River and one each from the Kali Bein, Chitti Bein, Beas River and one sample collected from Harike headworks with the assumption that the water is well mixed (Map 3.5). Physical parameters such as pH, temperature, electric conductivity, salinity and total dissolved solids were measured in the field using a portable Systonic S72 Multi-parameter Water Analyzer. 250 ml water was collected from each location in Tarson Low Density

Polyethylene (LDPE) 250 ml bottles. For calibration of the instrument, in-house standard prepared in Geography and Geology lab, Central University of Punjab, Bathinda were used. For pH calibration, 3 point calibration of pH 4, 7 and 10 pH capsules of Merck were used. For conductivity calibration 0.001N, 0.01N, 0.1N KCl (Potassium Chloride) solution and set conductivity 12890 µs, 1412 µs, 146 µs respectively were used. For TDS calibration, the same solution was used as mentioned for conductivity and value of conductivity multiplied by a factor 0.65 for salinity adopted the same method as TDS but for salinity, a multiplication factor of 0.5 was used. All the solution and standard were made with de-ionized water (Milli Q) in LDPE 125 ml bottle. All the solution were made at standard room temperature.

Map 3.5: Water Sample locations of Harike, Ropar and Nangal Wetlands



Source: Prepared by Researcher in QGIS

Table 3.17: Physical Characteristic of River Water Samples collected near Harike, Ropar and Nangal Wetland (18-11-2018)

Sample location	Location	Approximate location	Temp. (C˚)	Salinity (ppm)	PH	Conductivity (µs)	TDS (ppm)
H1	30°58.590' N to 75°41.102'E	Before Buddha Nallah	21.2	732	8.29	928	625
H2	30°58.477' N to 75°35.866'E	After 2 km Buddha Nallah	21.4	1098	7.7	1421	941
H3	30°58.481' N to 75°26.847'E	After 4-5 km Buddha Nallah	22.5	1128	7.48	1482	969
H4	31°08.110' N to 75°12.763'E	Chiti Bein	21.2	2580	7.51	3380	2228
H5	31°13.089' N to 75°11.214'E	Kali Bein	19.3	675	7.85	906	586
H6	31°07.751' N to 75°07.004'E	Before Meeting chitti Bein	20.2	1168	7.59	1561	1012
H7	31°07.309' N to 75°03.083'E	After meeting Chitti Bein	20.4	1260	7.47	1693	1090
H8	31°11.830' N to 75°00.242'E	Beas River Kambo Dhaiwala	19.8	371.4	8.08	497.6	322.3
H9	31°08.890' N to 74°56.711'E	After Dam	20	389.6	7.73	519.8	337.6
N1	31°25'041" N to 76°23'583"E	Near Handola Bridge	19.5	180	7.83	276	191
N2	31°21.318' N to 76°22.435'E	After treatment plant in Nangal wetland	22.8	316	7.28	463	329
N3	31°13.792' N to 76°26.940'E	Gharshankar-Anandpur sahib road after brdige	20.1	280	8.08	426	303
N4	31°09.439' N to 76°33.803'E	After Meeting Syl into Sutlej River	20.5	200	8.5	296	210
R1	31°06.765' N to 76°34.023'E	Beliyan	20.2	235	8.35	346	241
R2	31°02.663' N to 76°31.709'E	Chak Dher	24.7	231	7.74	338	241
R3	30°59.885' N to 76°32.030'E	Katli	21.6	274	8.02	397	284

Source: Data was collected during field Survey, 2018

3.6 Objective wise detailed research methodology:

Objective 1: To prepare map of spatial extent of Harike, Ropar and Nangal wetlands for year 2003 and 2017 and study the change.

- To prepare a map of three selected wetland for the year 2003 and 2017 and detect the change in the geographical area, the discussed procedures are

used. The topographic sheets were used to prepare a base map of each wetland. Geo-referencing of the data was done on WGS UTM projection and information was extracted on land use/cover, roads, canals, settlements etc. Satellite imageries are helpful to generalize the location, shape, condition, geographical area and changing the trend of wetlands in the selected time period of 2003 to 2017 and mapping was done in ArcGIS and QGIS. To detect a change in land use areas toposheets, Landsat 07 ETM for 2003 and Landsat 08 OLI and TIRS satellite data for 2017 were used.

- To detect the land use change and developmental activities around the wetland. Methods: 1.3. A buffer of 1km was created around the wetland and the land-use change and developmental activities falling in the buffer area are mapped. The Normalized Difference Water Index (NDWI) method was used to study the change in the open water resources of the wetland area.

Objective 2: To study and analyze the impact of human developmental activities on Harike, Ropar, and Nangal wetlands.

- To know the impact of human development activities data related to agricultural activities within the wetland area has been prepared for 2017. To meet this sub-objective, data related to change in land use pattern around the wetlands areas was analyzed with the help of satellite data, google earth and verified in the field.
- To know the impact of human development activities in terms of waste generated by human beings in terms of solid and liquid. The objective focuses on population growth and their associated wastage over the wetlands. For this interaction was done with people and questions were asked related to dumping of solid and liquid wastes through interview schedule. Besides this, the major source point pollution source was identified during the field survey through both field observation and interview schedule. The perception of respondents regarding the threats perceived by the wetland area has been calculated by using the three-dimensional matrix.
- Impact of water quality: To meet this sub-objective data related to the pressure of urban expansion, population growth, and solid waste within the buffer zone of wetland area were collected to analyze the impacts of these activities mainly on the quality of water resources. To know the relation between development

activities and declining wetlands areas were collected through secondary sources such as from the various governmental agencies and regional offices and previous studies.

- The threat perception index had been developed to know the perception of people about the drainage of effluents from industrial, agricultural and household wastages, hyacinth problem, the encroachment of wetland area sediment accumulation and overgrazing etc. For this, data were collected from field survey and index had been produced by giving weightage according to the severity of the threat.

Objective 3: To assess the socio-economic significance of Harike, Ropar and Nangal wetlands of Punjab.

The socio-economic significance of selected wetlands was derived by taking consideration of a few parameters. A wetland may cover several villages but only 22 villages and towns had been selected to study their significance. The social significance is derived on the basis of socio-religious, tourism and aesthetic parameters. These are mainly qualitative parameters so the significance will be assessed on three point's qualitative scale. Economic significance will be calculated for the selected 22 villages.

- Tourism: This objective mainly focuses on tourism activities around the wetland areas. Methods: 3.1. In this objective data related to social-economic profile had been collected by preparing of the interview schedule. The total value of the wetland area had been classified as; indirect use value, non-use value and direct use value. The chi-square and multiple linear regression model had been used for estimating the factors influencing on the use of wetland area for aesthetic uses. The three-point Likert scale had been used to know the perception about the dependency of the respondent's on the wetland area.
- In this objective, the data related to tourists were collected from the Harike Wildlife Sanctuary. In addition to this, supporting facilities were also taken into concentration. First of all, tourists data has been collected from Harike Wildlife Sanctuary by the counting of issues pass from 1 January 2017 to 31 December 2017. The economic value has been calculated by using the travel cost

methods. For this, information regarding the origin and destination was collected and value has been calculated on the basis on travel cost per cost.

- The livelihood of local peoples are also affected by tourism activities such as some tourist prefer to stay in the nearby localities due to the absence of any public or private guest house or hotels, Therefore, services generated through tourism activity for people of selected villages are also be combined to get the value.
- Religious/community harmony: In this sub-objective data related to cultural or religious activities were collected from the field observation through the interview schedule methods. This cultural or religious ceremony also helps in an economic way, because on these special days it becomes a source of income for many vendors.
- Agricultural: The data related to agricultural land fall within the wetland area of Harike, Ropar and Nangal were calculated with the google earth. To calculate the economic value of agricultural sectors, data related to the type of crop harvested, their production per acres and expenditure occurred on per acres were collected through the field survey.
- Fishing: To meet this sub-objective data related to earning of income from the fishing were collected through the interaction with the fish contractor at Harike, Ropar and Nangal wetlands.
- Livestock: For fulfilling this objective, first of all, data related to respondents dependent on wetland area for livestock grazing had been collected through the interview schedule. The economic value for the livestock had been calculated after the collection of data about the milk production and expenditure occurred on the livestock.
- New activity around the wetland: The data related to some activities such as special road vendors around the wetlands, horticulture/flowers near the wetland areas also were covered in terms of economic values (Figure 3).

Objective 4: To analyze management and conservation policies of State and Central government and role of NGOs and the local community in wetland maintenance activities.

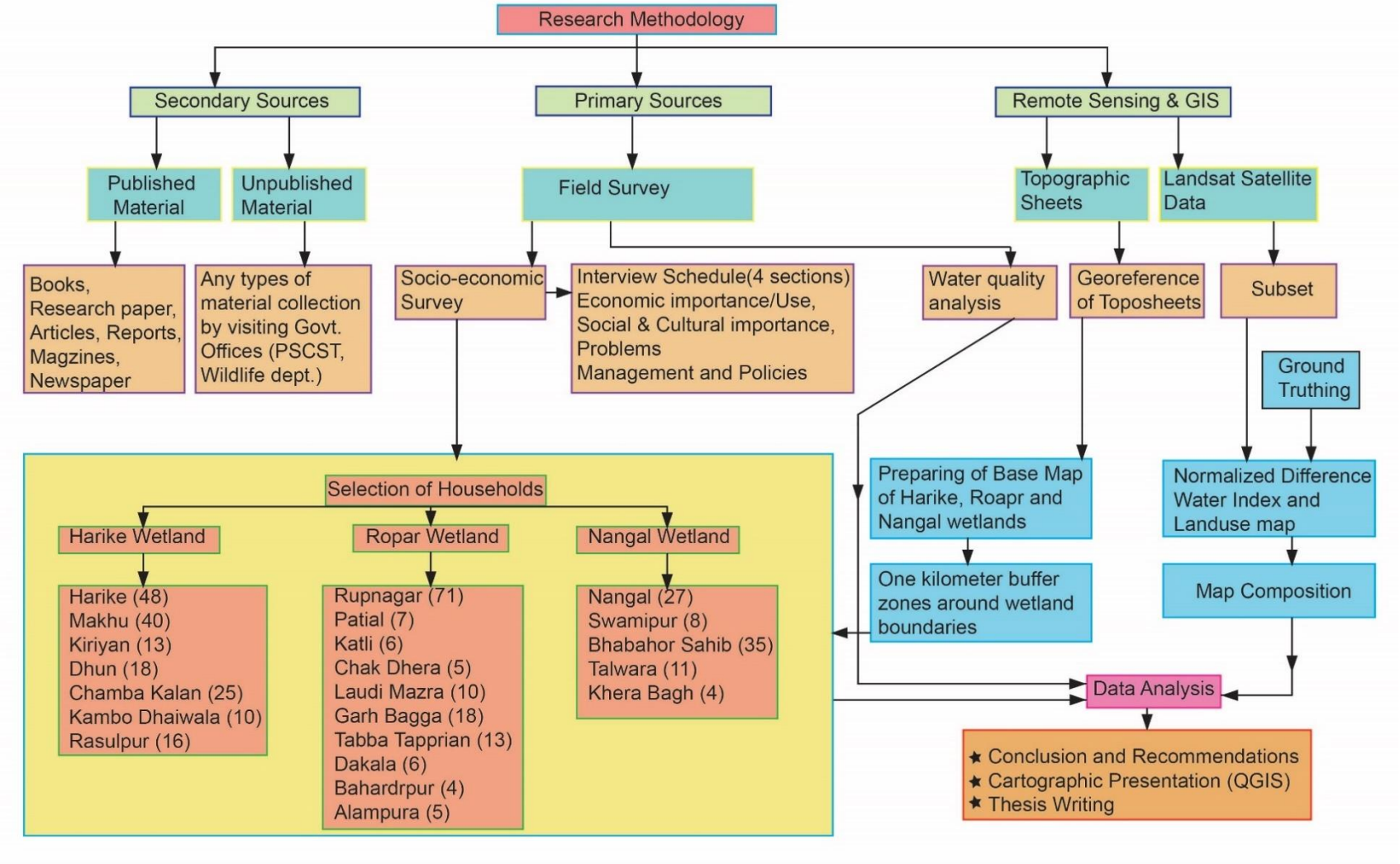
The fourth objective is split into two parts. The first part is entirely based on secondary data sources as mentioned above and the second part depends on the field survey

and interacting with NGOs and local people. The secondary data related to management and conservation were collected from the journals, articles, newspapers and published and unpublished reports of the Ministry of Environment, Forest and Climate Change, Punjab State Council for Science and Technology, Department of Forest and Wildlife Preservation (wildlife) Punjab, Punjab Pollution Control Board, Indian Space Research Organisation etc. The Primary data related to management and conservation of wetlands had been collected through the interview schedule by collecting data related to willingness to pay for the conservation and management of wetland area. Besides, field observation method also used. The unpublished data related to management and conservation of wetland areas were collected through the visiting concerned departments such as the Department of Forest and Wildlife Preservation (Wildlife), Mohali, Firozpur and Rupnagar. In addition to this, data related to NGO's working in the wetland area were collected mainly through the field survey. The probit model was used to know the willing to pay of respondents for the conservation and management of wetland area. The perception of people about the management and conservation of wetland area has been calculated through the collection of data related to awareness, demarcation of wetland area, treatment plant near a wetland area, removal of silt etc. The perception index had been developed for each wetland by giving weightage to an indicator of management activities.

Objective 5: To suggest recommendations for conservation and management of wetland.

After a full understanding of status and value of wetlands as well as problems associated with its recommendations are given at the end of the study. In addition to this, the policies adopted by governments at the local, national and international level is also be evaluated at ground level. Therefore, recommendations related to the conservation and management of wetlands are given after the evaluation of the whole study.

Figure 3.1: Flow Chart of Research Methodology



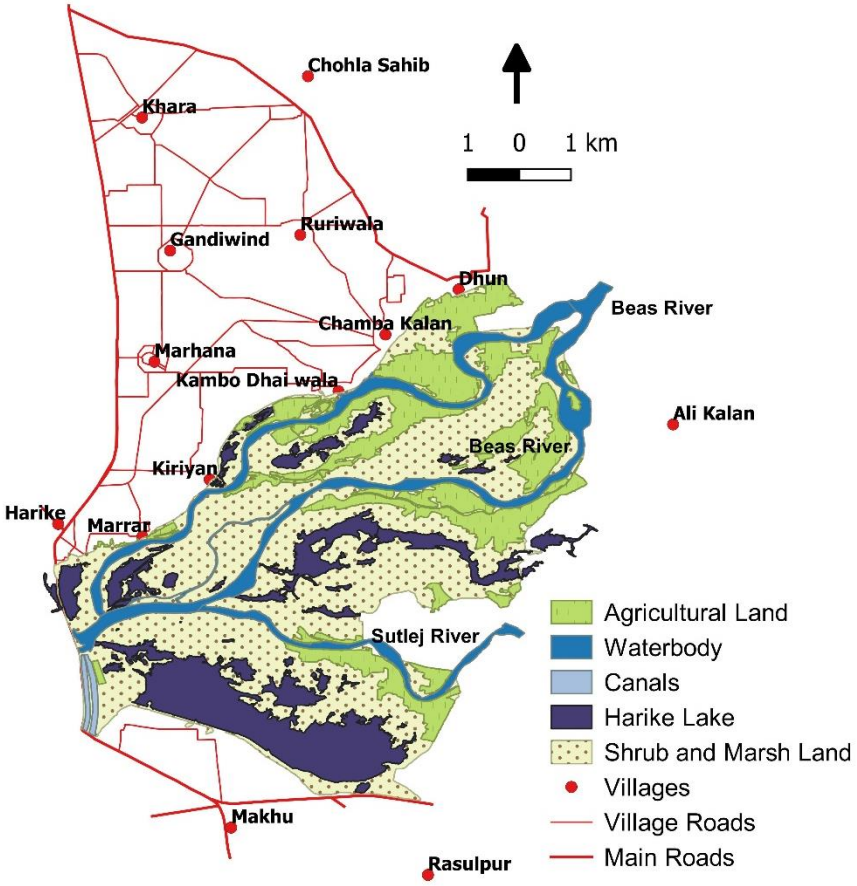
Chapter IV Result and Discussion

This chapter presents a comprehensive analysis of data collected from secondary sources and field survey. The results and analysis contained in this chapter are divided into four sections which follow the sequence of objectives.

Section I Spatial Extent and Change Detection

4.1 Land use and NDWI: Harike Wetland, Ropar and Nangal Wetlands

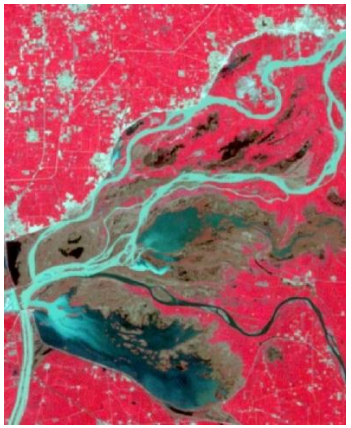
Wetland inventories are the prerequisite for management and conservation of any wetland. An inventory for the Harike wetland has been prepared for 2017 year. For preparing Inventory of Harike wetland, first of all, a base map of Harike map was prepared with the help of topographical sheets. After, preparing the base map of Harike wetland, land use map was prepared using google earth pro database. The result of land use consisted of five classes: shrubs and marshy land, river channel, lakes, canals and agricultural land. The area under each category is discussed below. Map 4.1 shows the land use classes of Harike wetland.



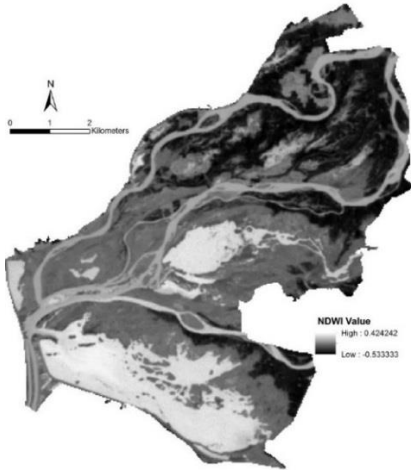
Map 4.1 Land use Map of Harike Wetland, 2017

Source: Map was created using QGIS Software

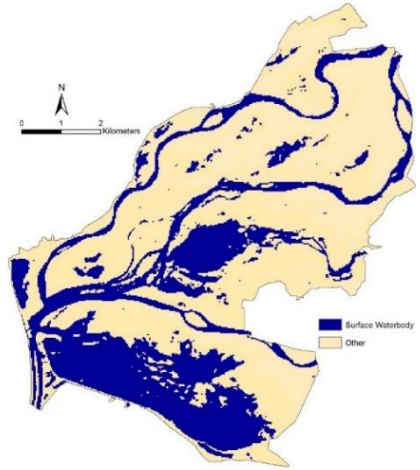
Map 4.2 NDWI for Harike Wetland (2003 and 2017)



Landsat Image of Harike Wetland of year 2003

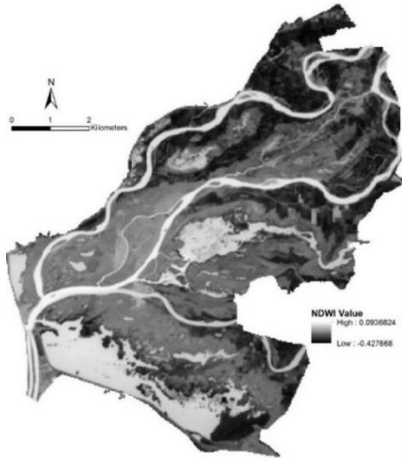


NDWI image of Harike Wetland of year 2003

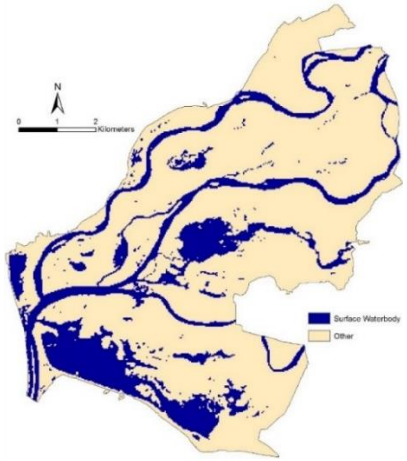


Color coded NDWI image of Harike Wetland of year 2003

Landsat Image of Harike Wetland of year 2017



NDWI image of Harike Wetland of year 2017



Color coded NDWI image of Harike Wetland of year 2017

Table 4.1: Area under Land use Classes in Harike Wetland

Sr. No.	Category	Areas in Hectare	Percentage
1	Agriculture Land	1268.9	17.06
2	Rivers catchment	750.41	10.09
3	Waterbody	1330.41	17.89
4	Shrubs and Marshy Land	4054.33	54.51
5	Canals	34.35	0.46
	Total area of Harike Wetland	7438.4	

Source: Computed by using Google Earth Pro database

To find out the water extent area, their variation and spread of aquatic vegetation, NDWI has been generated for the year of 2003 and 2017 using Landsat images. In satellite images, the waterbody appears very distinct in visible and infrared wavelength due to their strong absorbability. From the analysis, the Harike wetland expanse emerged out similar for both the years respectively. Although the total span of Harike wetland is 7438.4 hectares, the results revealed conspicuous changes in the land use pattern of Harike Wetland. The area under water resources declined from 33.55 percent (2149.29 hectares) to 23.12 percent (1481.40 hectares) of the total area of Harike Wetland. About 667.89 hectares area i.e. 10.42 percent of total areas under Harike wetland has experienced a decline in the extent of water resources from 2003 to 2017. The extent of other land use has increased from 66.45 percent (5289.11 hectares) to 76.88 percent (5957 hectares) in 2003-2017.

From map 4.2, it was observed that severe changes have occurred in the area of water in Harike wetland from 2003 to 2017. The most notable changes occurred in the South-eastern and central region of wetland areas. Area under the water resources declined at a higher level, due to the invasion of hyacinth in the wetland areas. Water hyacinth or Eichhornia Crassipes an aquatic plant, a native species of South America become a major problem for the water resources in the Harike wetland. Another major change was observed in the North and North-eastern direction of Harike wetland, where areas under small water bodies have converted into agricultural fields. From the map, it was also observed that the river course of the Sutlej River has changed from 2003 to 2017, which ultimately affects the land use of wetland areas. The major modification has occurred along the Sutlej River, where a temporary ‘bandh’ had been constructed by the government to lessen the

severity of floods. But, the land lies within these areas have been encroached by locals for agricultural activities. In addition to this, several changes occurred within the other category, where areas under the grassland have been converted into agricultural fields.

An Inventory for the Ropar Wetland has been prepared for the year 2017. The land use has been categorized into 10 classes on the basis of uses of the area for various purposes like use of the land for agricultural activities, forest, plantation, park, fish farming, training ground etc. The area under each class is given in the following table 4.2.

Table 4.2: Area under Land use Classes in Ropar Wetland

Sr. No.	Category	Areas in Hectare
1	Agriculture Land	520.48
2	Commercial Plantation	18.42
3	Sutlej River	501.69
4	Canals	16.61
5	Forest	128.85
6	Maharaja Ranjit Singh Park	8.38
7	Industrial Area	77.31
8	Fish Farming	8.14
9	Kayaking Training Ground	0.16
10	Marshy and Shrubs	185.44

Source: Computed by using Google Earth Pro database

Contrary to the observation of Harike wetland, areas under surface water bodies remain stable in the Ropar and Nangal wetland from 2003 to 2017. From map 4.4, it was observed that few changes occurred in the North-east direction of Ropar wetland. The major changes occurred in the East direction of wetland areas, under the Guru Gobind Thermal Power Plant. A very small changes seem to occur in the case of Ropar wetland because of presence of single river channel.

From the map 4.6, it was observed that areas under the surface water body has increased in the central parts of Nangal wetland, about 39.42 hectares under surface water body has increased from 2003 to 2017 (Table 4.4). There have been few changes occurred in the surface water resources due to the presence of a dam.

An Inventory of Nangal wetland has been prepared for 2017. For preparing this, a polygon has been created for each class. As per the notification of Department of Forest and Wildlife Preservation, Nangal wetland has expanded over 715.83 acres and about 95 percent area is covered under the water bodies. The area under each class is given in the below table 4.3.

Table 4.3: Area under Land use Classes in Nangal Wetland

Sr. No.	Category	Areas in Hectare
1	Agriculture Land	303.9
2	Waterbody	463.52
3	Forests	314.72
4	Settlements	21.7

Source: Computed by using Google Earth Pro database

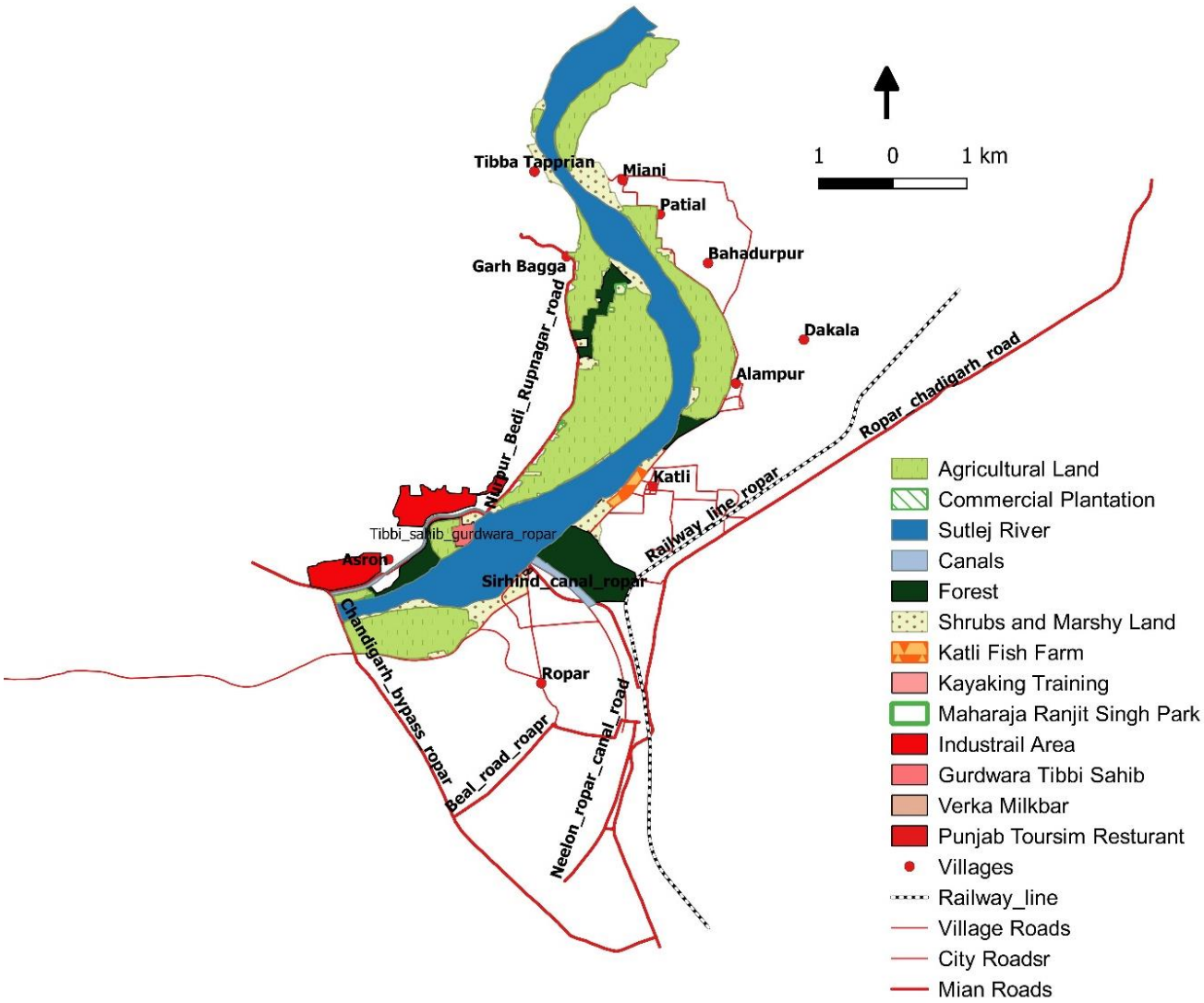
Table 4.4: Change in Area under Waterbody in Harike, Ropar and Nangal Wetlands

Land use type		Areas in hectares		Percentage		percentage change in areas
		2003	*2017*	*2003*	*2017*	*2003*
Harike	Waterbody	2149.29	1481.40	33.55	23.12	-31.07
	Others	5289.11	5957	66.45	76.88	15.68
Ropar	Waterbody	501.68	499.43	36.33	36.17	-0.44
	Others	879.07	881.32	63.67	63.83	0.25
Nangal	Waterbody	519.48	558.72	7.30	7.85	7.55
	Others	6600.78	6561.54	92.70	92.15	-0.59

Source: Computed from Landsat 7 and Landsat 7 satellite Images

From table 4.4, it has been revealed that area under water bodies has decreased from 21.49.29 hectares in 2003 to 1481.40 hectares in 2017 in Harike wetland. Whereas small changes occurred in Ropar wetland, where the area under water resources declined from 501.68 hectares in 2003 to 499.43 hectares in 2017. Contrary to this, the area under water resources has increased from 519.48 hectares in 2003 to 558.72 hectares in 2017 in Nangal wetland.

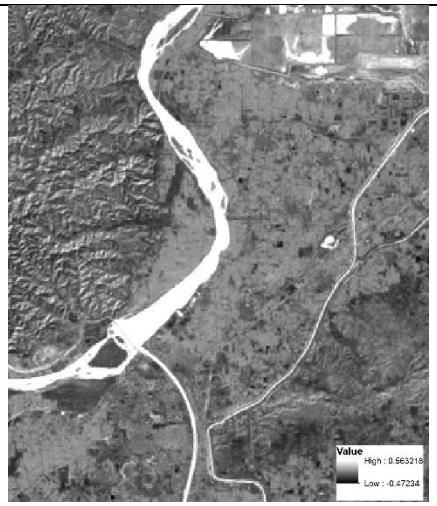
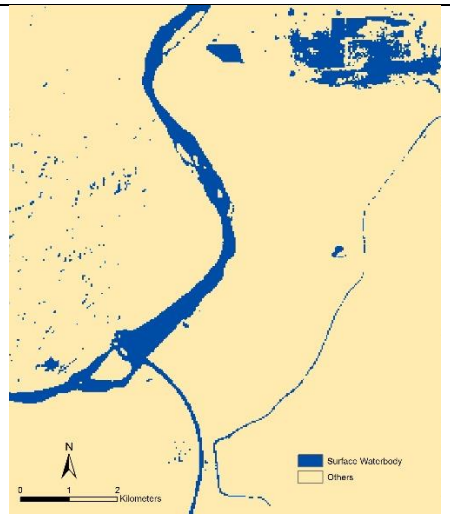
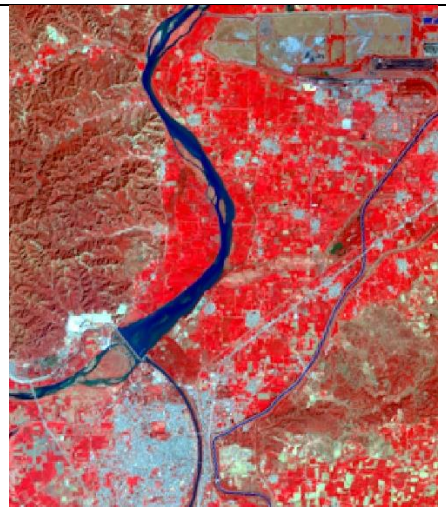
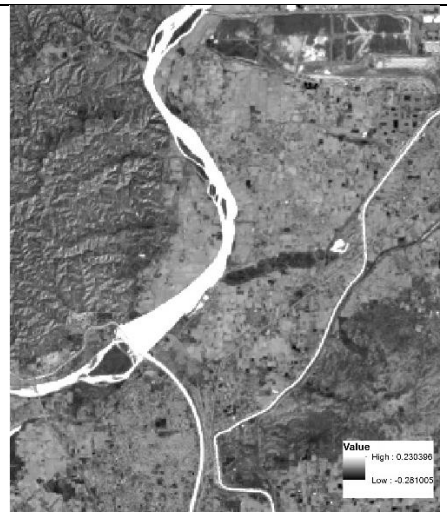
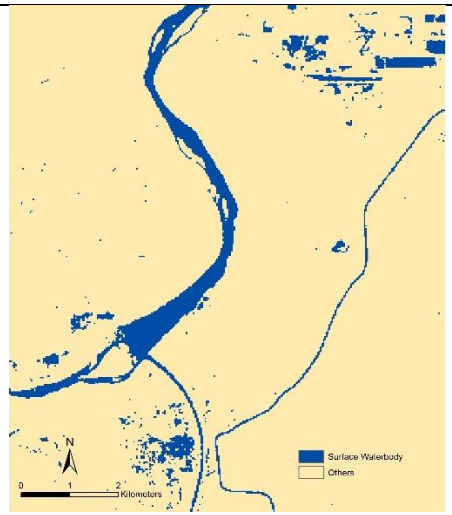
Comparably, there were very high changes (negative) occurred in Harike wetland in terms of water bodies rather than Ropar and Nangal wetlands. The percentage changes in water body areas of Harike wetland were -31.07, whereas -0.44 in Ropar and +7.55 in Nangal wetland from the year of 2003 to 2017. In terms of other land use types the positive percentage changes have been observed in Harike and Ropar i.e. 15.68 percent and 0.25 percent respectively. These results revealed that the threat of severe land use changes has occurred in Harike wetland in comparison to Ropar and Nangal Wetlands.

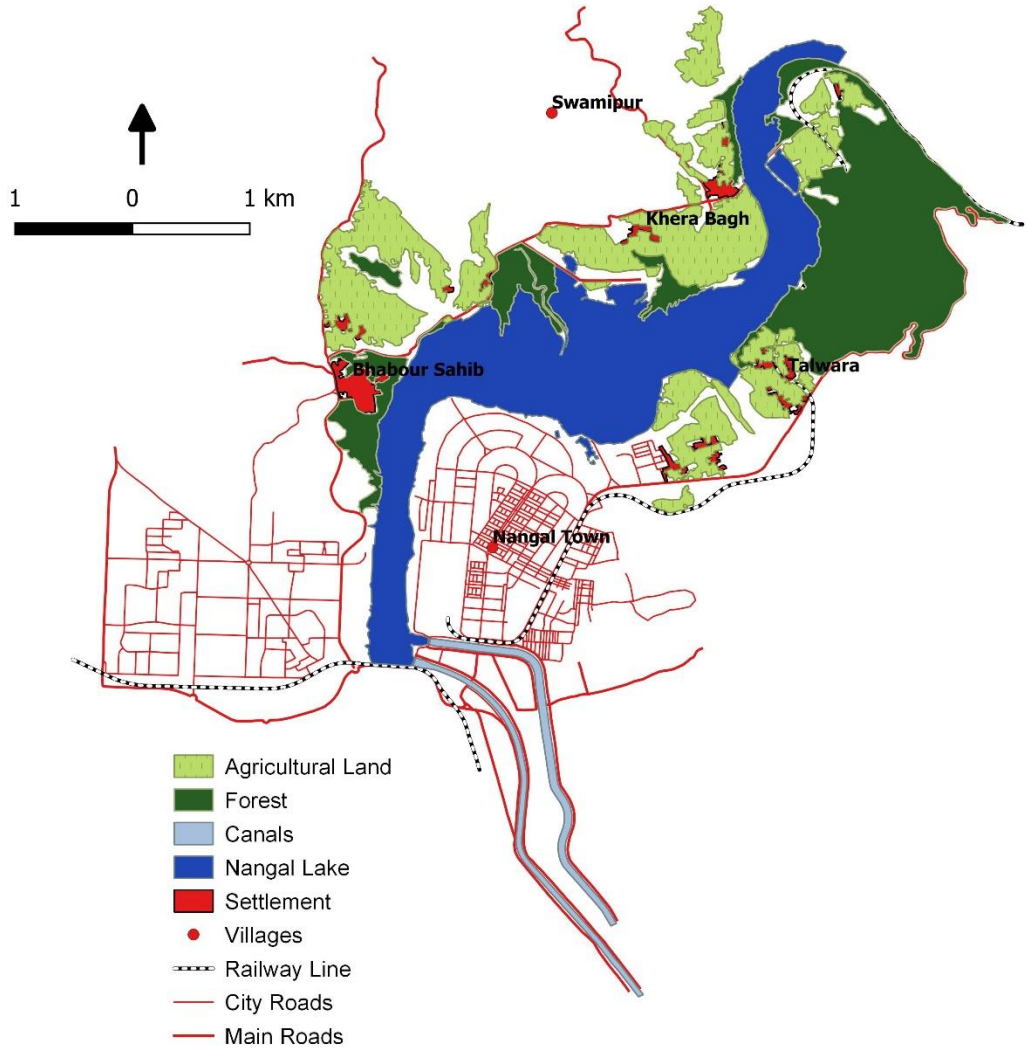


Map 4.3: Land use Map of Ropar Wetland, 2017

Source: Map was created using QGIS Software

Map 4.4: NDWI for Ropar Wetland (2003 and 2017)

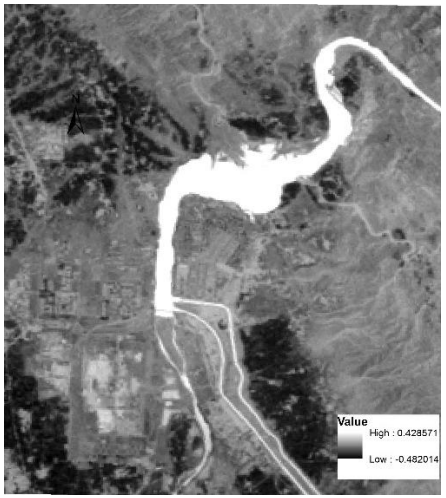
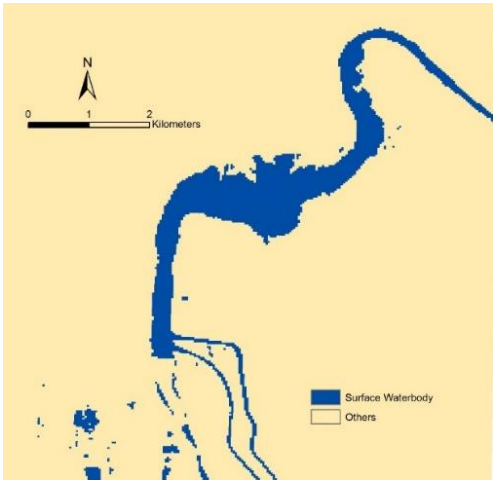
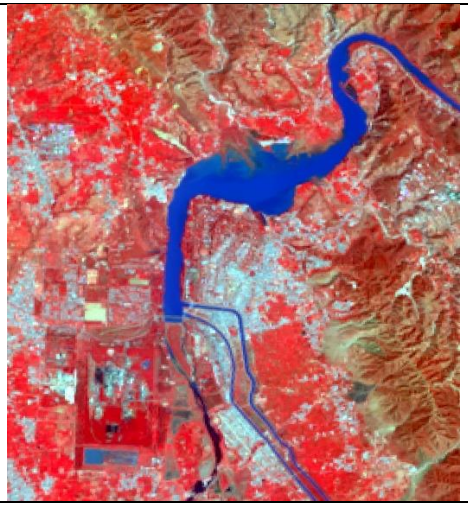
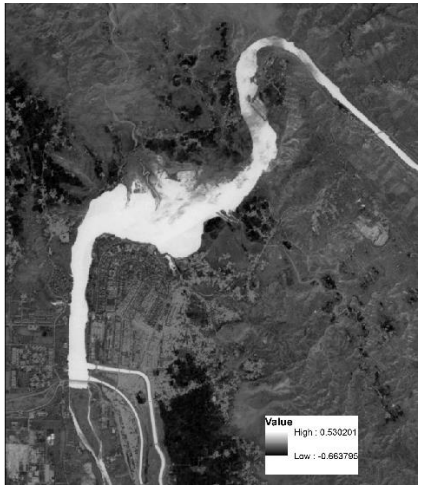
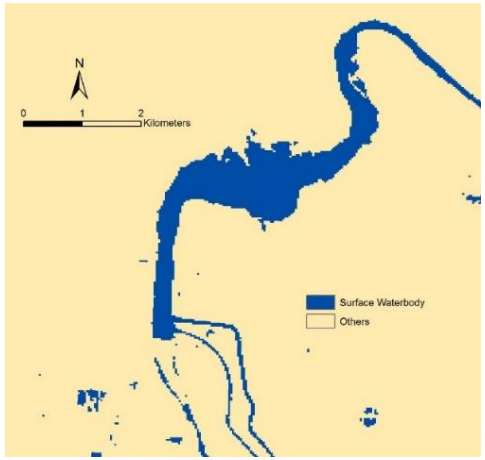
		
Landsat Image of Ropar Wetland of year 2003	NDWI image of Ropar Wetland of year 2003	Color coded NDWI image of Ropar Wetland of year 2003
		
Landsat Image of Ropar Wetland of year 2017	NDWI image of Ropar Wetland of year 2017	Color coded NDWI image of Ropar Wetland of year 2017



Map 4.5: Land use Map of Nangal Wetland, 2017

Source: Map was created using QGIS Software

Map 4.6: NDWI for Nangal Wetland (2013 and 2017)

		
Landsat Image of NangalWetland of year 2003	NDWI image of Nangal Wetland of year 2003	Color coded NDWI image of Nangal Wetland of year 2003
		
Landsat Image of Nangal Wetland of year 2017	NDWI image of NangalWetland of year 2017	Color coded NDWI image of Nangal Wetland of year 2017

Section II Socio-Economic significance of wetland areas

4.2 Demographic profile:

This study has examined the socio-economic significance of three selected wetlands. The primary data used in the study has obtained from a questionnaire survey of 401 respondents. Data has been collected to know about the socio-economic activities of local people who were living around the wetland areas. The socio-economic parameters of the respondents taken for the study are listed below:

4.2.1 Religion: It is one of the most important socio-economic parameters, which directly or indirectly affects the dependency of local people on wetland areas. Many religious places are situated on the bank of water bodies like wetlands, which connect the people directly to the wetland areas. Besides this, it also affects the dependency of local people on wetland areas in indirect way, because religion works as regulatory factor for the behaviours and choice of food of individuals. The religious norms of Sikhism and Hinduism prohibit their followers to eat non-vegetarian foods. Wetlands are a major source of fish production but the predominance of Sikhism and Hinduism religion around Harike wetland adversely affects the dependency of people on fishing (as their food item) and ultimately the socio-economic importance of wetlands.

Harike: In Harike Wetland, 83.52 percent belong to Sikhism, 12.94 percent to Hinduism, 1.76 percent to Islam and 1.76 percent to Christian religion.

Ropar: In Ropar Wetland, 54.48 percent belong to Sikhism, 33.79 percent to Hinduism and 11.72 percent to Islam

Nangal: In Nangal Wetland, 26.74 percent belong to Sikhism, 72.09 percent to Hinduism and 1.16 percent to Islam.

4.2.2 Social Groups: The respondents around the wetland belong to major three social group or categories i.e. General, OBC, and SC.

Harike: In Harike Wetland, people living around wetland areas belong to various social groups; 63.53 percent respondents belong to general category, 15.29 percent belong to OBC (Other Backward Classes) and 21.18 percent belong to scheduled castes.

Ropar: In Ropar Wetland, respondents who are living around wetland areas belong various social groups; 46.21 percent belong to general category, 21.38 percent belong

to OBC (Other Backward Classes), 32.41 percent respondent belong to SC (Scheduled Castes).

Nangal: In Nangal wetland, 51.16 percent of respondents belong to general category, 25.58 percent belong to OBC (Other Backward Classes) category and 23.26 percent belong to scheduled caste category.

4.2.3 Age: It is one of the most important parameters of socio-economic features, as each age group has its unique characteristics. The significance of the wetland areas changes with the particular age group. The age group has been categorized into four types; less than 20 years, 20-40 years, 41-60 years and more than 60 years.

Harike: In Harike wetland, 38.23 percent sample size belong to the 20-40 year age group, 49.41 percent belong to 41-60 year and 12.35 percent belong to more than 60 year age group.

Ropar: In Ropar Wetland, 0.69 percent respondent's are below 20 years age group, 35.17 percent belong to 20-40 year age group, 53.79 percent to 41-60 year age group and 10.34 percent respondents fall under more than 60 year age group.

Nangal: In Nangal wetland, 1.16 percent respondents fall under the category of below 20 years age group, 32.56 percent respondents belong to 20-40 age group, 59.30 percent belong to 41-60 age group and 6.98 percent of respondents belong to 60 and it's above age group.

4.2.4 Family size: The social, cultural and economic use of wetland areas are directly affected by the size of family members. When the number of family members increases the demand increases and when the number of members decreases then the dependency on wetland decreases. Family size of respondents is divided into three groups i.e. 1-3 members, 4-6 members and more than 6 members.

Harike: The majority of Harike respondents has family members between 4 to 6, 74.11 percent have a family size from 4 to 6 members, 18.82 percent have more than 7 members in the family and only 4 percent respondents have less than 4 members.

Ropar: In Ropar Wetland, 6.9 percent households have family size up to 1 to 3 members, 75.17 percent of households have family size up to 4 to 6 and 17.93 percent of households have family size more than 6 members.

Nangal: In Nangal wetland areas, 1.16 percent of respondents' family size is 1 to 3 family members, 88.37 percent of respondents' family size is 4 to 6 family members and 10.47 percent of respondents' family size is more than 6 family members.

4.2.5 Education: The development of any society, state, and nation depended on the quality and facilities of the education system. Education is one of the most significant parameters of socio-economic conditions of respondents that play a crucial role in the decision or use of the wetland areas.

Harike: In Harike Wetland, 30 percent respondents are illiterate, 47.06 percent have studied up to 10^{th}, 15.88 percent have studied up to senior secondary level and 7.06 percent have studied up graduation level or higher than this.
Ropar: In Ropar Wetland, 55.86 percent respondents are illiterate, 20 percent studied below 10^{th} standard, 13.79 percent studied to senior secondary and only 10.34 percent respondents have studied up to bachelor level or higher than this.
Nangal: In Nangal wetland, 16.28 percent respondents are illiterate, 24.42 percent respondents have studied below 10^{th} standard, 31.40 percent respondents are qualified up to +2 level and 27.9 percent educated graduation and more than this.

4.2.6 Income Group: The monthly income of the respondents has been divided into six categories: less than 5000, 5000-15000, 15000-25000, 25000-35000, 35000-45000 and more than 45000.

Harike: In Harike wetland, 21.18 percent respondents earn less than 5000 rupees, 48.24 percent earn 5000-15000, 16.47 percent earn 15000-25000, 3.53 percent earn 25000-35000, 4.70 percent earn 35000-45000 and 5.88 percent respondents earn more than 45000 per month. The income level of sample size varied according to urban and rural areas that are described in table 5.1.
Ropar: In Ropar wetland, 6.20 percent respondent earn less than 5000 per month, 41.38 percent respondents earn 5000-15000 per month, 22.07 earn 15000-25000 per month, 9.66 percent earn 25000-35000 per month, 9.66 earn 35000-45000 per month and 11.03 percent respondents earn more than 45000 per month.
Nangal: In a Nangal wetland, 6.98 percent respondents earn less than 5000 rupees, 31.4 percent earn 5000-15000, 32.56 percent earn within 15000-25000, 12.79 percent

have earn 25000-35000, 13.95 percent earn 35000-45000 and 2.32 percent respondents earn more than 45000 per month.

4.2.7 Occupation: Occupation is an important variable that affects the dependency as well as degradation activities by local people in wetland areas. For example, some of the respondents are directly linked with the activities like livestock rearing, fishing, agricultural activities, mining etc.

Harike: In Harike Wetland, about 47.65 percent respondents depend on agricultural practices to meet their livelihood, 14.71 percent are engaged in business activities (shops, hotels, restaurants), 12.94 percent respondents depend on wages and salary, 7.05 respondents are engaged in livestock activities, 9.41 percent in fishing activities and 8.24 percent are dependent on other earning activities likes street vendors, rickshaw pulling, boating etc.

Ropar: In Ropar Wetland, 24.83 percent respondents are engaged in the agricultural activities to sustain their livelihood, 12.41 percent respondent depends on business (shop, restaurants, hotels), 31.72 percent respondents depend on wages and salary (involves labour work, private and government job), 19.31 percent are engaged in agricultural allied activities (livestock grazing), 6.21 percent depend on fishing activities (catching and sale of fish) and 5.52 percent respondents depend on other activities (vendor near wetland areas, coaching, sale of sand (mining at very low level)).

Nangal: In the Nangal wetland, out of total respondents, 5.81 percent of respondents depend on the agriculture activities, 15.12 percent of respondent depends on business, 60.47 percent of respondent depends on wages and salary, 1.16 percent of respondent depends over the agricultural allied activities such as livestock grazing, 2.33 percent of respondent depended over the fishing and 15.11 percent people over the sand mining and street vendor etc.

Table 4.5: Demographic/ Socio-economic Profile of Sample from Study Area

Wetlands		Harike						Ropar						Nangal					
		Rural		Urban		Total		Rural		Urban		Total		Rural		Urban		Total	
Total Respondents		130		40		170		74		71		145		59		27		86	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Religion	Sikhism	114	*87.7*	28	*70.0*	142	*83. 52*	51	*68.90*	28	*39.4*	79	*54.48*	14	*23.7*	9	*33.3*	23	*26.74*
	Hinduism	12	*9.2*	10	*25.0*	22	*12.94*	23	*31.10*	26	*36.6*	49	*33.79*	45	*76.3*	17	*63*	62	*72.09*
	Islam	3	*2.3*	0	*0.00*	3	*1.76*	0	*0.00*	17	*23.9*	17	*11.72*	0	*0.00*	1	*3.7*	1	*1.16*
	Christen	1	*0.8*	2	*5.0*	3	*1.76*	0	*0.00*	0	*0.00*	0	*0.00*	0	*0.00*	0	*0*	0	*0.00*
Category	General	81	*62.3*	27	*67.5*	108	*63.53*	30	*40.5*	37	*52.1*	67	*46.21*	29	*49.2*	15	*55.6*	44	*51.16*
	OBC	24	*18.5*	2	*5*	26	*15.29*	22	*29.7*	9	*12.7*	31	*21.38*	18	*30.5*	4	*14.8*	22	*25.58*
	SC	25	*19.2*	11	*27.5*	36	*21.18*	22	*29.7*	25	*35.2*	47	*32.41*	12	*29.6*	8	*29.6*	20	*23.26*
Age	<20	0	*0*	0	*0*	0	*0*	0	*0*	1	*1.4*	1	*0.69*	0	*0*	1	*3.7*	1	*1.16*
	20-40	53	*40.8*	12	*30*	65	*38.23*	27	*36.5*	24	*33.8*	51	*35.17*	14	*23.7*	14	*51.9*	28	*32.56*
	40-60	61	*46.9*	23	*57.5*	84	*49.41*	39	*52.7*	39	*54.9*	78	*53.79*	41	*69.5*	10	*37*	51	*59.3*
	>60	16	*12.3*	5	*12.5*	21	*12.35*	8	*10.8*	7	*9.9*	15	*10.34*	4	*6.8*	2	*7.4*	6	*6.98*
Family Size	0-3	6	*4.6*	2	*4.0*	8	*4.70*	2	*2.7*	8	*11.3*	10	*6.9*	0	*0*	1	*3.7*	1	*1.16*
	3-6	106	*81.5*	24	*60*	126	*74.11*	60	*81.1*	49	*69*	109	*75.17*	53	*89.8*	23	*85.2*	76	*88.37*
	7 and above	18	*13.8*	14	*35*	32	*18.82*	12	*16.2*	14	*19.7*	26	*17.93*	6	*10.2*	3	*11.1*	9	*10.47*
Education	Uneducated	39	*30*	13	*32.5*	52	*30.58*	38	*51.4*	43	*60.6*	81	*55.86*	13	*22.03*	1	*3.7*	14	*16.28*
	Up to 5th	31	*23.8*	1	*2.5*	32	*18.82*	13	*17.5*	5	*7.04*	18	*12.41*	13	*22.03*	5	*18.5*	18	*20.93*
	6^{th} to 10^{th}	40	*30.7*	7	*17.5*	47	*27.64*	15	*20.2*	4	*5.63*	19	*13.1*	4	*6.78*	2	*7.41*	6	*6.98*
	11^{th} to12^{th}	17	*13*	10	*25*	27	*15.89*	5	*6.7*	7	*9.86*	12	*8.28*	16	*27.12*	7	*25.9*	23	*26.74*
	Graduation & above	3	*2.3*	9	*22.5*	12	*7.06*	3	*4.05*	12	*16.9*	15	*10.34*	13	*22.03*	12	*44.4*	25	*29.07*
Family Income	<5000	26	*20*	10	*25*	36	*21.18*	3	*4.1*	6	*8.5*	9	6.2	6	*10.2*	0	*0*	6	*6.98*
	5000-15000	68	*52.3*	14	*35*	82	*48.24*	27	*36.5*	33	*46.5*	60	*41.38*	22	*37.3*	5	*18.5*	27	*31.4*
	15000-25000	18	*13.9*	10	*25*	28	*16.47*	19	*25.7*	13	*18.3*	32	*22.07*	15	*25.4*	13	*48.2*	28	*32.56*

	25000-35000	5	*3.9*	1	*2*	6	*3.53*	8	*10.8*	6	*8.5*	14	*9.66*	6	*10.2*	5	*18.5*	11	*12.79*
	35000-45000	7	*5.4*	1	*2*	8	*4.7*	11	*14.9*	3	*4.2*	14	*9.66*	9	*15.3*	3	*11.1*	12	*13.95*
	Above 45000	6	*4.6*	4	*10*	10	*5.88*	6	*8.1*	10	*14.1*	16	*11.03*	1	*1.7*	1	*3.7*	2	*2.32*
Occupation	Agriculture	65	*50*	16	*40.0*	81	*47.65*	26	*35.14*	10	*14.08*	36	*24.83*	5	*8.47*	0	*0*	5	*5.81*
	Business	11	*8.46*	14	*35.0*	25	*14.71*	3	*4.05*	15	*21.13*	18	*12.41*	11	*18.64*	2	*7.40*	13	*15.12*
	Wage/Salary	21	*16.1*	1	*2.50*	22	*12.94*	21	*28.38*	25	*35.21*	46	*31.72*	34	*57.63*	18	*66.67*	52	*60.47*
	Livestock*	11	*8.46*	1	*2.50*	12	*7.05*	20	*27.03*	8	*11.27*	28	*19.31*	1	*1.69*	0	*0*	1	*1.16*
	Fishing	16	*12.3*	0	*0*	12	*9.41*	0	*0*	9	*12.68*	9	*6.21*	0	*0*	2	*7.40*	2	*2.33*
	Other	6	*4.62*	8	*20.0*	14	*8.24*	4	*5.40*	4	*5.63*	8	*5.52*	8	*13.56*	5	*18.52*	13	*15.11*
Household Type	Kaccha	7	*5.38*	3	*7.50*	10	*5.88*	3	*4.05*	21	*29.58*	24	*16.55*	0	*0*	1	*3.70*	1	*1.16*
	Pukka	101	*77.6*	30	*75.0*	131	*77.06*	57	*77.03*	37	*52.11*	94	*64.83*	56	*84.91*	16	*59.26*	72	*83.72*
	Semi	22	*16.9*	7	*17.5*	28	*17.06*	14	*18.92*	13	*18.31*	27	*18.62*	3	*5.08*	10	*37.03*	13	*15.12*

Source: Data was collected during field survey, 2016-17 & 2017-18

In the case of Nangal wetland livelihood of most of the people depended directly over the wetland areas, because of most of the respondent work under the BBMB (Bhakra Beas Management Board) and National Fertilizer Limited (NFL).

4.2.8 House Structure: The type of house structure depends on the occupation and income of the respondents.

Harike: In Harike Wetland, only 5.88 percent respondents are residing in the mud or kachha houses, 77.06 percent lives in brick or pukka houses and 17.06 percent have resides in semi house structure both kachha and pukka. The house structure remains almost the same both in urban and rural areas.

Ropar: In Ropar wetland, 16.55 percent of respondents living in mud or kachha houses, 64.83 percent have a brick or pukka house and 18.62 percent respondents have a semi type of house structure.

Nangal: In Nangal wetland, 1.16 percent of respondent lives in kaccha house, 83.72 percent of respondents have pukka and 15.12 percent of respondents have a semi-household type.

4.3 Socio-Economic activities around Wetlands: The local people's activities around the wetland areas are ultimately adding to the economic values of wetlands. The local people are getting benefits in terms of economic, social and aesthetic values of the wetland. On the other hand, wetlands are the sources which have their own environmental importance. The resources available in wetlands provide many types of services to local residents who are living around the wetland areas, i.e. regulating services, cultural services, provisioning and economic services. These activities could be best fit in the Barbier et al. (1997) table of classification of the total value of wetland (Table 4.6). The entire value can be divided into direct use value and indirect use value and the method in the present work is adapted from the work of Ramachandra et al, 2005. The non-use value denotes the existence value and has not been included in economic valuation in this work.

Table 4.6: Classification of Total Value for Wetland

Value	Indicators	Data Sources
Indirect Use Value	Religious Recreational Aesthetic Habitat Conservation Species Conservation Flood and Landslide Control Groundwater Recharge	Calculated from field survey
Non-use value	Cultural heritage Bequest Biodiversity	Data collected from the literature
Direct Use Value	Fish Agriculture Production Livestock Tourism Restaurant	Calculated from field survey and secondary sources
Expenditure	Government	Data collected from officials

Source: Adopted from Barbier et al. 1997

4.3.1 In-direct Use Value and Non-Use Value: Respondents visit to wetlands for a specific cause, is considered as the performance of that activity around wetland area i.e. if a respondent visit wetland area for walking or exercising that is considered as a recreational activity. The social and economic activities performed by the people living in one-kilometre buffer zones of selected three wetlands, which have been divided into four types of activities: Social, Economic, Recreational, Governmental and Educational (Table 4.7) which can be considered as Indirect use value of wetlands. In terms of government activities, during field visits, the activities like availability of government centres, sanctuary, fencing, plantation and boating club etc. were observed. Except that governmental reports and data is also used for the same. The information about the people visit to wetland areas for educational

and are research purposes has been collected from the governmental informational centres.

Table 4.7: Comparison of Socio-Economic activities in Harike, Ropar and Nangal wetlands

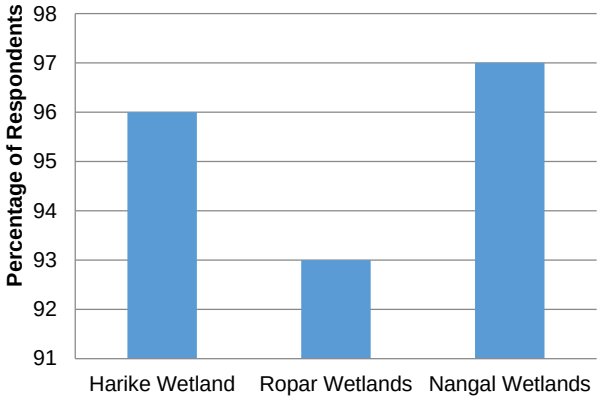
Types	Activities	Harike	Ropar	Nangal	Total
--	Respondents	170	145	86	401
Social	Religious festivals	164	145	84	393
	Cremation grounds	-	145	59	204
	Fuel(woods)	80	102	68	250
	Woods for cremation	-	102	51	153
	Water use for household	17	62	45	124
	Fishing activities	40	24	9	33
Economic	Agriculture	99	75	21	195
	Commercial Fishing	37	9	9	55
	Livestock	108	73	20	201
	Shops	25	5	13	43
	Hotels/food junction	5	4	2	11
	Vendors	1	1	-	2
	Boating clubs	Closed	Yes	No	--
	Sand Mining	-	4	-	4
	Commercial Plantation	-	13	-	13
	Water for irrigation purpose	-	76	-	76
Recreational activities	Walking	159	124	86	369
	Exercise	15	66	27	108
	Relaxing	55	124	62	241
	Use of parks	60	66	27	153
Government	Tourist Information Centre	Yes	Yes	Yes	--
	Wetland interpretation Centre	Yes	Yes	Yes	--
	Bird Sanctuary	Yes	No	Yes	--
	Wildlife Sanctuary	Yes	No	Yes	--
	Fencing	No	No	No	--
	Plantation	No	Yes	Yes	--
	Conservation Reserve	Yes	Yes	No	
	Tourist guest house	No	Yes	No	--
	Bird watchtowers	Yes	Proposed	Proposed	--
	Boating	For Officials only	For Officials only	For Officials only	--
Educational	Educational visit	Yes	Yes	Yes	--

Source: Data was collected during field survey, 2016-17 & 2017-18

4.3.1.1 Social Activities: The major social activities enlisted after survey around selected wetlands include; visit to religious places for worshipping and religious festivals, use of wetland or riverbanks as cremation grounds, use the woods of wetland areas for fuel as well as for cremation purposes, water use for household purposes such as for drinking, bathing, washing and fishing activities for food purposes. Nature and culture of the society, both are interlinked with each other. The culture of society is directly or indirectly related to the surrounding areas. Thus, the wetland has been a great effect over the surrounding areas in defining the culture of people that are living in the wetland areas.

4.3.1.1.1 Religious: The water has a great value in the whole world, as it is one of the essential natural resource available over the earth because life is not possible without it. In addition to it, human being worship water as God in various countries like India. The importance of water is rooted in religious beliefs as people believe that the sins of human beings are washed away by taking a sacred bath. People consider rivers as mothers (like in India, Ganga river is considered as the sacred river), even in some religious places, water ponds are constructed which are called 'Sarovar' or 'Kund' in which people take a sacred bath. There are many religious sites developed around the riverine wetland areas. The River Sutlej has great historical importance in the Sikh religion because of life events of 10th Sikh *Guru Gobind Singh Ji* around this river. In addition, the second temple of Brahma in India is situated along the banks of Sutlej River nearby Nangal wetland. Many religious places Nanaksar Gurdwara and Baba Bidhi Chand Gurdwara are situated on the banks of Harike Wetland, Baba Harnam Singh Gurdwara and Dargahi Shah in Chamba Kalan, Baba Deep Singh Gurdwara at Harike. There are major two or three festivals celebrated on each religious place, where people come from different parts of Punjab. About 96 percent of the respondents on an average, visit the wetlands to celebrate festivals at Gurudwara Sahib (Fig 4.1).

Figure 4.1: Visit to Wetland for Religious Purpose



There are various historical and cultural-religious places situated on banks of the river such as Tibbi Sahib Gurdwara near Ropar headworks, Kumma Maski Gurdwara on the bank of Sutlej River near Chak Dera Village, Dargah of Kawaza Peer etc. About 93 per cent of respondents visit the wetlands during the visits to Gurudwara sahib nearby Ropar Wetland (Fig 4.1). In addition, followers of Sikh religion throw ashes or remains of a human being in Sutlej River (Patalpuri Gurdwara, Kiratpur Sahib). There are many historical temples and Gurdwara located in the vicinity of Nangal wetland areas. Major is Brahma temple and Bhabhour Sahib Gurdwara on the bank of Nangal wetland, Old Shiv temple in Swamipur, Julfa Mata Temple near Nangal wetland areas. 97 percent of respondents visit the wetland areas due to nearby religious places of Nangal wetland (Fig 4.1).

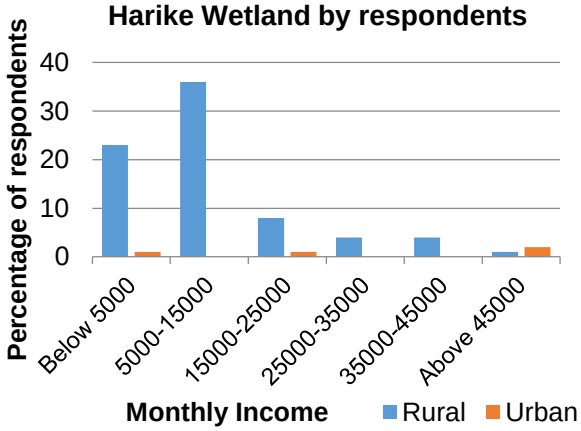
4.3.1.1.2 Cremation Grounds: Wetland areas are used for cremation purpose due to the easy availability of woods, space, and religious belief. A number of respondents depend on wetland areas for cremation and throwing of waste such as flowers, coconut, ashes etc. In Harike wetland, almost every village build their cremation ground on the banks of either River Beas or Sutlej. The followers of Nanaksar throw ashes and remaining related the dead person in wetland areas. The respondents living near the wetland areas use water of wetland for various religious rituals like to throw flowers, remaining of dhoop, portraits of god etc. In Ropar Wetland, most of the cremation grounds are built on river banks due to the easy availability of land. The dependency of respondents for the woods over wetland areas varied from areas to areas. In Nangal wetland, most of the cremation ground fall on the banks of the river, where people depend on wetland areas for the fulfilment of their needs regarding woods. People also use the areas to throw ashes and belonging of the dead person into the river

Pic 4.1: Wastages Thrown by People in Nangal Wetland

(Pic 4.1). From the total sample of 401 respondents, 393 respondents use the nearby wetlands areas as cremation grounds (Table 4.7).

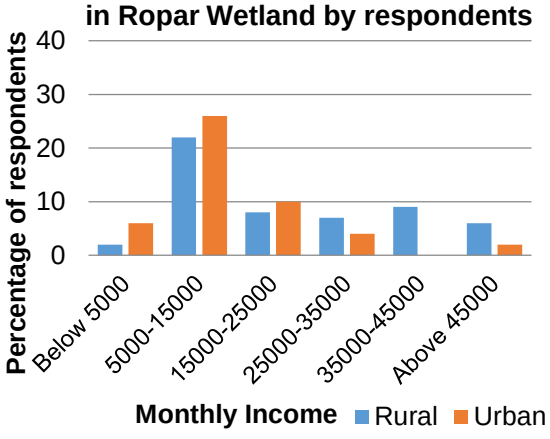
4.3.1.1.3 Fuel (Woods): Wetland area has many types of natural shrubs, sarkanda, and variety of trees. From ancient times, people lives nearby wetland areas are dependent for the collection of woods for fuel purposes. In Harike wetlands, 80 respondents among 170 total respondents, 102 respondents among total 145 respondents from Ropar wetland and 68 respondents among 86 respondents of Nangal wetland collect the woods and bushes from wetland areas for fuel purposes. But, in present times, the importance of wood for fuel purpose started declining due to the increasing use of cooking gas.

Figure 4.2: Fuel Wood Collection in Harike Wetland by respondents



In Harike Wetland, the people living around the wetland use sarkanda and bushes as fuel for cooking purposes. Most of the rural people use woods and bushes as fuel in their households. But after the wetland declared as a wildlife sanctuary in 1999 was restricted for fuelwood collection. Now, people do not get fuel material directly but in indirect ways. In suburban areas of Makhu, people who depend upon agricultural activities and earn more than Rs. 45000 per month income, use these things as fuel (Fig 4.2).

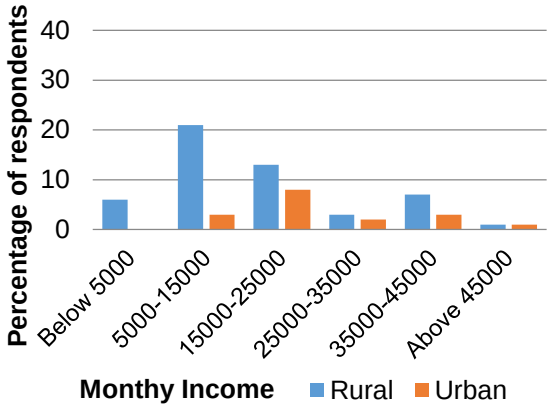
Figure 4.3: Fuel Wood Collection in Ropar Wetland by respondents



In Ropar Wetland, people living in rural areas are more dependent on wetland areas for fuel than urban areas (Fig 4.3). About 54 percent of respondents of rural areas use the wetland areas for fuel in comparison 48 percent of respondents in urban wetland areas. Urban people prefer to use Liquefied Petroleum Gas (LPG) as cooking gas in their households rather than woods or bushes as fuel. In urban areas, about 50 per cent of the lower-income group uses wetland plants for cooking food. Importance of wetland plants for fuel also changed within rural areas with

respect to terrain or slope of areas such as; Tibba Tapprian and Grah Bagga villages depend over forest areas for collection of woods for fuel. The average monthly income of these villages falls in second income group.

Figure 4.4: Fuel Wood Collection in Nangal Wetland by respondents



In Nangal wetland, about 68 respondents among 86 total respondents depend on wetland areas for fuel or collection of timbers. The significance of wetland areas for fuel varies from rural to urban areas. In rural areas, 86.44 percent of respondents depend for fuel material collection as compared to 62.96 per cent respondents in urban areas (Fig 4.4).

4.3.1.1.4 Water for Domestic uses: Water is one of the most significant components of wetland areas. The wetland areas provide a flux of water for irrigation, bathing, washing, drinking, industrial uses etc. The respondents living nearby wetland areas use the water of wetland areas for drinking and bathing of livestock. In Harike Wetland, 13.08 percent rural people use the wetland water for domestic use, while in urban areas no one respondents directly depend on the wetland area for water uses for domestic purpose.

Pic 4.2: Kuchha Type Households within the Wetland Boundary of Ropar Wetland

Source: Photos collected during the field survey, 2017-18

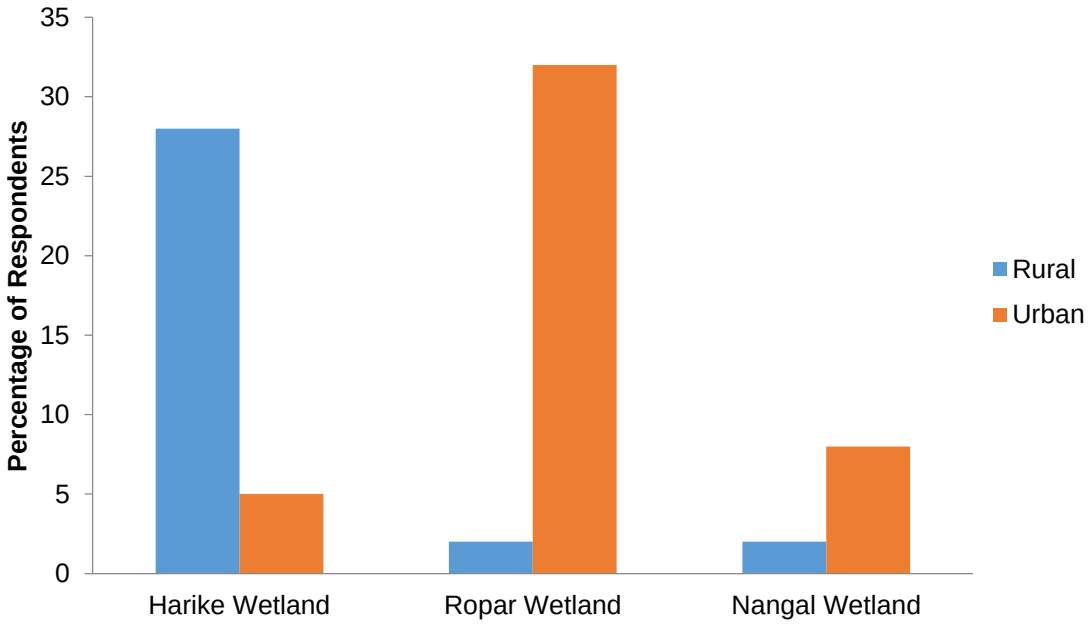
In Ropar wetland, some respondents are directly depended on wetland areas for the use of water for drinking, washing and bathing purposes. There are some people

of Ropar city who are living in Kuchha type settlements within the wetland boundary areas are depends on wetland areas for water uses (Pic 4.2).

In Nangal wetland, people of urban and rural areas use the water for drinking, bathing and washing purposes. The ratio of use of water has changed from rural to urban areas. About 76.27 percent respondents of rural areas use water of wetland areas for domestic purposes. In urban areas about 40.74 percent respondent use the water of wetland areas for domestic uses. The municipalities of the urban areas of three wetlands use wetlands water for the water supply to urban households.

4.3.1.1.5 Fishing for household uses: Fishing is the major resource that is easily available in wetland areas. Wetlands also play a role in terms of food security due to the availability of aquatic fauna. The local people living around wetlands give higher preference to the inland fishery. Punjab being dominated by the Sikh community and an inland state has less dependency on seafood as compared to the coastal states. The respondents living in the vicinity of wetland areas use the wetland as fishing areas for household consumption.

Figure 4.5: Respondents Visit for Fishing Activities to Wetland areas



Source: Data was collected during field survey, 2016-17 & 2017-18

In Harike wetland, people of rural areas visit the wetland areas for fishing. People involved in agricultural activities within the wetland areas also catch fish for food. In comparison to Harike wetland, the urban respondents of Ropar wetland are more dependent on fishing activities for household consumption (Fig 4.5). In Ropar wetland, a large proportion of Muslim respondents live near or in the periphery of wetland areas consume fish as a major food. The dependency or importance of fishes for food vary with respect to rural and urban areas In addition, in rural areas, people mostly prefer to use food grain rather than fishes.

4.3.1.1.6 Aesthetic use of wetland area: During fieldwork, a question regarding the loss of the scenic beauty of wetland areas' impact on the life of respondents were asked. In Harike wetland, 77.88 percent responded response that loss of the scenic beauty of the wetland area impacts their daily lifestyle activities. The proportion was changed in the Ropar and Nangal wetlands i.e. 64.83 percent and 96.51 percent respectively.

Model Specification: Microeconomic theory suggests that use of wetland area for the aesthetic purpose should change across the individual having different socio-economic demographic characteristics (Casey et al., 2006). Multiple linear regression analysis is conducted, which is almost similar in the specification with that of Casey et al., 2006 and Sarkar and Alam (2013). The equation of the model is as below:

$$\text{Aesthetic}_j = \alpha_{0+}\beta_1 X_{1+}\varepsilon \ldots\ldots\ldots\ldots \text{(i)}$$

Where X_1…….X_7 indicate seven explanatory variables (X_1=religion, X_2= caste, X_3= age, X_4= occupation, X_5= education, X_6= family member and X_7= family income) and j represents aesthetic use of wetland area. The estimation method of the model is multiple linear regression. This model is important to study the use of wetland area for aesthetic uses.

Table 4.8 shows that education has been significant at a 5 percent level, as p-value is 0.000 and religion of the respondents significant at the 10 percent level, as p-value is 0.77.

Table 4.8: Estimates of Factors Influencing the use of Wetland Area for Aesthetic uses

Model 1	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
Constant	1.37	0.17	8.13	0.00
Religion	-0.06	0.04	-1.78	0.08**
Caste	0.01	0.03	0.43	0.67
Age	0.02	0.03	0.59	0.59
Occupation	-0.02	0.02	-1.30	0.19
Education	-0.08	0.02	-4.55	0.00*
Family Members	0.05	0.05	1.07	0.29
Family Income	0.01	0.02	0.50	0.62
Model Summary R^2=0.08 F=5.04, No. of Observation =401				

Source: Data collected from the field survey, 2016-17 & 2017-18

The question related to the use of the wetland area for the religious purpose was asked from the respondents. The result of chi-square shows that religion of the respondents plays a crucial role in the use of Harike and Nangal wetlands for religious use. Whereas the other variables like income, education and occupation were not significantly impact the use of wetland area to religious visit, as their p-value more than 10 percent level (Table 4.9).

Table 4.9: Results of Chi-square for the Religious uses of Wetland Area

Religious Value		*Religion*	*Income*	*Education*	*Occupation*
Harike wetland	Chi-square value	19.53	2.46	1.37	3.76
	P Value	0.00*	065	0.85	0.44
Ropar Wetland	Chi-square value	2.51	4.81	3.58	10.36
	P Value	0.28	0.31	0.47	0.03
Nangal Wetland	Chi-square value	9.78	1.60	1.22	7.67
	P Value	0.01*	0.81	0.87	0.10

Source: Data was collected during field survey, 2016-17 & 2017-18

*means significant at 5 percent level

The question related to use of the wetland area for the aesthetic uses was asked from the respondents. The result of chi-square shows that the occupation of the respondents plays a crucial role in the use of Ropar wetlands for aesthetic use.

Other variables like religion, income and education were not significantly impact the use of the wetland area for aesthetic uses (Table 4.10).

Table: 4.10 Results of Chi-square for Aesthetic uses of Wetland Area

Aesthetic Value		*Religion*	*Income*	*Education*	*Occupation*
Harike wetland	Chi-square value	5.53	4.68	6.25	14.39
	P Value	0.14	0.33	0.18	0.01
Ropar Wetland	Chi-square value	1.29	4.01	12.80	13.96
	P Value	0.52	0.40	0.12	0.01*
Nangal Wetland	Chi-square value	7.52	5.75	1.24	2.62
	P Value	0.23	0.22	0.87	0.67

Source: Data was collected during field survey, 2016-17 & 2017-18

*means significant at 5 percent level

4.3.2 Economic Activities: Out of these all services provide by wetlands, economic services play a vital role in decision making of local people as well as the government regarding the use and management of wetland areas. Consequently, it has become necessary to know the economic importance of wetland areas especially for people living around the wetland. The economic importance of wetland areas varies with respect to areas, such as in coastal areas people much dependent on fishing activities than agricultural activities. In the case of Punjab state, the importance of wetland areas for agricultural and its allied activities are higher than in other sectors. Apart from agricultural activities, people of Punjab state are also dependent on commercial fishing. Numbers of economic activities which are directly or indirectly related to wetland areas become important to analyse the economic importance and to calculate the economic value of wetlands. In the selected wetlands (study area), agriculture, commercial fishing, livestock, shops, hotels/food junction, vendors (selling fish or other foodstuff for visitors), boating clubs, sand mining, commercial plantation, and use of water for irrigation purpose are the major economic activities contribute to the economic value of wetlands:

4.3.2.1 Agriculture: Agriculture is the main source of livelihood in India, in general, and Punjab in particular. The production and availability of land for agricultural activities are directly or indirectly linked with the wetland areas. Like, changes in water level or release of water amount in the Sutlej River affect the agricultural production and cultivated areas.

In Harike wetland, 58.24 percent of respondents do agricultural practices. The dependency of respondents over agricultural activities varied with respect to areas, as in urban areas 45 percent are engaged in agricultural activities as compared to 62.31 percent in rural areas. Among all respondents whose main occupation is agriculture, 54 percent of respondents are doing agriculture within the wetland areas.

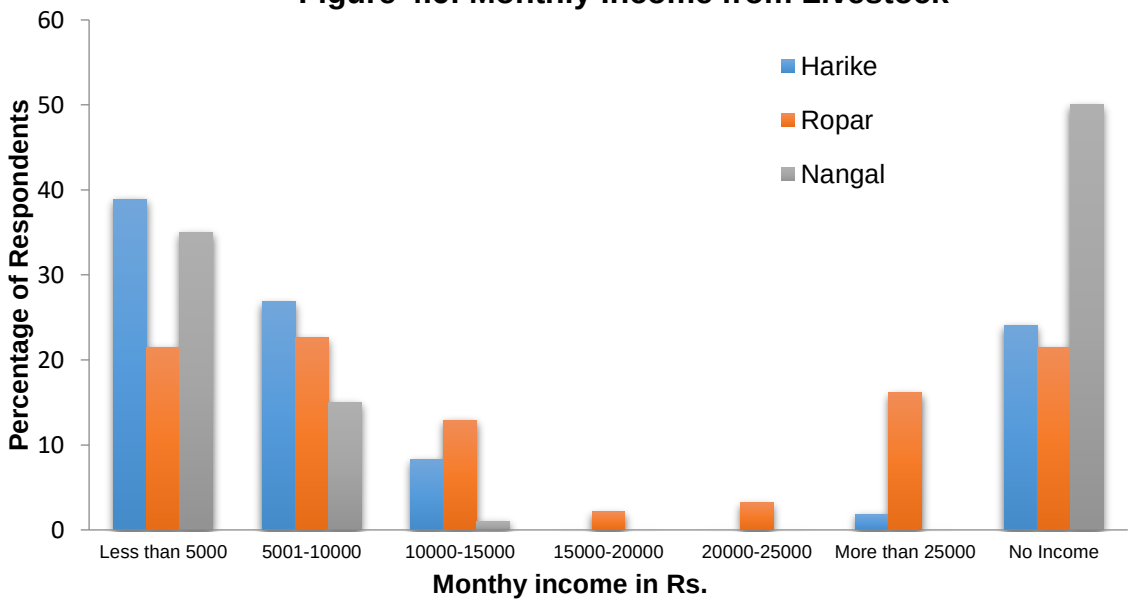
In Ropar Wetland, 51.72 percent of respondents are depending on agricultural activities among them 25 percent of respondents doing agriculture activities within the boundary of wetland areas. As per the respondent's view, the land lies within the floodplain areas of Sutlej River was given to local people on lease but after the declaration of this area as wetlands, they were asked to leave the land (the time for the lease is over) as the areas fallen inside the wetland boundary. But, people have not stopped using the land for agricultural practises in this area and they also claim ownership of this land. The matter, between government and local people, is yet not resolved and agricultural practices are being performed inside the wetland area.

In Nangal wetland, only 24.41 percent of respondents have agricultural land, but that land is not within the wetland boundary. Before the declaration of this area as a wetland, most of the land was either acquired by the Bhakra Beas Management Board (BBMB) or by the National Fertilizer Limited (NFL). On the other hand, physiography of the Nangal wetland areas on the west side is not suitable for agricultural activities.

4.3.2.2 Commercial Fishing: There are number of people depended over the fishing activities for livelihood. Wetland provides a suitable environment for breeding and growth of fish. The fishing is allowed only within the boundary of Ropar wetland and is banned within the sanctuary area of Nangal and Harike wetlands. The permission for fishing activities is given by the fishery department through a contractual system. In addition, the significance of wetland areas for commercial fishing has been narrowed down by the Punjab government, because it is controlled by the government through the contractor or tender system. With the tender system, Fishery Department of Government of Punjab issue a license to the fish contractor for one year. The contractor further issues licenses to fishermen for fishing activities in the wetland areas and purchase fishes from them at a controlled rate according to the species of fish.

4.3.2.3 Livestock: Apart from agricultural and fishing activities, people living around the wetland areas are also dependent on the livestock for commercial as well as for household purposes. Livestock is the second most important source of income for the local residents living near to wetland areas, as it provides a significant land for the grazing of livestock. The wetland areas are significant for livestock activities, as it provides space for growing of fodder and grazing purposes. The significance of wetland areas for livestock activities changed over the past few decades. In the present time, people use the wetland areas for growing fodder for livestock rather than the animals grazing. The significance of the wetland areas decreased in some villages due to the declaration of the wildlife sanctuary. In addition, the use of grassland for the agricultural activities declined the overall dependency to a limited period of two or three months in a year.

Figure 4.6: Monthly Income from Livestock



Source: Data was collected during field survey, 2016-17 & 2017-18

In Harike Wetland, 63.53 percent of respondents are engaged in livestock activities. The respondents depend on livestock for various food items likes' milk, curd, ghee, cheese, buttermilk (lassi) etc. for household and commercial purposes. Among them 66 per cent sale the milk and dairy items in the market to earn money (Fig 4.6). The income earned from livestock varied with respect to their numbers and use of wetland areas for grazing purposes. About 38.89 percent respondents earned less than 5000 rupees, 26.85 percent earned 5001-10000, 8.33 percent earned 10001-

15000, 1.85 percent earned more than 25000 and 24.07 percent rearing the livestock only for household uses.

In Ropar wetland, 64.14 percent of respondents have livestock and among them, 79 percent are dependent on livestock for commercial purposes. The 21.51 percent respondents earned below 5000, 22.58 percent received 5001-10000, 12.9 percent 10001-15000, 2.15 percent 15001-20000, 3.23 percent 20001-25000 and 16.12 percent got more than 25000 rupees per month. In addition, 21.51 percent depend on livestock only for household uses.

In Nangal wetland areas, only 23.26 percent respondent is dependent on livestock. About 50 percent of respondents are dependent on livestock for only household uses and 50 percent are for both commercial and household use. The earning of income varies from people to people depend on the numbers of livestock. Out of half respondents, 35 percent of respondents earn less than 5000 rupees per month from livestock and 15 percent earn between 5000-10000 rupees per month.

4.3.2.4 Tourism: Tourism is an activity which mainly depends upon the attraction, accessibility and accommodation provision. In the wetland areas, tourism plays a great role in the economic value of wetlands. Most visitors come to enjoy the natural beauty, bird watching, educational and research purposes, religious and fishing activities (Ramsar & UNWTO, 2012). The Harike, Ropar and Nangal wetlands have great potential for the attraction of tourists (Government of Punjab, 2003; Tiwana et al., 2008; Singh & Kaur, 2016).

4.3.2.5 Restaurant and Allied Activities: Tourism being an economic entity provides employment to many people. Local people get benefitted economically by tourists. Around Harike wetland, 33.53 percent of respondents earn their income from tourism and allied activities. These people are working in restaurants, shops, tea stalls etc. near the wetland areas. In Ropar wetland, 50.34 percent of respondents said that the wetland area is important for their economy. In addition to it, some street vendors run their business nearby wetland areas expressed that their economy depends upon visitors of wetland areas.

4.3.2.6 Boating clubs: Tourism activities are not well developed along the Harike wetland. The Department of Punjab Tourism is working for the promotion of tourism activities around the wetland areas. A water bus was started by the tourism board,

but it was not found in working conditions during the field survey. The infrastructure development around the Harike wetland is under process. Similarly, in Ropar wetland, numbers of tourist visit the wetland area to enjoy the boating and scenic beauty of the area. But it was shut down by the government. After this, the numbers of visitors decreased. Currently, one government boating club is operating on the banks of Ropar wetland which is used for training or educational purposes. In present times, people visit the wetland for walking, relaxing and to enjoy the scenic beauty.

4.3.2.7 Sand Mining: Due to the prohibition under government policies, after the declaration of the areas as wetlands, sand mining has not been observed in Harike and Nangal Wetlands. The declaration of Harike Wetland as a wildlife sanctuary plays a positive role in stopping the sand mining in Harike wetland. In Nangal wetlands, due to embankments on the southern side and availability of deepwater does not allow sand mining in wetland areas. In Ropar wetland, sand mining is done by local people by using bullock-carts and horse-carts. The sand mining is illegal but the open boundaries of wetland provide a space for people to do sand mining. Sand mining through horse-cart can be seen in pic 4.3.

Pic 4.3: Sand Mining within Ropar Wetland Areas

Sand Mining using Horse-Cart

Tracks within wetland areas

4.3.2.8 Commercial Plantation: The wetland area of Ropar wetland which is being used for agricultural purposes by local people is also used for commercial plantation. Popular is the tree which is grown in the fields for sale in the market. Whereas, the

respondents of the Harike and Nangal wetland areas are not involved in the commercial plantation.

Analysis of dependency of the respondents for various purposes using Likert Scale: The three-point Likert scale has been used to know the perception of the respondent's about their dependency on the wetland area for various type of activities such as food purposes, fuel, recreational, religious, tourism, livestock grazing and fishing. Respondents were asked to say about their dependency on the wetland area as high dependency=1, medium dependency=2 and no dependency=3. To know the perception of respondents, mean as well as standard deviation is calculated for the three selected wetland area (Table 4.11).

Table 4.11: Respondents' Perception about the use/dependency on the Wetland Area

	Variables	Mean	Standard Deviation
Harike Wetland	Food Grains	2.25	0.70
	Fuel	2.34	0.75
	Recreational	2.13	0.56
	Religious	1.43	0.60
	Commercial Fishing	2.84	0.54
	Tourism	2.95	0.25
	Commercial Livestock	2.56	0.72
Ropar Wetland	Food Grains	2.51	0.72
	Fuel	1.88	0.81
	Recreational	1.85	0.75
	Religious	1.68	0.63
	Commercial Fishing	2.77	0.60
	Tourism	2.77	0.59
	Commercial Livestock	2.19	0.92
Nangal Wetland	Food Grains	2.80	0.43
	Fuel	1.94	0.67
	Recreational	1.26	0.44
	Religious	1.26	0.46
	Commercial Fishing	2.87	0.39
	Tourism	2.51	0.73
	Commercial Livestock	2.84	0.51

Source: Data was collected during the field survey, 2016-17 & 2017-18

In Harike wetland, results show that the mean value for the uses of the wetland area range from 1.43 to 2.95. The respondents are highly dependent on wetland areas for religious uses. The value of standard deviation was 0.60, means that actual data was 0.60 values deviated from the mean value. The medium is dependent for food grains, collection of fuel and recreational uses, as mean value range between 2.13 to 2.34. The respondents are not dependent for commercial livestock, fishing and tourism, as value varies from 2.56 to 2.95. The reason behind the no dependency on wetland area for commercial livestock was that respondents depended on livestock grazing for their household used. The respondents were not dependent for fishing on the wetland area, as the fishing resource was controlled by the government through the contracting system. Besides, livestock grazing and fishing activities within the Harike wetland were banned by the government after the notification of area as a wildlife sanctuary.

In Ropar wetland, the respondents are medium dependent on wetland area for commercial livestock, fuel, religious, and recreational activities, as parks like Maharaja Ranjit Singh Park and religious places (Tibbi Sahib Gurdwara) are located on the bank of the wetland area. Whereas, the respondents are not depended on wetland area for tourism due to the construction of bypass road and closing of boat club by the government. The mean value for commercial fishing and food grains also revealed that people are not dependent on wetland areas for these activities. The reason behind no dependency is the control of fishing resources by the government. Whereas in the case of food grains the value of standard deviation was .070, means that actual data was 0.70 deviated from the actual mean value.

In Nangal Wetland, respondents are highly dependent on the wetland area for recreational and religious uses. The medium dependency is for the collection of firewood and no dependency is for food grains, tourism, commercial fishing, and livestock activities. Because most of the respondents are engaged in tertiary activities.

The three-point Likert scale has been used to analyse the dependency of the people on the wetland area for direct and indirect uses. The responses related to their dependency over the wetland areas were noted in term of higher dependency, medium dependency and no dependency. The dependency of the people living nearby the wetland area greatly fluctuates in the case of the Harike, Ropar and

Nangal wetlands. Such as, in the Harike wetland, 15.29 percent respondents expressed that they are highly depended on wetland area for food purpose. However, the dependency of the people for food purpose is less on the Ropar and Nangal Wetland area (13.10 percent in Ropar and 1.16 percent in Nangal wetland). The major reason behind such variations is larger areas of Harike wetland used for agricultural activities as compared to the Ropar and Nangal wetlands.

Table 4.12: Respondents' Perception about the use of Wetland Services and Functions of three Selected Wetland Area

	Variables	No. of Response			Percentage of Response		
		HD	MD	ND	HD	MD	ND
Harike Wetland	Food Grains	26	76	68	15.29	44.71	40.00
	Fuel	28	57	85	16.47	33.53	50.00
	Recreational	17	114	39	10.00	67.06	22.94
	Religious	107	53	10	62.94	31.18	5.88
	Commercial Fishing	13	2	155	7.65	1.18	91.18
	Tourism	1	7	162	0.59	4.12	95.29
	Commercial Livestock	23	28	119	13.53	16.47	70.00
Ropar Wetland	Food Grains	19	33	93	13.10	22.76	64.14
	Fuel	57	48	40	39.31	33.10	27.59
	Recreational	53	60	32	36.55	41.38	22.07
	Religious	59	73	13	40.69	50.34	8.97
	Commercial Fishing	12	7	126	8.28	4.83	86.90
	Tourism	12	10	123	8.28	6.90	84.83
	Commercial Livestock	50	18	77	34.48	12.41	53.10
Nangal Wetland	Food Grains	1	15	70	1.16	17.44	81.40
	Fuel	22	47	17	25.58	54.65	19.77
	Recreational	64	22	0	74.42	25.58	0.00
	Religious	65	20	1	75.58	23.26	1.16
	Commercial Fishing	2	7	77	2.33	8.14	89.53
	Tourism	12	18	56	13.95	20.93	65.12
	Commercial Livestock	5	4	77	5.81	4.65	89.53

Source: Data was collected during the field survey, 2016-17 & 2017-18

Note: HD- High Dependency; MD-Medium Dependency; ND-No Dependency

The dependency of respondents for fuel purpose also varied among the three selected wetland areas, as 16.47 percent, 39.31 percent and 25.58 percent respondents respectively are highly depended on the Harike, Ropar and Nangal wetlands for the collection of firewood. The easy availability of firewood in the lower

Shivalik region of Ropar and Nangal wetlands affects the dependency of the people on the wetland area for collection of fuel.

About 16.47 percent of respondents of Harike wetland, 36.55 percent of Ropar and 74.22 percent of Nangal wetland are highly depended on the wetland area for recreational purposes. The availability of recreational sites likes parks, restaurants, favourable climate condition nears the Ropar and Nangal wetlands are the foremost reasons for such fluctuations. Similarly, a situation occurred in the case of tourism, where 0.59 percent respondents of the Harike wetland, 8.28 percent of Ropar and 13.95 of Nangal wetland are depended on the tourism and its associated services.

The declaration of Harike and Nangal wetlands as wildlife sanctuary affects respondents' dependency on wetland area for livestock activities. Such as only 5.81 percent of respondents of Nangal and 13.53 percent respondents of Harike wetland depend for commercial livestock than the 34.48 percent of Ropar.

In Harike wetland, 62.94 percent of respondents are highly dependent, 31.18 percent are medium and 5.88 percent is not dependent on the wetland area for the religious point of view. In Ropar wetland, 40.69 percent of respondents are high, 50.34 percent are medium and 8.97 percent is not dependent on the wetland area for religious purpose. In Nangal wetland, 75.58 percent of respondents are high, 23.26 percent are medium and 1.16 percent is not dependent on the wetland for a religious visit (Table 4.12).

4.3.3 Non-Use Value of Wetland:

4.3.3.1 Habitat Conservation: The wetland area provides a suitable habitat for the residents of flora and fauna. There are certain measures adopted by the Department of Forest and Wildlife preservation Punjab for the improvement and conservation of habitats for the wildlife in the Harike, Ropar and Nangal wetlands. The Habitat Improvement Working Circle has been established for the conservation and protection of wildlife habitats. The main objective and conservation measure include plantation around the wetland, clearing of weeds, awareness among the farmers for adopting agroforestry etc.

In Harike Wetland, for the protection and conservation of habitats for the wildlife several efforts are made by the department which includes removal of water hyacinth, planation around the bandh, and clear of unwanted grasses and shrubs. In Ropar wetland, during the field survey, it was observed that plantation near the

wetland area was done by the Department of Forest and Wildlife Preservation. But that plants were destroyed by the local people for doing agricultural practices.

In Nangal wetland, from survey it comes to know that, the department is concentrating on the growing of fruit trees for feeding of wildlife. Besides this, to control the soil erosion in the hilly area plantation has been done by the department as well as local NGO.

4.3.3.2 Species Conservation: The wetland area is rich in natural resources and has a great faunal diversity. According to a study by Bombay Natural History Society (BNHS), 167 species of bird were recorded in 1980-85, out of which 40 species were migrant birds. A total of 391 species of avifauna, 7 species of Indian roofed turtle, 49 species of fishes and several reptiles and mammals like wild boar, smooth Indian otter, jackal, jungle cat, hog deer and common Indian hare are recorded in the Harike wetland area. The several endangered and threatened species are supported by the Harike Wetland, which includes Ferruginous duck, Palla's fishing eagle, Black-bellied Tern, Indian Skimmer, Long-billed vulture etc. (Department of Forest and Wildlife Preservation, Firozpur). In Nangal wetland areas, a total of 162 residents species and 33 migratory species of birds, 49 species of fishes, 4 species of amphibians, 3 species of reptiles and mammals likes hog deer, wild boar, jungle cat, jackal, common Indian hare and common mongoose etc. are recorded in the area (Department of Forest and Wildlife Preservation, Punjab). Likewise, several species of flora and fauna have been supported by the Ropar Wetland area.

4.3.4 Economic valuation of wetland on the basis of direct use value and expenditure: For evaluation of direct use value and expenditure, the economic value of wetlands have been calculated. Economic valuation is a widely used method to find out the functions and benefits of wetland. It also helps in preparing conservative plans for the wetlands (Barbier et al., 1997; Ramachandra et. al., 2005). Economic value has been calculated from the economic worth of goods and services provided by a wetland and are converted into monetary value. Valuation is done by using Contingent Valuation Method (CVM), Market Value Method and Travel Cost Method. The CVM is based on the Willingness to Pay (WTP) of the local people for certain services provided by the wetland (Siew et al., 2015; Lamsal et al., 2015; Zhu et al., 2016). Market value method is based on the prevailing price of goods in the domestic market. The study areas are also popular tourist spots of

Punjab and hence, the recreational value has been calculated using the travel cost approach (Sharma et al., 2015).

Total Economic Value has been extracted from Direct Use value (Except direct Water value) + Expenditure of government for the maintenance of wetland areas. The valuation has done for the year 2017; Government Data, Remote Sensing data and field survey has been conducted in the year 2017.

4.3.4.1 Harike Wetland: The indicators used to calculate the direct value are agriculture production (converted into annual income), commercial harvesting of fishes, income from livestock, tourism and recreation and income from the restaurant (Table 3.12). The expenditure done by the government for the managing and conservation of area is also calculated. According to a study, numbers of animal are directly depended over the wetland areas for drinking water that was recognized at 40 litres/animal/day. Use of wetland areas for livestock can be calculated by collection of data regarding milk production and their productivities from the livestock (Kakuru et al, 2013). The direct use values of Harike wetland are listed below;

4.3.4.1.1 Agricultural value: For calculating the economic value of the wetland area, first of all, the agricultural activities within the wetland area have been calculated with the help of google earth pro for 2017. After, knowing the area under the agricultural practices, data related to numbers of crop harvested in the field have been collected through the field survey. From the survey, it was identified that the respondents living along with the Beas River harvest single crop. However, the respondents living along the Sutlej River harvest double crops within wetland area due to the building of a temporary ‘bandh’ along the Sutlej River. The total expenditure to grow and harvest any crop (per season) has been calculated from the responses of agriculturalist during survey. In the same way, production of each crop was calculated after knowing per acre values individually. The net value for per acre have been calculated after the excluding of each expenditure .i.e. 15000 per acres.

4.3.4.1.2 Livestock value: The economic value of livestock which is directly dependent on the wetland areas has been calculated. For this, first of all, data related to how much percentage of the respondent are dependent on the wetland area for livestock grazing has been identified from the total sample and then

multiplied by the total household living within the one-kilometre buffer zone around the wetland area. The average annual income from the sale of milk production has been calculated through the subtraction of annual expenditure occurred over the livestock. The economic value has been calculated only for those households who are totally dependent on wetland areas for livestock grazing. The value has not been calculated for an indirectly dependent household over wetland areas. The other limitation regarding the valuation of livestock products is that it includes only milk production rather the average consumption of fodder and water consumption.

Table 4.13 Total Direct Use values of Harike Wetland (in Rs.)

Indicators	Values	Calculated (per year)
Agriculture*	3700 Acres* Rs. 15000 (Annual Income per acre by local people)	5.55 crore
Fish	Income from Tender to the State Government=2.97 crore+ Income earned by a fish contractor=5.03 crore	8 crore
Livestock**	3285 households* Rs. 100421 (Annual average income from livestock per household)	32.98 crore
Tourism***	No. of Tourists visited Harike Wildlife Sanctuary from 1st January 2017 to 31 December 2017	61.31 Lakh
Restaurant****	5 Restaurants inside the buffer*Rs.12 lakhs (Annual average income per restaurant)= 60 lakhs+ Food Points and Tea Stall =7*150000=1050000	70.50 Lakh
	Total	47.84 crore

Note: *****The economic value of agricultural production has been calculated by using of Contingent and market value methods. The calculated agricultural land fall within the Harike Wildlife Sanctuary.

******The economic value for the livestock grazing has been calculated by using the market value methods within the one-kilometre buffer zone around Harike Wildlife Sanctuary.

*******The economic value for the tourist visited the Harike Wildlife Sanctuary by using the travel cost method.

********The economic value for the restaurant and tea stall has been calculated by using contingent and Market value methods within the one-kilometre buffer zone around Harike Wildlife Sanctuary.

Source: Data was collected during the field survey, 2016-17

4.3.4.1.3 Fishing: In a Harike wetland, about 2.97 crores income is earned through the tendering of the Beas and Sutlej Rivers for fishing activities by the Punjab Government. The contractors extract at least 8 crores amount of fish from Beas and Sutlej Rivers. Because of the non-availability of fish production data (how much amount of fish is extracted), the economic value for the fish production has been calculated through the interaction with the fish contractor. As fish has been supplied

to all market through the fish contractor. The Harike fish is supplied to Jammu, Chandigarh, Ludhiana, Mohali, Haryana, Delhi, Himachal Pradesh, Rajasthan and Siliguri in West Bengal. In addition to this, the people living nearby the Harike wetland visited especially to the area for eating of local fish. In the Harike wetland, 18 types of fish found (Ladhar, 2002; Moza & Mishra, 2008).

4.3.4.1.4 Tourism value: For the calculation of tourism value of Harike Wildlife Sanctuary, data related to tourist visited the Wildlife Sanctuary between 1st January 2017 to 31st December 2017 has been collected from the Harike Wildlife Range. The information obtained was: number of total tourists, no. of passes issued, travel distance and mode of transport data. As there are limited tourism facilities existed in the Harike Wildlife Sanctuary, hence most of the visitors come to enjoy the natural beauty, bird watching, educational and research purposes, religious and fishing. The tourism value is based on the expenditure method and travel cost method. For the valuation process, only travel cost has been calculated due to no or limited accommodation facilities available near the sanctuary areas.

4.3.4.1.5 Restaurants value: There are no formal records of income earned by the restaurants and tea stalls near the wetland area. The data related to the income of the restaurants' owner and tea stall owners was calculated after direct interaction with the owner and workers.

4.3.4.2 Ropar wetland: For calculating the direct use value of wetland areas of Ropar wetland the major indicators includes; agricultural production, fish production, livestock grazing and milk productivity, sand mining, commercial plantation, kayaking training, restaurants etc. The details about each indicator of direct use value are listed below;

4.3.4.2.1 Agricultural value: First of all, the area lies under the agricultural activities within the wetland area have been identified with the help of google earth pro database for 2017. During the survey, it was observed that respondents living near the city are more depend over wetland area by growing vegetables. In rural areas respondents depend over wetland area by harvesting two crops (wheat-rice) a year. The data related to production and expenditure for growing and harvesting of both crops have been collected from the survey. The net value for per acre had been

calculated after the excluding of each expenditure .i.e.45000 per acres. About 5.78 crore rupees are annually earned by the people living nearby the wetland area.

Table 4.14 Total Direct Use values of Ropar Wetland (in Rs.)

Indicators	**Values**	**Calculated (per year)**
Agriculture*	1286.12 Acres* Rs. 45000(Annual Income per acre by local people)	5.78 Crore
Fish	Income from Tender to the State Government 26 Lakh + Income earned by fish contractor= 70 Lakh	96 Lakh
Livestock**	1240 households* Rs. 359137 (Annual average income from livestock per household)	44.50 Crore
Sand mining***	20 households* Rs. 430000	86 Lakh
Commercial Plantation****	48.5 acres*100000	48.50 Lakh
Kayaking Training*****	40*60000	24 Lakh
Restaurant******	2 Restaurants* Rs. 6 lakhs (Annual average income per restaurant)= 12 lakhs + Food Points and Tea Stall =8*100000=800000	20 Lakh
	Total	52.94 crore

Note: *****The economic value of agricultural production has been calculated by using of Contingent and market value methods. The calculated agricultural land falls within the Ropar wetland.

******The economic value for the livestock grazing has been calculated by using the market value methods within the one-kilometre buffer zone around Ropar wetland.

*******The economic value for the sand mining near headworks of the Ropar wetland has been calculated by using the Contingent valuation methods.

**** The economic value for commercial plantation has been calculated within Ropar wetland by using Market value and Contingent valuation methods.

***** The economic value for the kayaking training has been calculated within the Ropar wetland by using contingent valuation method.

**********The economic value for the restaurant and tea stall has been calculated by using contingent and Market value methods within the one-kilometre buffer zone around Ropar wetland.

Source: Data was collected during the field survey, 2017-18

4.3.4.2.2 Livestock value: The human activities are allowed in the part of Ropar wetland which is not covered under the sanctuary area. Therefore, the people living nearby the Ropar wetland are more depended on wetland area for the rearing of livestock. For the calculation of the economic value of livestock, data related to how much percentage of respondent dependent on the wetland area for livestock grazing has been identified from the total household sample of Ropar wetland and multiplied

by the total household living within a one-kilometre buffer zone around the wetland area. From the livestock activities, about 44.5 crore rupees were earned by the people living near the wetland area.

4.3.4.2.3 Fishing value: The fishing activities are allowed in the Ropar wetland area, but are controlled by the Punjab Government. For the catching of fishes, a license has been issued to the contractor through a tender. The contractor further issues license to the fishermen to do fishing activities. According to the survey, about 96 lakh rupees have been earned by the government as well as the fishermen.

4.3.4.2.4 Sand mining value: The respondents living nearby the Ropar wetland are depended on the wetland area for sand mining. For this, they use horse-cart and sale it in the market at 400 Indian rupees per horse-cart. About 20 lakh rupee are annually earned through this activity.

4.3.4.2.5 Plantation value: The people living around the Ropar wetland area cultivate commercial plantation mainly popular tree near the Ropar wetland area, as plywood industries situated in the Kurali and Ludhiana. Because crops in the wetland area are destroyed by the wildlife mainly wild boar. Therefore people gave prefer to grow plantation near the river banks. From the cultivation of commercial plantation about 48.5 lakh rupees are earned by the people.

4.3.4.2.6 Kayaking Training value: The Punjab Sport Institute provides a kayaking training centre on the bank of Ropar wetland. About 24 lakh rupees have been generated by giving training regarding the kayaking.

4.3.4.2.7 Restaurants value: To provide services to the tourist visiting the Ropar wetland area, a facility of the restaurant (water Lily) has been provided by the Punjab Tourism. Apart from this, a verka booth is also located near the Ropar headworks. Besides this, there are many food vendors are standing along the wetland area.

4.3.4.3 Nangal Wetland: The economic dependency of the people on Nangal wetland is lower as compared to Ropar and Harike Wetlands. Tourists are not allowed to visit the Nangal wildlife sanctuary owing to security reasons. Besides this, the larger part of Nangal wetland (95 % of the area) lies under the water resources. Therefore, encroachment is a not a big problem in the wetland area. Some area of the wetland has been encroached by the local people for kitchen garden, dumping of solid wastes like cattle dungs and stocking fodders.

4.3.4.3.1 Livestock value: The economic dependency of the respondents living within a one-kilometre buffer around the Nangal wetland is about 1.2 crore rupees. The respondents living in the rural areas of Nangal wetland are dependent on the wetland area for the rearing of livestock. The people get average 3.5 litter milk per day from the livestock and they use the milk for household consumption as well as for selling in the market.

4.3.4.3.2 Sand Mining value: The people living near the Nangal wetland depends on it for sand mining.

Table 4.15 Total Direct Use values of Nangal Wetland (in Rs.)

Indicators	Values	Calculated (per year)
Agriculture	No agricultural land within wetland areas	-
Fish	Income from Tender to the State Government = 26 lakhs + Income earned by fish contractor= 1 crore	1.26 crore
Livestock*	179 households* Rs. 67166 (Annual average income from livestock per household)	1.20 Crore
Sand mining**	30 households*Rs. 400000	1.2 Crore
Tourism	Tourists are not allowed to visit Nangal Sanctuary due to security reasons	-
Restaurant***	10 Restaurants * Rs. 10 lakhs (Annual average income per restaurant)= 1Crore + 5* 80000 Food Points and Tea Stall = 4Lakh	1.04 Crore
	Total	4.70 crores

Note: *****The economic value for the livestock grazing has been calculated by using the market value methods within the one-kilometre buffer zone around Nangal Wildlife Sanctuary.

******The economic value for the sand mining near headworks of Nangal Wildlife Sanctuary has been calculated by using the Contingent valuation methods.

*******The economic value for the restaurant and tea stall has been calculated by using contingent and Market value methods within the one-kilometre buffer zone around Ropar wetland.

Source: Data was collected during the field survey, 2017-18

4.3.4.3.3 Fishing value: The Nangal wetland provides food to the locals in the form of fishes and the economy of the locals are also affected by the wetland area. The Nangal wetland is home to the large fish population, as 49 fish species are found in wetland area. Before the declaration of Nangal Lake as a wildlife sanctuary area, it

was used for fishing activities and approximately 1.8 lakhs revenue generated through this. Approximate, 8.42 tonnes/month fish biomass were extracted from the Nangal wetland in 2007-08 when fishing was allowed within the wetland area (Department of Forest and Wildlife Preservation, Punjab). The total amount of 1.26 crore income has been earned through the extraction of fish resources of Nangal wetland area. Out of which, about 26 lakhs rupees are earned by the state government by floating a tender of fish in Bhakra and SYL canals from Nangal to Bela. The income earned by the fish contractor has been calculated through the interaction with the fish contractor because fish production data is not available.

4.3.4.3.4 Restaurants value: The economy of the people of Nangal area is dependent on the tourist activities, as visitors come from across India to visit the Nangal dam, Bakhra Dam, Anandpur Sahib, Naina Devi Mandir etc. The international tourists are not allowed to visit the Nangal and Bakhra Dam due to security reasons. About 1.04 crore rupees are earned by the people engaged in the restaurants and allied activities. The data related to the income earned by the people has been collected through the interaction with the owner and workers.

Section III Impact of Human Activities on wetland

Wetlands of the world are under major threat to destruction in terms of hydrology and biology. In the study area, as seen earlier in this chapter, only Harike wetland shows fluctuation in surface water body while remaining two wetland shows negligible fluctuation. These wetlands are suffered from various types of a threat as identified during the field survey. The following sections identify how the respondents from the different socio-economic sections perceive their interactions and threats to three wetlands. At present, wetland areas are primarily facing the problem of solid and liquid pollution and encroachment of wetland areas (Verma et al., 1998; Samra, 1991). Pollution causes water-borne diseases, destruction of aquatic life, the disappearance of migratory birds, and the problem of foul smell etc. According to Punjab Department of Forests and Wildlife Preservation, the number of migratory birds around Harike wetland has declined by 12 percent from 105,890 in 2016 to 93,385. Loss of natural resources around or in the wetland is difficult to restore and depends on the severity of the destruction. A good functional wetland creates balance in the ecosystem and provides livelihood opportunities to its people while a degraded wetland is less effective in offering such services. The wetland water is used by

human beings for a couple of activities such as for drinking purpose, bathing and washing, irrigation for agriculture, industrial activities, settlement and recreation activities. The pressure on wetland areas increased due to urbanization, industrialization and agricultural activities.

4.4 Impact of Human Activities on wetland areas:

4.4.1 Encroachment of wetland areas: The wetland area faces the problem of encroachment for the various activities; agricultural activities, urban expansion, mining activities and industrial activities (Chopra et al., 2001; Brar & Chandel, 2012). The unsustainable use of wetland area for fishing and livestock activities further increases the intensity of degradation (Prasad et al., 2002).

4.4.2 Urbanisation: The increasing areas under urban activities plays a significant impact on the functions and structure of wetland areas through a couple of actions like withdrawal of water, discharge of effluents. The impact of urbanization also assessed in term of decreasing the areas under green and open spaces (Ramachandra & Aithal, 2016). According to a study, the areas of Bangalore city increased from 5448 hectares in 1973 to 37266 hectare in 2010, but on the other hand area under vegetation and water decreased from 46639 hectare in 1973 to 16031 hectare in 2010 and 2324 hectare in 1973 to 617 hectare in 2010 respectively (Ramachandra & Aithal, 2016). The use of lake areas for illegal construction and landfilling by the municipal bodies are chiefly responsible for the loss of wetland areas (Ramachandra, 2009). In addition, 629 water bodies identified in the National Capital Territory of Delhi, out of it 232 water bodies cannot be revived due to mass encroachments (Khandekar, 2011). Similarly, wetland areas of Ludhiana city that were on 8 hectare land in 1911 disappeared due to urban expansion (Brar and Chandel, 2012). Apart from this infrastructure development activities like construction of railway lines or road highway are accountable for declining geographical area of wetland. As the construction of North-West railway line and Grand Truck road divided the Hambowal wetland of Beas floodplains divided into two parts, which certainly responsible for the conversion of wetland areas from water body to other land use (Brar & Chandel, 2012). The same situation happened with the Harike wetland areas that road highway near the headworks is accountable for the decline of wetland areas because at present this area is used for dumping of liquid and solid wastage, livestock activities (Field photo).

Pic 4.4: Construction of Highway Spit the Harike wetland into two parts near Harike Headworks

Source: Photo collected during the field Survey

4.4.3 Agricultural activities: The development and growth of agricultural activities is the prime cause of loss of wetland areas in the Punjab state. The areas under agricultural activities increased after the green revolution and the advancement of technologies. The floodplains areas are highly encroached for agricultural activities because of their high fertility (Verhoeven & Setter, 2010). The lower part of the floodplain is less suitable for agricultural activities as compared to upperparts. As lower floodplains faced the problem of floods each year, but are suitable for grazing purposes. After the construction of dams the lower floodplain areas have been converted into agricultural land by locals (Verma et al., 1998). Therefore, massive land use changes occurred in the floodplains areas; where marshy, swampy or grassland areas used for agricultural activities after the advancement of the green revolution. For example, the net sowed areas in the floodplain of the Sutlej River increased from 15.80 percent to 37.90 percent from a time span of 1951-1966 (Brar & Chandel, 2012). The area under natural cover was higher as compared to the area under human use in 1975, which was 54.42 percent and 45.58 percent respectively. But, the areas under natural use shrink to only 6.5 percent, because of increasing the pressure of population and technological advancement (Kaur & Brar, 2013). According to a study, more than 85 percent areas of wetland and barren land have transformed into agricultural land from 1975 to 2011 (Kaur & Brar, 2013).

In Harike Wetland, 90 percent respondents illegally use the floodplains of the Sutlej and Beas Rivers for agricultural activities. The respondents, falling within the one-kilometre buffer zone, along the Beas River sow one crop in lower floodplains as the

areas affected by over banking floods each year during the rainy seasons. The areas under agricultural activities increased from 919 hectares in 1995 to 2329 hectare in 2017 (Najar & Pandey, 2017). In Ropar wetland, 44.83 percent encroached the wetland areas and used it for agricultural activities. Whereas, in Nangal wetland areas, 10.47 respondents used the wetland areas for the cultivation of crops. According to an engineer of Ropar headworks, 97.04 hectare land of Ropar wetland are encroached by local residents for agricultural activities. Out of this encroached land, 50.54 hectares area encroached by people of Bhadahupur Village, 44.17 hectares by Alampura Village and 2.33 hectare by Katli Village (RTI, Ropar Headworks Division). The similar situation has been seen in the Harike wetland, where about 1056 hectare land of the wildlife sanctuary is encroached by local residents in 2018 (RTI, Forest Officer (Wildlife), Firozpur).

4.4.4 Degradation of water quality in wetland areas: The water quality of Harike, Ropar, and Nangal wetlands are affected by the mixture of polluted water from various sources. The polluted water is thrown directly or indirectly to the wetland by industries, agricultural activities and urban wastages (Prasad et al., 2002; Tiwana et al., 2008). The water pollution in wetland areas caused by point and non-point pollution. The point pollution is that in which the exact location of pollution is known, as polluted water discharged through the industrial activities and sewage treatment points. The non-point pollution is those in which source of pollution is difficult to trace, as pollution caused by agricultural activities (Prasad et al., 2002; Jain et al., 2008; Bassi et al., 2014). The degradation of water quality is directly interlinked with population growth and associated activities (Chopra, 1985).

4.4.4.1 Point Pollution: The types of pollution in which source of pollution traced easily, as pollution released from the sewage treatment plants, industrial plants etc. The water quality of Sutlej River deteriorates from Class B in upper Nangal stream to Class E after passing the Ludhiana city of Punjab due to disposing a huge amount of untreated water from both point and non-point sources. The sewage of major towns and cities such as Nangal, Roopnagar, Ludhiana, Nawanshahr, Phagwara, Jalandhar fall in Sutlej River. On another hand, the water quality of Beas River deteriorates from class A in Pong dam to class B at Harike Lake after receiving a huge amount of polluted water from Mukerian town, Beas city and Gobindwal Sahib (Punjab Pollution Control Board, 2014). The water

quality of wetland areas is greatly affected by industrial activities by disposing of untreated water in it.

4.4.4.2 Non-point Pollution: The types of pollution in which it is impossible to identify to the exact location from which polluted water discharged into river areas as runoff from agricultural fields. The overflow of extra water from agricultural region in the wetland areas are responsible for the degradation of water quality of wetland areas. Because the consumption of pesticides used for agricultural activities increased from 43584 metric tonnes in 2000-01 to 54121 metric tonnes in the year 2014-2015 (Indiastat). In Punjab state consumption of insecticides/pesticides increased from 3200 metric tonnes in 1980-81 to 5843 metric tonnes in the year 2016-17, which 82.59 percent high than the earlier (Indiastat). Thus, runoff from the agricultural sectors is a major source of non-point pollution in river areas (Jain et al., 2008). Besides this, the water quality of wetland areas is also degraded by social rituals such as throw of ashes in river areas. In a Harike Wetland, huge amounts of fertilizer are used by the respondents' .i.e. average 400 kg Urea and 50kg DAP annually.

4.4.5 Dumping of Household solid/liquid wastes: The dumping of liquid/solid waste in a proper place is a major issue in general in India, particularly in the case of Punjab. In ancient times, wetland areas are used for dumping of liquid and solid wastages, as it regarded as a wasteland. The situation has not changed during present times, as wetland areas are used for dumping of liquid and solid wastages of industrial, agricultural, religious, and sewage of residential areas. The amount of disposal off liquid and solid waste varies from urban and rural areas on the basis of nature and amount of waste.

In a Harike wetland, liquid and solid wastage of Makhu town are dumped into samnala that runs parallel to Harike wetlands. The samnala which is now used for disposing of solid and liquid wastage was filled with the clean water about 20 years backs. The liquid wastages of Makhu town are connected with the sewage treatment plants, where only sludge is removed and treated water is used for irrigation purposes. As per 80 percent respondents, the final disposal of household liquid waste reach the sewage plants, 10 percent drained outside the home, 7.5 percent near the wetland areas and 2.5 percent in wetland areas. This trend completely changed in rural areas, as 68.46 percent respondents discharged water near wetland areas, 18.46 percent

directly in wetland areas, 12.31 percent outside the home, 0.77 percent in protected plots.

Table 4.16: Results of Chi-square for Dumping of Liquid/solid Wastage in Harike Wetland

Harike Wetland		*Income*	*Education*	*Occupation*
Rural	Chi-square value	1.92	5.15	2.43
	P Value	0.74	0.27	0.66
Urban	Chi-square value	3.34	2.38	3.69
	P Value	0.50	0.67	0.45
Total	Chi-square value	4.44	16.34	19.03
	P Value	0.35	0.00*	0.00*

Source: Data was collected during the field survey, 2016-17 & 2017-18

*means significant at five percent level

The question was asked from respondents where do they dump their household solid and liquid waste. Both in rural and urban areas, household income, education and occupation has a non-significant impact over the dumping of liquid or solid wastage (Table 4.16).

In Ropar wetlands, discharging of liquid and solid waste varies in urban areas, as 35.22 percent respondents state that waste material is discharged into a protected site, 16.9 percent drained outside the home, 12.68 percent near the wetland areas, 28.16 percent in the wetland areas and 7.04 percent in own plots. The profile has changed in rural areas; 25.68 percent drained outside the home, 29.73 percent near the wetland areas, 39.19 percent in wetland areas, 4.05 percent in the commonplace and 1.35 percent in own plot.

The question was asked from respondents where do they dump their household solid and liquid waste. In rural areas, household income has been significant at 10 percent level and education significant at 5 percent. In urban areas, both income and education were significant at 5 percent level and occupation at a 10 percent level (Table 4.17).

Table 4.17: Results of Chi-square for Dumping of Liquid/solid Wastage in Ropar Wetland

Ropar Wetland		*Income*	*Education*	*Occupation*
Rural	Chi-square value	9.12	15.64	7.19
	P Value	0.06**	0.00*	0.13
Urban	Chi-square value	11.36	13.02	8.54
	P Value	0.02*	0.01*	0.07**
Total	Chi-square value	6.97	23.34	10.69
	P Value	0.14	0.00*	0.03*

Source: Data was collected during the field survey, 2016-17 & 2017-18
*means significant at 5 percent level, **means significant at 10 percent level

From the respondents of urban areas of Nangal wetland, 62.96 percent discharged liquid and solid waste in the commonplace, 25.93 percent outside the home, 3.70 percent near wetland areas and 7.41 percent in wetland areas. This trend is different from rural areas as 69.50 percent discharged village wastage into wetland areas, 5.08 percent in a protected place and 8.47 percent each near the wetland areas, drained outside the home and commonplace respectively.

The question was asked from the respondents where do they dump their household solid and liquid waste. In rural areas, household income has been significant at 5 percent level. Whereas, in urban areas, income, education and occupation are non-significant factors for the disposal of solid or liquid wastes (Table 4.18).

Table 4.18: Results of Chi-square for Dumping of Liquid/solid Wastage in Nangal Wetland

Nangal Wetland		*Income*	*Education*	*Occupation*
Rural	Chi-square value	11.53	6.97	1.00
	P Value	0.02*	0.14	0.91
Urban	Chi-square value	2.47	3.72	2.74
	P Value	0.65	0.45	0.60
Total	Chi-square value	14.83	1.67	2.82
	P Value	0.01*	0.80	0.59

Source: Data was collected during the field survey, 2016-17 & 2017-18
*means significant at 5 percent level

4.5 Household Liquid and Solid Waste Management by surrounding areas: The wetlands areas are degraded by a number of wastes in the form of liquid and solid wastes. The method and nature of disposal of any liquid and solid wastages plays a vital role in respect of environmental problems (Magrinho et al., 2006).

4.5.1 Solid waste: The solid waste in urban areas generated by various activities includes; industrial, educational, commercial, residential and agricultural activities. Solid waste is a type of garbage, sludge and refuses subject such as bottles, plastic, dust, electronic, medical, rubber (Lenton & Omotosho, 2004; Babayemi & Dauda, 2009). The disposal of solid waste is divided into three classes on the basis of the location where it was disposed; wetland areas, an outer boundary and protected space (provided by municipal or at the outside of the home in the village on Rurhi or dung garbage).

Presently, in urban areas, 87.5 percent respondents of Makhu city, 46.48 percent of Roopnagar city, and 92.59 percent of Nangal disposed solid wastes at a site provided by the government, while 5 percent respondents of Makhu, 5.63 percent of Roopnagar and none from Nangal dumped solid waste at outer areas of the city. The remaining respondents of urban areas; as 5 percent of Makhu, 47.89 percent of Roopnagar and 7.41 percent of Nangal city disposed of solid waste in the wetland areas. The percentage of respondents was higher in Roopnagar who disposed off solid waste in the wetland areas because no service for the collection of solid waste was provided in an illegal house structure in the wetland areas.

In rural areas, the situation is different as compared to urban areas, as only 14.61 percent respondents of Harike, 32.43 percent of Ropar and 8.48 percent of Nangal wetlands dumped solid waste mostly at home outside, which was further used as fertilizer for agricultural activities. The 81.54 percent of respondents of Harike, 32.43 percent in Ropar and 25.42 percent in Nangal wetland dumped solid waste at the outer areas of villages, also used for agricultural production. Therefore, most of the solids generated in rural areas are used for agricultural activities. Only 3.85 percent respondents of Harike, 35.13 percent of Ropar and 66.1 percent dispose off solid waste in wetland areas that include ashes and residual of cremation rituals.

4.5.2 Liquid Waste: liquid waste is a kind of waste that is not suitable for the environment and human beings. The situation completely differs regarding the disposing of the liquid waste site in comparison to solid waste.

In the urban area, about 87.5 percent respondents of Harike, 47.89 percent of Ropar and 88.89 percent of Ropar wetlands water treated by sewage treatment plants, while 12.5 percent respondents of Harike, 52.11 percent of Ropar and 11.11 percent of Nangal wetland discharged liquid waste near or in the wetland areas.

In rural areas, about 98.46 percent of Harike, 70.27 percent of Ropar and 94.92 percent of Nangal wetlands discharged household liquid waste directly or indirectly near or in the wetland areas, while only 1.54 percent of Harike, 29.73 percent of Ropar and 5.08 percent respondents discharged household liquid wastages in any others places like agriculture fields.

The reasons responsible for polluting the water quality of wetland areas varies with the location of each wetland. Apart from this, distance covered by the river also affected the level of water quality in wetland areas. These three wetlands namely Harike, Ropar and Nangal are situated on the banks of River Sutlej, but the quality of water is totally fluctuating in rivers as well as wetland areas of each region. The water quality of river changed from class B into Class E near the Harike wetland areas, because of disposing of liquid waste with several chemicals, pesticides, fertilizers and sewage effluents (Punjab Pollution Control Board, 2014). From field surveyed, it analyzed that amount or nature of effluents discharged into river water changed from the entry of the river in Nangal to Harike region. As per 52.94 percent respondents, the water of Harike wetland is being polluted by toxic industrial effluents in the river by the Budda Nala. On the other side, the contribution of industrial pollution is low in Ropar and Nangal wetlands as compared to Harike Wetland, because only 23.26 percent respondents in Nangal and 10.34 percent in Ropar wetlands perceived the industrial effluents as polluters of wetland water. The 76.74 percent respondents of Nangal, 69.66 percent of Ropar and 40 percent of Harike wetlands responded that discharge of sewage effluents are responsible for water pollution. The remaining respondents say that water in river areas has been polluted by the agricultural activities.

4.6 Perception of respondents about the major threats in wetland areas

During the field survey, data was collected from the respondents related to main problems of the wetlands, the impact of human activities on the wetlands and their perception about the threats to wetlands. The major threat identified by the respondents is given below in the table.

Table 4.19: Respondents Perception on the Threat to Wetland

S. No.	Major threats
1	Agricultural drains to wetland
2	Industrial effluent drained to wetland
3	Sediment accumulation and suspension
4	Excessive water extraction for urban use, agriculture, and industry
5	Overgrazing
6	Weeds/hyacinth/ another aquatic plant
7	Increased human activity within the wetland
8	Poor water quality
9	Encroachment of wetland by human activities
10	Household waste dumped to wetland/around the wetland

Source: Data was collected during the field survey, 2016-17 & 2017-18

The locals of Harike wetland recognise that the water quality of Sutlej River is more degraded as compared to Beas River. Because a huge amount of polluted water is discharged into Sutlej River by the industries and cities on the banks of the Sutlej River as compared to Beas River. About 61.76 percent of respondents of Harike wetland, 28.27 percent of Ropar and 25.58 percent respondents of Nangal wetland acknowledged that water quality of wetland areas are affected by the industrial activities. Secondly, the water quality of wetland areas is polluted by agricultural activities as 27.06 percent in Harike, 16.55 percent in Ropar and 6.98 percent in Nangal state that extra water of agricultural water is drained to wetland areas. Water quality of wetland areas are affected by social and religious activities; 12.41 percent respondents said that Ropar wetland is degraded by religious activities, as most of the cremation ritual occurs on the river banks. In addition, liquid wastage of urban areas and villages are discharged into wetland areas. In addition to it, wetlands of Punjab areas are suffering from the problem of siltation. The increasing amount of siltation affects the wetland area by lowering of water holding capacity by filling of area or reduce the depth of wetland area. The process of siltation accountable for increasing of silt in the wetland areas that directly affect the water storing capacity of wetland. The problem of siltation increased during rainy seasons. The livestock grazing in wetland areas increased the frequency of soil erosion because upper soil becomes loose due to excessive livestock grazing (Chopra et al., 1998). The

absence of vegetation cover in the areas further leads to high sedimentation in wetland areas. The problem of siltation is directly linked with slope and vegetation cover of the landscape. The three wetlands; Harike, Ropar, and Nangal suffered from the problem of siltation. A huge quantity of silt has been removed from the Harike headworks in 2017 (Field Survey, 2017).

4.6.1 Three-dimensional Matrix Analysis for threat perception index

A three-dimensional matrix analysis has been calculated using 10 indicators of threats to wetlands areas as identified by the respondent living within the one kilometres area. The value for each indicator has been calculated by using rank and the weightage as per their priority to the threat. The index clearly reveals the threat perceived by the locals to each wetland (Model 2, Table 3.15).

4.6.1.1 Harike Wetland: Concerning the perception about the problem of wetland, the results reveal that all the villages identified that polluted water from industries and agricultural lands are a major threat to Harike Wetland. This response varied according to the location of the sampled villages. The villagers along Sutlej River consider these as the biggest threat because industries release harmful chemicals to the water bodies that affect the health of human, animal and aquatic life while the villagers near the Beas River do not consider these as a major threat. Weeds/hyacinth and other aquatic plant are also considered a threat by all the respondents.

Figure 4.7: Major Threats to Wetland Perceived by Respondents of Sampled Villages around Harike Wetland

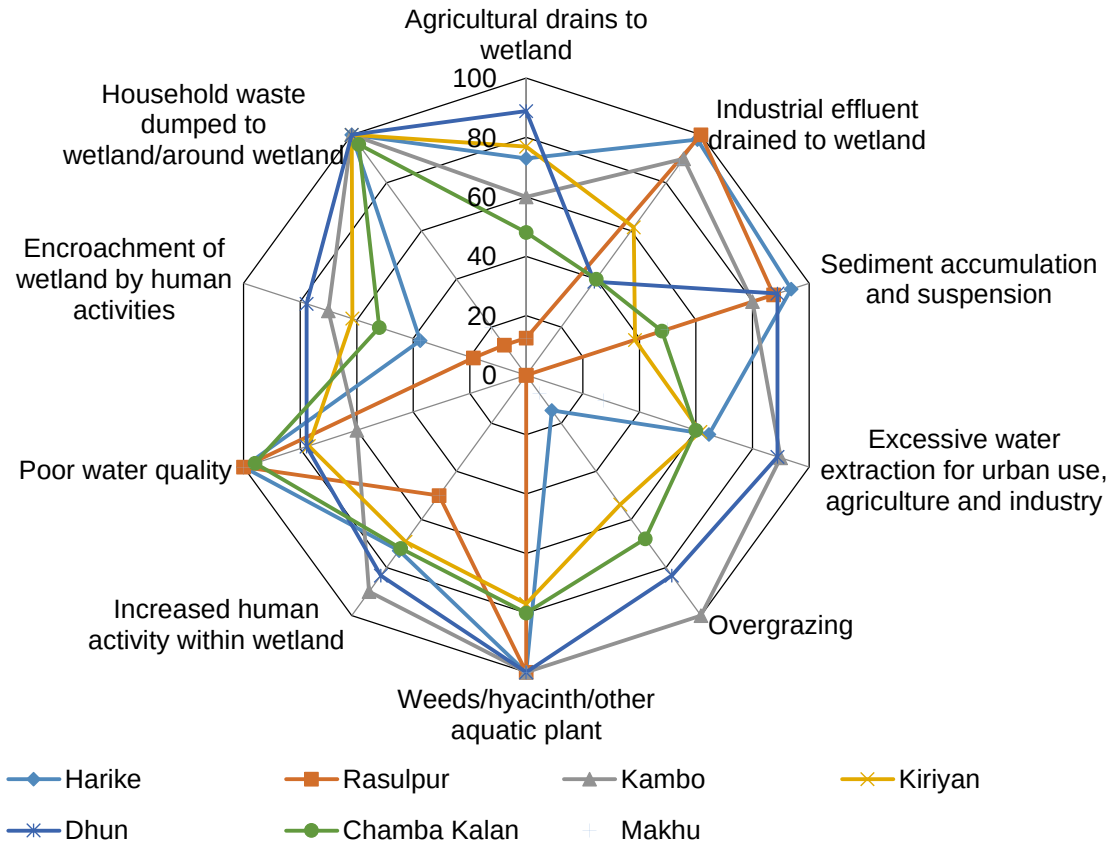
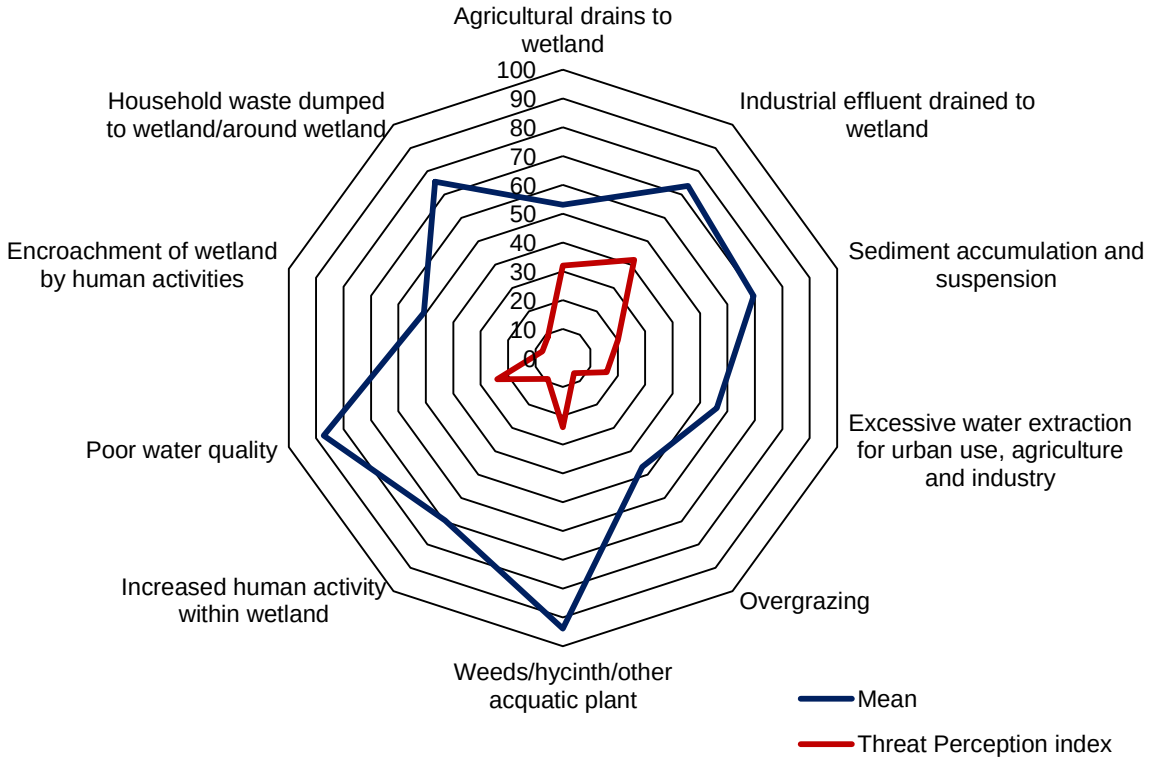


Figure 4.8: Threat Perception Index for Harike Wetland



The response plotted in the figure (4.7) shows that encroachment of wetland for human activity is not considered a threat by the people by the respondents. While the management report of Harike wetland considers it as a big problem. It points out the potential source of conflict among different stakeholders living around the wetland. The people living around the sanctuary areas blame that government did not give proper compensation to the local residents. During the time of the acquisition, the government allotted land in Rajasthan. But, people do not get land in Rajasthan. The people also claim that the government also give right for the cultivation of land falling in the wetland areas (Field Survey).

Mean response of all the villages plotted in the figure (4.8) shows that the major identified threat are industrial waste, poor water quality, household waste and spread of hyacinth. The Threat perception index shows that industrial effluent drained to wetland, poor water quality and hyacinth are the major threat for long term sustainability of the Harike wetlands.

4.6.1.2 Ropar Wetland: As regard to the perception about the threat to Ropar wetland, the results reveal that all the respondents identified that household waste (solid and liquid) and agricultural runoff drained to the wetland areas, the encroachment of wetland by human activities, excessive water extraction is causing a threat to Ropar wetland. Industrial effluent drained to wetland and overgrazing are also considered threats. Respondents do not consider any problem with the infestation of weeds/aquatic plants and siltation.

Mean response of all the villages plotted in figure matches with the major threats identified and mentioned in the previous paragraph. The Threat perception index shows that agricultural runoff to the Ropar wetland and excessive water extractions are the major threat for the long-term sustainability of the Ropar wetlands as identified by the respondents (Figure 4.9. & 4.10).

Figure 4.9: Major Threats to Wetland Perceived by Respondents of Sampled Villages around Ropar Wetland

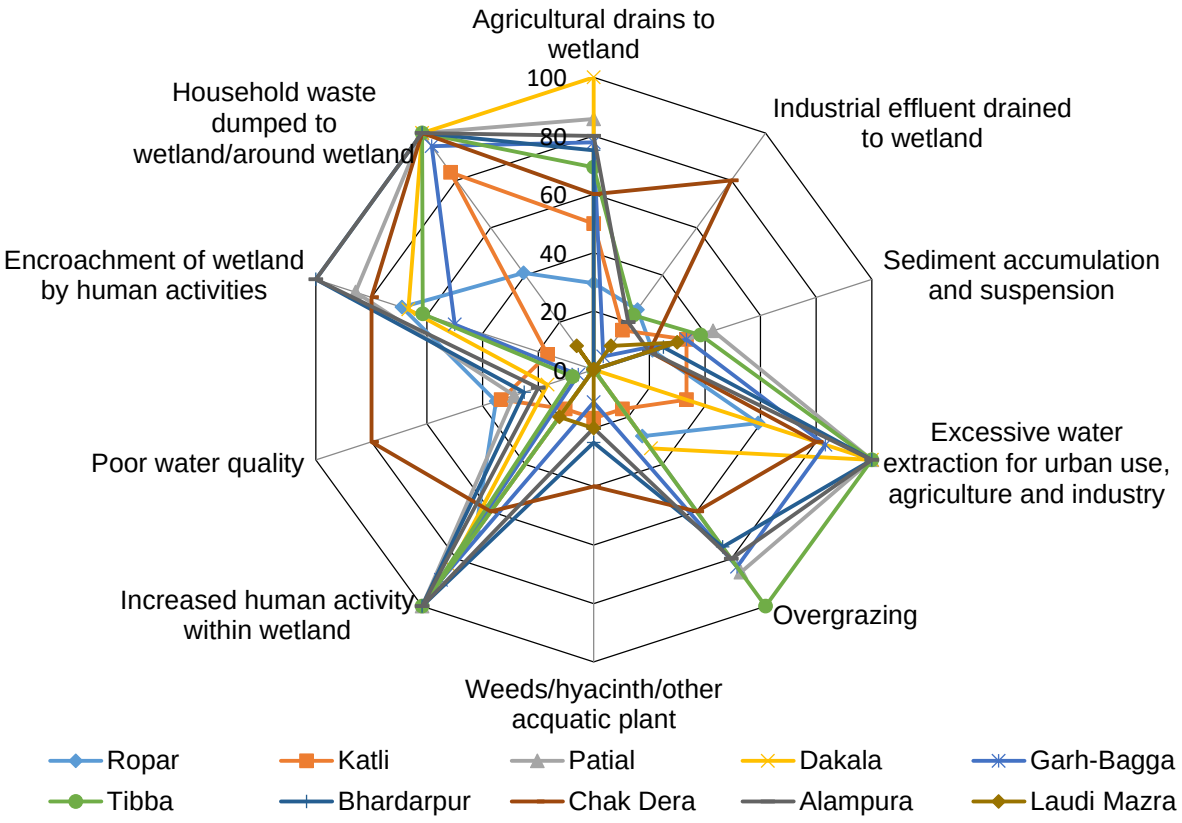
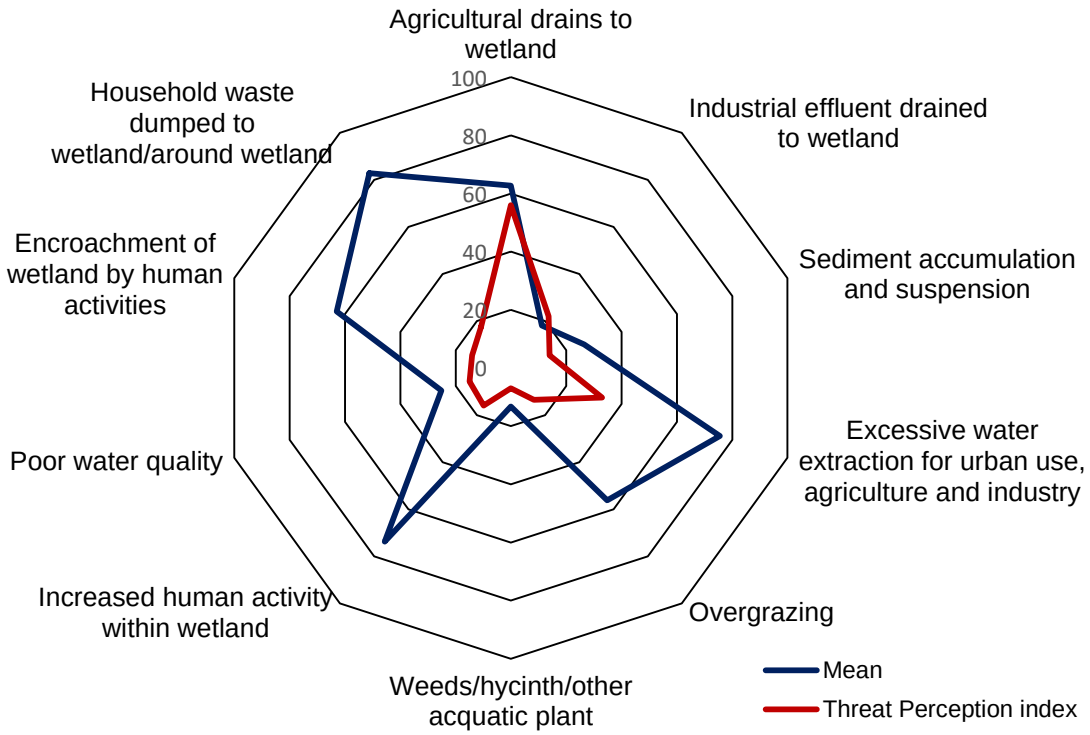


Figure 4.10: Threat Perception Index for Ropar Wetland



4.6.1.3 Nangal Wetland: With regard to the perception about the problem of wetland, the results reveal that all the respondents identified that household waste (solid and liquid) dumped into the wetland areas is causing a threat to Nangal wetland. Industrial effluent drained to wetland and encroachment of wetland for human activities, agricultural runoff from cropland and overgrazing around Nangal wetland is other threats. Grazing causes soil erosion and increases the problem of siltation in the wetland. Respondents do not consider any problem with the quality of water and infestation of weeds/aquatic plants (plotted in figure 4.9). Neither do they recognise siltation as a big threat to the wetland. However, the location of Nangal wetland in Hilly areas and report of several research papers reveal that siltation is a major problem in this area.

Mean response of all the villages plotted in figure 4.11 shows that the major threat identified is household waste and industrial waste dumped to the wetland and increased human activities in the wetland. The Threat perception index shows that industrial effluent drained to the wetland is the major threat for the long-term sustainability of the Nangal wetlands as identified by the respondents (Figure 4.12).

Figure 4.11: Major Threats to Wetland Perceived by Respondents of Sampled Villages around Nangal Wetland

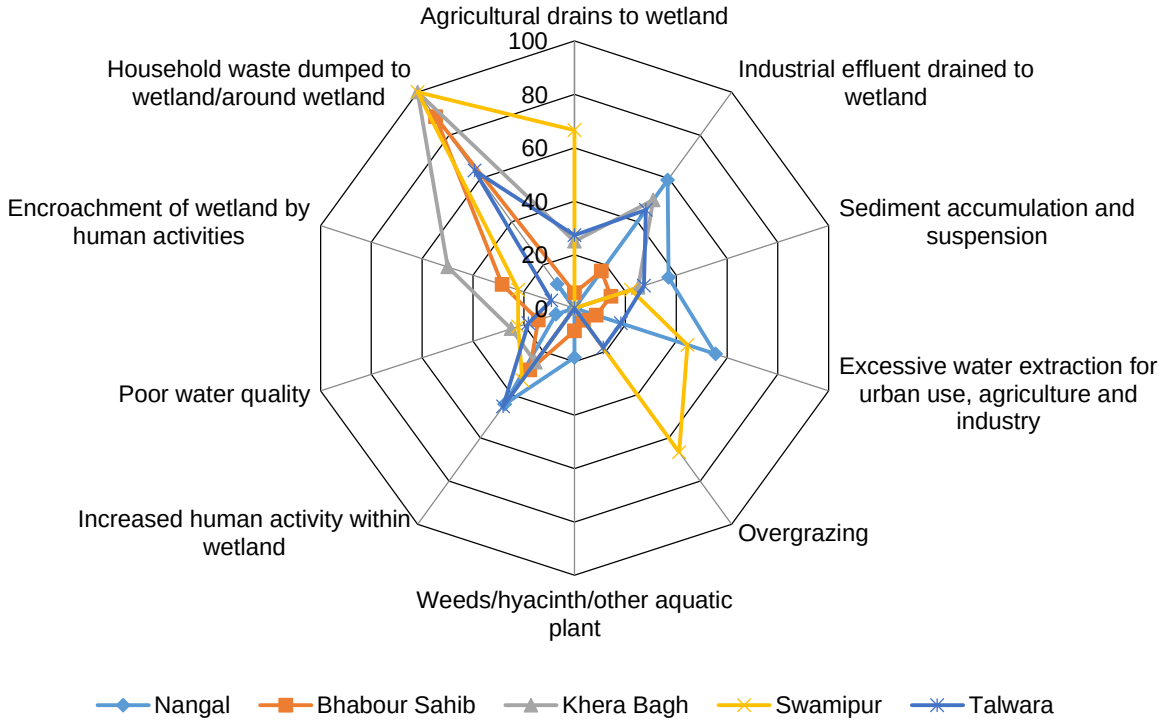


Figure 4.12: Threat Perception Index for Nangal Wetland

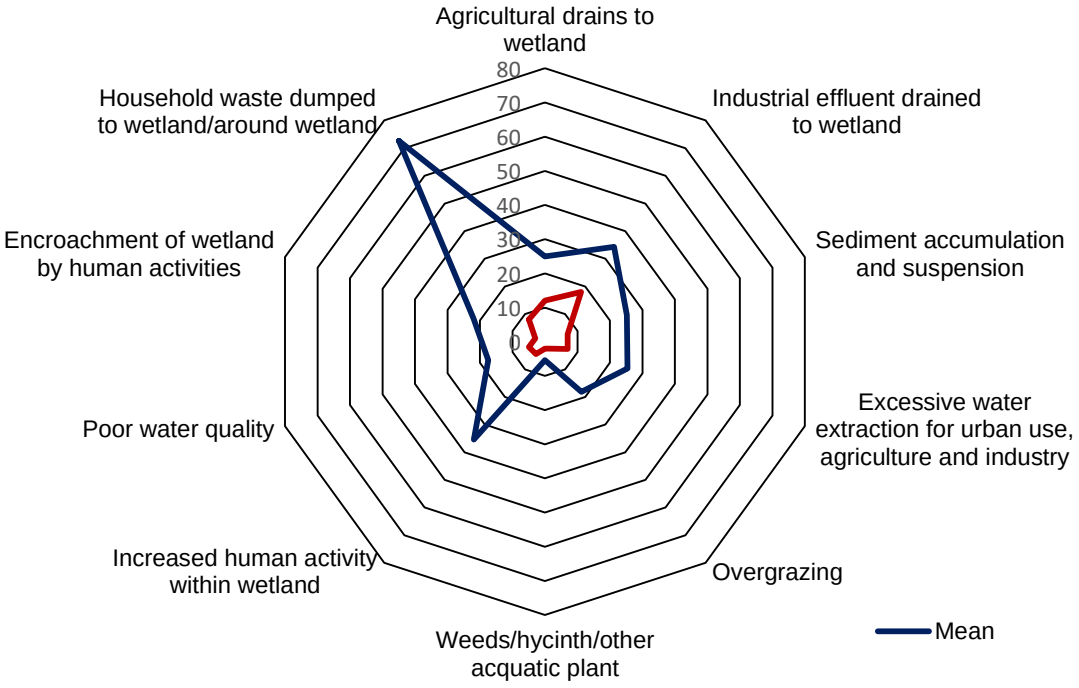


Table 4.20: Matrix Analysis for Threats to Harike Wetland

Sr. No	Respondents perception on threat to wetland	Weightage	Harike		Rasulpur		Kambo		Kiriyan		Dhun		Chamba Kalan		Makhu		Total Score
			Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	
1	Agricultural drains to wetland	2	3	6	1	2	3	6	4	8	4	8	2	4	1	2	32
2	Industrial effluent drained to wetland	2	4	8	4	8	4	8	3	6	2	4	2	4	4	8	42
3	Sediment accumulation and suspension	1	4	4	4	4	4	4	2	2	4	4	2	2	2	2	20
4	Excessive water extraction for urban use, agriculture and industry	1	3	3	0	0	4	4	3	3	4	4	3	3	2	2	16
5	Overgrazing	0.5	1	0.5	0	0	4	2	3	1.5	4	2	3	1.5	1	0.5	6.5
6	Weeds/hyacinth/other aquatic plant	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	24
7	Increased human activity within wetland	0.5	3	1.5	2	1	4	2	3	1.5	4	2	3	1.5	2	1	9
8	Poor water quality	1	4	4	4	4	3	3	4	4	4	4	4	4	5	5	24
9	Encroachment of wetland by human activities	0.5	2	1	1	0.5	3	1.5	3	1.5	4	2	3	1.5	2	1	7.5
10	Household waste dumped to wetland/around wetland	0.5	4	2	1	0.5	4	2	4	2	4	2	4	2	1	0.5	9

Source: Data was collected during the field survey, 2016-17 & 2017-18

Table 4.21: Matrix Analysis for Threats to Ropar Wetland

Sr. No	Respondents perception on threat to wetland	Weightage	Ropar		Katli		Patial		Dakala		Garh Bagga		Tibba		Bhardarpur		Chak Dhera		Alampura		Laudi Mazra		Total Score
			R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	
1	Agricultural drains to wetland	2	2	4	2	4	4	8	4	8	3	6	3	6	3	6	3	6	4	8	0	0	56
2	Industrial effluent drained to wetland	2	2	4	1	2	0	0	0	0	1	2	1	2	0	0	4	8	1	2	1	2	22
3	Sediment accumulation and suspension	1	1	1	2	2	2	2	0	0	2	2	2	2	1	1	1	1	1	1	2	2	14
4	Excessive water extraction for urban use, agriculture and industry	1	3	3	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	0	33
5	Overgrazing	0.5	2	1	1	0.5	4	2	2	1	4	2	4	2	3	1.5	3	1.5	4	2	0	0	13.5
6	Weeds/hyacinth/other aquatic plant	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	2	2	1	1	1	1	7
7	Increased human activity within wetland	0.5	3	1.5	1	0.5	4	2	4	2	4	2	4	2	4	2	3	1.5	4	2	1	0.5	16
8	Poor water quality	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	4	4	1	1	0	0	15
9	Encroachment of wetland by human activities	0.5	3	1.5	1	0.5	4	2	3	1.5	2	1	3	1.5	4	2	4	2	4	2	0	0	14
10	Household waste dumped to wetland/around wetland	0.5	2	1	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	1	0.5	17.5

Source: Data was collected during the field survey, 2016-17 & 2017-18

Note: R*= Rank, S*=Score

Table 4.22: Matrix Analysis for Threats to Nangal Wetland

Sr. No.	Respondents perception on threat to wetland	Weightage	Nangal		Bhabour Sahib		Khera Bagh		Swamipur		Talwara		Total Score
			Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	
1	Agricultural drains to wetland	2	0	0	1	2	1	2	3	6	1	2	12
2	Industrial effluent drained to wetland	2	3	6	2	4	2	4	0	0	2	4	18
3	Sediment accumulation and suspension	1	2	2	1	1	1	1	1	1	2	2	7
4	Excessive water extraction for urban use, agriculture and industry	1	3	3	1	1	0	0	2	2	1	1	7
5	Overgrazing	0.5	0	0	1	0.5	0	0	3	1.5	1	0.5	2.5
6	Weeds/hyacinth/other aquatic plant	1	1	1	1	1	0	0	0	0	0	0	2
7	Increased human activity within wetland	0.5	2	1	2	1	1	0.5	2	1	2	1	4.5
8	Poor water quality	1	1	1	1	1	1	1	1	1	1	1	5
9	Encroachment of wetland by human activities	0.5	0	0	2	1	2	1	1	0.5	1	0.5	3
10	Household waste dumped to wetland/around wetland	0.5	1	0.5	4	2	4	2	4	2	3	1.5	8

Source: Data was collected during the field survey, 2016-17 & 2017-18

4.7 Impact of wetland areas over crop production: The people who are living nearby the wetland areas, are suffering from the problem of flash floods mainly in rainy season. The flood situation in rivers is responsible for damage to crops grown near the banks of the river. The release of a high amount of water or changing the level of water in wetland areas are harmful to agricultural productivity also. The presence of wildlife in the wetland affect the local people who lives nearby wetland areas. Some wild animal such as wild boar, Neelgai, Swampy deer become a major challenge for the local respondents, because these animal destroy the crops during the night time.

In Harike wetland, 63.64 percent respondents' state that nearness of agricultural field to the wetland areas badly impact the agricultural productivity. There are other reasons responsible for low farm productivity near wetland areas; wild animals, floods, siltation and water pollution. The level of damage by wild boar changed from crop to crop such as sugarcane and maize are highly damaged by the wild animal of wetland areas. These causes are accountable for the change of crop combination near the wetland areas from mixed crop to the wheat-rice combination. Other problems in the region faced by people are flood and presence of waterlogging. In rainy season, agricultural land near the wetland areas is severely affected by the floods due to the confluence of Beas and Sutlej River in Harike wetland. The agricultural land lies in *mand* areas along the banks of the Beas River are highly suffered by the floods due to Harike barrage. In addition, change of river course and the occurrence of temporary structure along the river banks add to the problems. The crops cultivated in *mand* areas of Dhun, Chamba Kalan, and Kambo Dhai Wala villages are highly affected by the flood, because the villages are lying on other side of river banks have constructed a temporary barrage to stop the water. This stoppage force the water to move another bank of the rivers which ultimately cause flood like situation. After the flood, water in *mand* areas cause the problem of waterlogging. Sometimes the locals are not able to harvest their ripen crops. In addition, agricultural crops are destroyed by the silt taken by the river. In a Harike wetland, respondents living along the Beas River harvest only a single crop from the *mand* areas. The agriculture crops along the Sutlej River are affected by certain crop diseases like *Tella*. About 9.09 percent respondents perceive that location near the wetland areas plays a positive impact on the agricultural productivity. As some

respondents use the wetland areas for the cultivation of *Sanghera*. The 27.27 percent respondents perceive that production of agriculture is not affected by location of agricultural land. The response of local varies with the areas of their living. In rural areas, 66.67 respondents faced the negative impact on wetland areas, whereas in urban areas it decreased to 50 percent.

In Ropar wetland areas, about 49.33 percent respondents suffered from low agricultural productivity near the wetland areas. The agricultural production in Ropar wetland areas majorly damaged by wildlife such as wild boar. In addition, some crops are affected by the problem of waterlogging near the river banks. 15-20 year back the agricultural field around Ropar wetland were suffering from floods. Ropar wetland areas do not face floods from the last 10 years. About 30.67 percent respondents of Ropar wetland areas consider that wetland areas put a positive impact on the agricultural production. The people in areas also make effort to low down the negative impact of wetland areas on agricultural productivity. To overcome this situation, locals are dependent upon commercial plantation on river banks .i.e. are beneficial for both wetland areas and human beings. In addition, some respondents grow vegetables near the wetland areas that are less affected by the increase of water in wetland areas. About 20 percent respondents whose agricultural land lies far away from the wetland areas neither have positive nor have a negative impact.

In Nangal wetland, 83.33 percent of respondents are suffering in economic terms due to low agricultural productivity. The agricultural crops in Nangal wetland areas mainly affected by wildlife such as wild boar, Neelgai, Swampy deer and some migratory birds. The level of damage to crops increased after the declaration of Nangal Lake as Nangal Wildlife Sanctuary. After the notification of wildlife sanctuary, many new species of wild animals are taken to Nangal Wildlife Sanctuary, but due to improper food facilities these animals go to surrounding agricultural fields. The wetland areas are not covered by fencing and at the night time, these wild animals damage the crops. Some of the respondents made their personal fencing around the agricultural field to save their crops from wild animals' attack. Some respondents did not grow any crops due to high damages, as their expenditure is higher than income. Only 5.56 percent respondents

say that wetland areas are good for the agricultural production and 11.11 percent says that no impact of wetland areas on agricultural productivity.

4.8 Flood: The respondents who are living nearby the wetland areas are suffered by overbank flooding. The over bank flood occurred due to increase in the amount of water than the capacity of river owing to rain or melting of snow. In this case, water within the river overflow its banks and spread across the land around it. The locals of Harike wetland are suffered from this problem. In rainy season, the amount of water in the Beas River is higher than its capacity and excessive water of the Beas River spread into the low-lying areas near the river.

In Harike wetland, 95.29 percent respondents face the problem of over bank flood every year (July-September months). This situation becomes worst due to Harike headworks, when the water from headworks is not released.

In Ropar wetland area, 77.24 percent people are suffered from over banks floods from the last 20 years. The damage by floods is now declined due to the control over water through the construction of Nangal Dam. In addition to it, location of wetlands also plays a critical role in occurrence of floods. The Ropar wetland situated on one river i.e. Sutlej River which means water flow from only one river lower down the frequency of damage. On the other side Harike wetland is situated on the confluence of two river and excessive water can't be released into lower areas due to presence of barrage. In another way, the location of Harike wetland nearby international boundary there are many regulations under Indus treaty water can't release directly.

In Nangal wetland areas, 15.12 percent of respondents are affected by the problem of over banking flood. The hill slope or altitude of areas lower the frequency of damage in Nangal wetland areas.

4.9 Water Quality analysis of Harike, Ropar and Nangal Wetland: The pH values determine acidic and basic nature of water, which depends on the concentration of H^+ ion and OH^- ion in a water sample. Increase or decrease of H+ or OH- ions depends on anthropogenic as well as a natural activity. Sometimes algae activity become a good indicator of pH or water pollution and it tries to neutralize water through the process of photosynthesis. High algal activity consumes more amount of CO_2 during

photosynthesis, leads to water towards basic nature. From figure 4.13, it shows change in pH value with the traverse starting from the Hindola Bridge, Nangal to Headward of Harike dam. From Figure 4.13 at location N1 water sample reading shows pH value 7.83 and it is assumed that this water is freshwater. Moving downstream of Sutlej from Nangal to location N2, shows little reduction in pH values which might be due to the addition of polluted or wastewater in Sutlej river from National Fertilizer Limited (NFL) and this increase the acidic nature of water. At this location algal was also high, represents favourable condition for algal growth. Further downstream N3, low algae activity and interaction of Sawan River water to Sutlej River water nearby Aggampur Village (Garhsankar-Nawanshahr road) bridge increase the pH, so Sutlej River water becomes slightly basic in nature. In a study of Nangal wetland by Chauhan and Sagar (2013), the dumping of liquid or solid wastages from the domestic, religious, agricultural and industrial sectors affects the water quality of Sutlej River near the Nangal Wetland. From this, water samples were collected in July 2010 to June 2011 from three selected sites; upstream Nangal wetland, downstream Nangal wetland where NFL treatment plant is situated and 2 km downstream from the mixing of NFL wastages into Sutlej River. In between the location N3 and N4, an SYL canal is contributing water to Sutlej river, which results in little enhancement of pH Value as well as low algae activity. Reduction in pH value between N4 and R1 and high algal activity within this length of the river is due to the addition of water from Kundlu Khadd. In between R1 and R2 sudden decrease in value of pH and very high algal activity due to thermal water discharge and addition of water from Sirsa River and Lotan khadd. Further downward increment in pH in between R2 and R3 because of mixing seasonal water and unknown tributaries contribute water which dilute the acidic nature of water so that Sutlej River water tends towards basic nature. There is no algae activity and high agricultural activity in river flood plains, which most probably leads Sutlej River towards basic in nature in between R3 and H1 locations. From H2 and H3 shows lowering the pH value of Sutlej river water because of the addition of water through Buddha Nallah, which carries industrial wastewater from Ludhiana city and it also turns colour of Sutlej river water into black and changes the water odour completely. Location H6 and H7 are before and after meeting points of Chitti Bein to Sutlej Rive respectively, it shows a

reduction in pH from H3 due to low algae activity and Chitti Bein carries industrial acidic water from Jalandhar city. Chitti Bein, which clearly represents the acidic nature of water and this water interact with Sutlej River and raise the acidic nature of Sutlej River water. Similarly, a study by Sharma et al. (2017), analyzed the impact of discharging of untreated polluted water by the 'Buddha Nallah' and 'Chitti Bein 'or 'East Bein' into the Sutlej River near Ludhiana and Sultanpur Lodhi respectively. From the results, it is clear that the surface water quality of the Sutlej River, as well as the ground water quality, had been severely affected by the dumping of untreated water from industrial, domestic and agricultural sectors. H5 sample is from Kali Bein, which directly enter in Harike wetland and have pH value of about 7.85, Kali Bein originate from Hoshiarpur district marshy and swampy land, municipal wastages dumped into Bein mainly from Kapurthala district, which contributes waste acidic water to Kali Bein and results in acidic nature after a long traverse of Kali Bein. Sample H8 is collected from Beas River at Kambo Dhaiwala village, it has pH 8.03 which represent that after long traverse it is little basic in nature because to less intrusion of other water bodies (figure 4.14). Sample H9 is collected from Headward of Harike Dam and we assumed proper mixing of all water bodies such as River Sutlej, Beas and Kali Bein, after well mixing of water pH value tends towards 7.73. The pH value of well-mixed water represents interesting results, it says that at Harike wetland the contribution of Beas River water is greater than Kali Bein and Sutlej Rivers, which tends to neutralize acidic nature of River Sutlej and Kali Bein water.

Figure 4.13: Level of pH in the Sutlej River

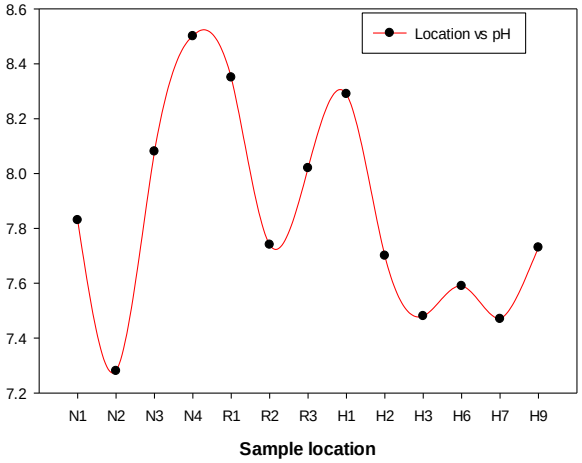
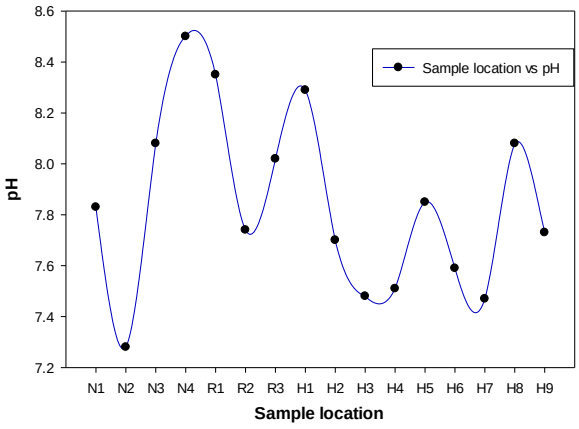


Figure 4.14: Location vs pH Plot



Source: Data was collected during field survey, 2017-18

Acidic and basic nature of water affects the soil during irrigation. pH value lower than 8.5 causes white crust on the surface called saline soil. Saline soil mainly contains low Sodium (Na^+) ion and principally consists Na^+, $Ca^{2+,}$ $MgCl_2$, SO_4^{-2} (sodium, calcium, Magnesium, Sulphate respectively), in other hand water pH ranges between 8.5-10, turns soil colour into black and known as sodic soil or black alkali soil. The well-mixed water of Harike wetland is favourable for aquatic life and for irrigation purposes. The impact of flora on Harike wetland water needs to be more studied.

Figure 4.15 EC in the Sutlej River

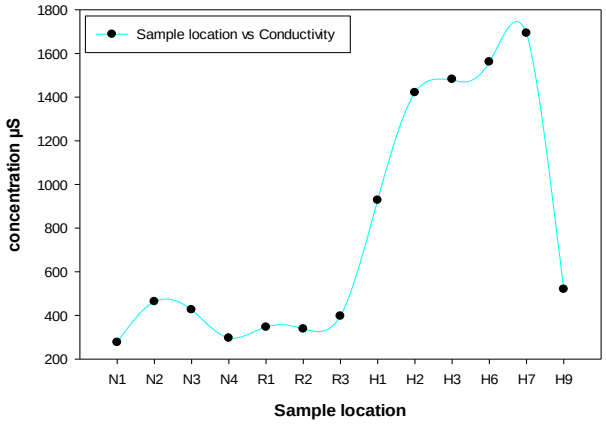


Figure 4.16 Sample Location vs Conductivity Plot

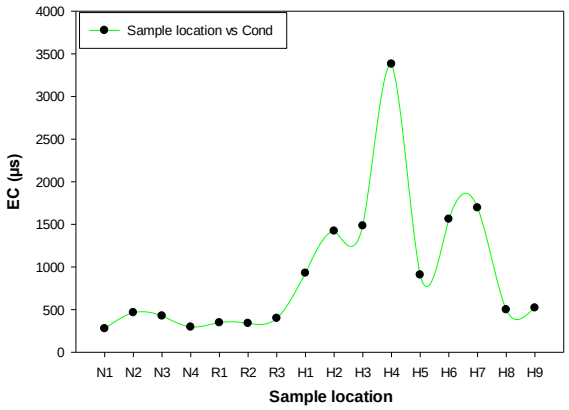


Figure 4.17 Level of TDS and Salinity in the Sutlej River

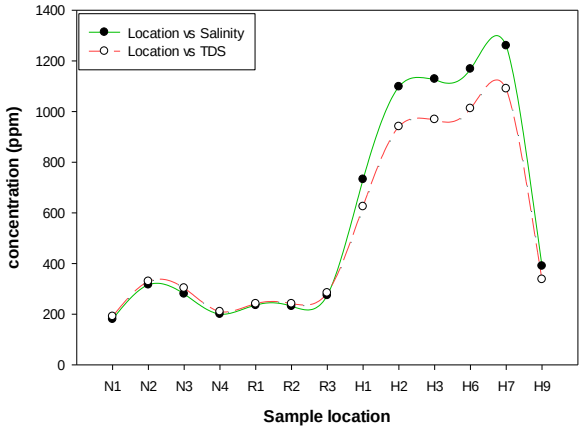
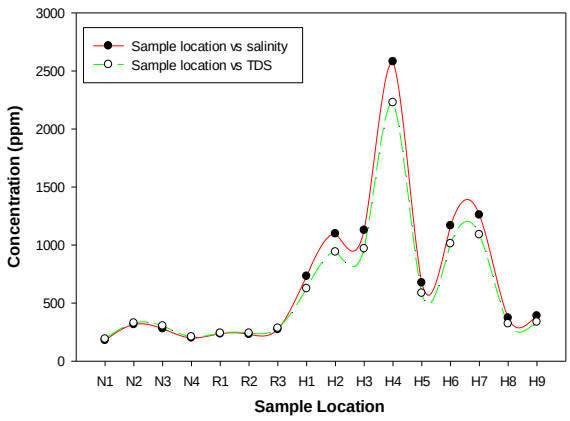


Figure 4.18 Location vs TDS, Salinity



Source: Data was collected during field survey, 2017-18

Conductivity represents the ability to flow free ions within a waterbody, it depends on temperature, salinity and TDS (Talley, 2000). Sudden change in conductivity of water indicates water pollution, which can be caused by sewage, surface runoff, ions from erosion, evaporation, urban runoff etc. In fresh streams and rivers normal conductivity

level maintains through surrounding geology (Wetzel & Limnology, 2001). Addition of water from other sources such as from springs, rainwater and the confluence with tributaries can change the conductivity, salinity and TDS of water bodies. The change in the flow and amount of water level affects the conductivity with the changes in salinity. Addition of warm water can change the conductivity as the solubility of warm water is higher than cold water for water-soluble substance.

Figure 4.15 represents conductivity of Sutlej River water from a different location and figure 4.16 includes the conductivity values of the sample collected from Beas River, Chitti Bein, Kali Bein River. Conductivity, salinity and TDS follow the same pattern in Plots, which shows a direct relationship between these three Parameters.

At location N1 conductivity of a water sample is lowest (276 ppm) within all the sample and salinity and TDS were also lowest. At location N2 and N3, conductivity is higher than the N1 due to the intrusion of water from the NFL. At location N4, lowering the conductivity is due to water discharge to Sutlej from the SYL canal. SYL canal originates from Nangal dam and carries a high volume of fresh and unpolluted water, which impacts lowering the conductivity of Sutlej River. At location R1, little increase in conductivity of river water to surface runoff from agricultural land and addition of water from Kundlu Khadd just before location R1. The level of conductivity and salinity fall down at location R2 due to the discharge of warm water to Sutlej River from the Guru Gobind Singh Thermal Plant. Conversely, the conductivity is directly related to temperature, but due to use of less conductivity water from the Bhakra canal in the thermal power plant maintained the buffering with the main water. This effect runs up to Ropar wetland area at location R3. At location H1 sudden increase in conductivity, salinity and TDS is mainly due to urban runoff from Ropar city and excessive use of pesticide in agricultural activities in Sutlej flood plain. In between H1 and H2, there is a confluence of Buddha Nallah, which contribute industrial, agricultural and domestic untreated water from Ludhiana city to Sutlej River. This contribution of water increases the conductivity, TDS and salinity of Sutlej at H2. At location H3 increment in physical parameters are continued because of the very high activity of sand mining in Sutlej River bed. At H6 increment is due to traversing of a river or due to the erosional feature of river contributes free ions to river water. There is a confluence of Chitti Bein in

between H6 and H7, it provides the addition of a large volume of waste/ polluted water to Sutlej River which results in an increase in conductivity, salinity, TDS of Sutlej water at location H7. Sample H9 is Collected from headward of Harike dam, at this location sudden reduction in values of physical parameters due to the mixing of Beas River water and Kali Bein water and at Harike dam, water discharge through Beas River is maximum as compared to Kali Bein and Sutlej River. High Volume water discharge from Beas play a major role in lowering the conductivity, salinity and TDS. The physical parameters of Kali Bein, Chitti Bein and Beas Rivers have been mentioned in Table 3.17 and graph 4.16 & 4.18 for the same has been plotted with the water samples of Sutlej River (figure 4.14, 4.16 & 4.18). The presence of flora and fauna in Harike, Ropar and Nangal wetland areas also have effects on physical parameters of water. To understand the role of Flora and fauna on water chemistry need further more research.

For irrigation purposes water divided in classes, which mentioned in below table

With reference to Irrigation water standard and observed data from table 4.23 using electrical conductivity. N1 has the lowest conductivity among all the samples and the sudden change in conductivity in N2 and N3 may be due to water discharge from National Fertilizer Limited and sewerage water from Nangal City. Sample N4 shows that sudden reduction in conductivity is due to the addition of SYL canal water coming from Nangal dam, which dilutes Sutlej River water and further downstream direction R1 slowly increase in conductivity due to traverse of the river. At sample R2 and R3 shows moderately high in conductivity and TDS is due to the addition of water from the thermal power plant, Chak Dhera and it also increases the water temperature.

Sample H1, H2, H3 show an exponential increase in Conductivity and TDS due to anthropogenic activity and industrial wastewater contribution of Buddha Nallah to Sutlej River. H4 show maximum conductivity among all the samples because of Chitti Bein water is full of sewerage water and industrial waste from Jalandhar city, Phagwara etc. H6 is before meeting of Chitti Bein shows little increment due to traverses of stream whereas H7, after meeting of Chitti Bein, the water of Chiiti Bein became major contributor to increase in TDS and conductivity at this point. Sample H8 is Beas River water which represents less polluted water than Sutlej River water. H9 represents well mixed of Kali Bein, Beas and Sutlej Rivers water and collected from headward of Harike

dam, shows that reduction in TDS and conductivity at this location due to high contribution of water from Beas River than the Kali Bein and Sutlej River, which results exponential lowering of the value of TDS and conductivity.

Table 4.23: Water Standard for Irrigation Uses

Classes of water	Permissible limit for classes of irrigation	
	EC, µs	TDS PPM
Class I- Excellent	250	175
Class II- Good	250-750	175-525
Class III- Permissible	750-2000	525-1400
Class IV- Doubtful	2000-3000	1400-2100
Class V- Unsuitable	3000	2100

Source: Fipps, 2003

Samples collected from the study area (N1- N4, R1-R3) and H8, H9 is good for irrigation purposes, whereas H1. H2, H3, H5, H6 are permissible for irrigation purposes in the other hand the water samples collected from Chitti Bein (H4) is unsuitable for irrigation. On the basis of TDS readings, Samples N1, N4, R1 R2 are excellent for irrigation, samples N2, N3, R3, H1, H5, H8, and H9 are good for irrigation and samples H2, H3, H6, and H7 are permissible for irrigation and last sample H4 is unsuitable for Irrigation purposes.

Suitability of water quality for drinking purpose: The physical parameters of the collected water samples has been compared with the World Health Organization (WHO) and Bureau of Indian Standard (BIS) for drinking and domestic purposes. Water samples from Sutlej River in Nangal wetland area shows pH, TDS, EC, ranges of 7.28-8.5, 191-329 ppm, 276-463 µs respectively, which lies under the desirable condition for drinking purpose. Samples collected from Ropar wetland area shows pH, TDS, EC ranges of 7.74- 8.35, 241-284,338-397 µs respectively, which comes under the maximum desirable condition for drinking. Whereas sample collected from Harike wetland area shows pH, TDS, EC of 7.47-8.29, 586-1090, 906-1693 µs respectively which lies out of the permissible condition for drinking purposes. Sample H5 shows pH, TDS, EC 7.85, 586 ppm, 906 µs, which comes highly permissible condition for drinking purpose.

To understand health of Sutlej River and their impact on livelihood, further research on parameters such as Dissolved Oxygen, Biological Oxygen Demand and Heavy metal analysis is necessary.

Table 4.24: Range in values of collected River Water Samples near Harike, Ropar and Nangal Wetland for Drinking Water (18-11-2018)

S. No.	Para-meters	WHO (1997)		BIS (1991) IS: 10500		Range			Mean		
		Max. desirable	Highest Permissible	Max. desirable	Highest Permissible	H	R	N	H	R	N
1	pH	7.0-8.5	6.5-9.2	6.5-8.5	8.5-9.2	8.29-7.47	7.74-8.35	7.28-8.5	7.77	8.03	7.92
2	TDS	500	1500	500	2000	322.30-1090	241-284	191-329	735.36	255.33	258.25
3	Salinity	-	-	-	-	371.40-1260	231-274	180-316	852.75	246.67	244
4	EC	750	1500	-	-	497.60-1693	338-397	276-463	1126.05	360.33	365.25

Source: Modified and adopted from Singh et al., 2008

4.10 Diseases: The perception of people about diseases related to wetland area varied with respect to each wetland. About 36.47 percent respondents in Harike wetland were said that jaundice, hepatise etc. prevalent in the region due to industrial wastage in the Sutlej River. Whereas, seasonal diseases are spreading mainly in the Nangal and Ropar wetlands.

Table 4.25: Perception of People about the Diseases related to Wetland Areas

Diseases	Harike Wetland	Ropar Wetland	Nangal wetland
Yes	36.47	3.45	4.65
No	63.53	96.55	95.35

Source: Data was collected during field survey, 2016-17 & 2017-18

Section IV Management and Conservation Activities

Wetland is vital for the provisions of biodiversity and livelihood to the local community. Management of wetland provides the basis for maintaining the hydro-ecological character of a wetland and to allow judicious use of the resources by the users/local community. Since all the activities around wetland are not sustainable and in fact are causing a threat to wetland, management and conservation of wetland is vital. Management of wetland involves several processes like government plan implementation, conservation strategies, procedures, and inventories on current status of wetlands, the geographical extent of wetland, the monitoring of strategies/implementation of plans/effectiveness of implementation and community participation.

A detailed document on wetland management plans which describes the process of management and conservation with target year is available for all the three wetlands. This document discuss their major threats and importance at the international, national and state level. The following section analyses and describe the management plans/action plans to be taken up in the study areas from the responses received during the field survey. The respondents were asked various questions related to their perception of the management of wetland or action plan taken up for the wetland (table 4.26).

Table 4.26: Respondents Perception on the Management of Wetland Action Plan taken up for the Wetland

S. No.	Questions
1	Demarcation/fencing around the wetland
2	Afforestation programme around the wetland
3	Waste treatment plant near a wetland
4	Removal of weeds/hyacinth/other aquatic plant
5	Removal of silt
6	Restriction on increased human activity within the wetland
7	Restriction on encroachment of wetland by human activities
8	Outreach and education action/awareness camp
9	Participatory planning/involvement of local community/NGOs

Source: Data was collected during field survey, 2016-17 & 2017-18

Apart from the above-mentioned questions, respondents were also asked many open-ended questions on wetland management and conservation which are discussed in the following paragraphs.

Analysis of respondents' perceptions showed that the major management action plan in the Harike wetland is in the form of removal of aquatic plants, removal of silts and restriction on increased human activities around Harike. Participatory planning has become a very important approach to management and conservation of natural resources where diverse groups of people/stakeholders engage themselves in reaching for a consensus on a plan and its implementation. According to the response received during the field survey, it was found that participatory planning is completely missing in the management process of Harike Wetland.

4.11 Awareness

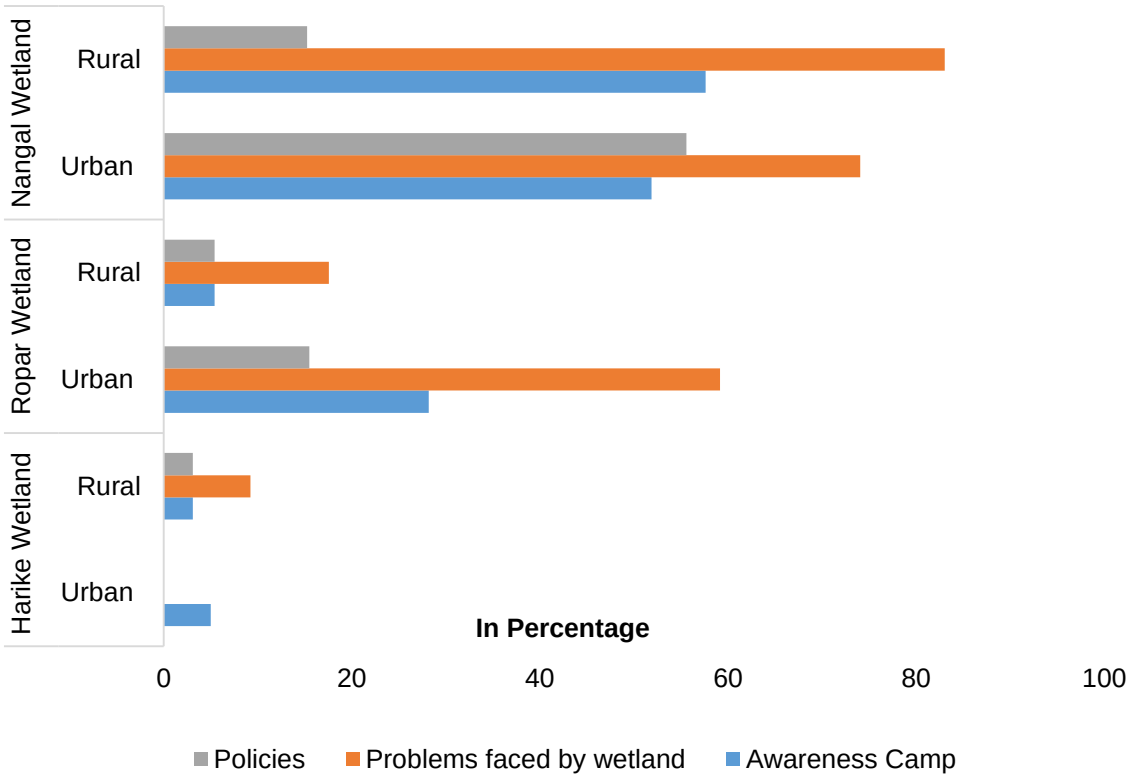
Similar is the case with creating awareness regarding conservation and management of wetland. It was found during a field survey that people have not been communicated about the significance of wetland. Such a lack of knowledge of the immense values of wetland results in either negligence towards it or various forms of degradation. Degradation ultimately causes ecological imbalances and affect the livelihood of local people. During the field survey, the question was asked from the local community about their knowledge and awareness about various conservational methods and management plans/policies related to wetland areas.

In Harike wetland, about 9.23 percent respondents of rural areas are aware of the government plans and policies. The lack of awareness and proper guidance is a serious concern in this region, one local news reporter told that many years ago a short training was given by the people from Kerala in making of handicraft things from the hyacinth local name known as “kalali butty”. But this project has been stopped due to unawareness or lack of share of knowledge with the local residents. Thus, a major self-generated employment resource has been shut down due to this. There are only “chhikku” a kind of bowl container and “chajj” made from the “sarkanda” that are grown in the mand or near the wetland areas. The wild fire in wetland occurs every year that is responsible for the destruction of the natural habitats. The level of awareness of respondents changed with respect to Ropar wetland, where 17.57 percent of respondents of rural areas and 59.15 percent of respondents of urban areas are aware of the government plans and policies for wetland areas. The level of awareness further increased in Nangal wetland areas, where 74 percent of respondents of urban areas and 83 percent of respondents of rural areas are aware of the government plans and policies.

4.12 Awareness camp related to the use and management of wetland areas:

Awareness plays a key role in the management and conservation of wetland areas. The awareness camp shed light on the problems from which wetland areas suffered and also make people aware of the benefits of wetland areas to their routine activities likes water recharging, biodiversity conservation, ecological benefits etc. In Harike wetland, only 3 percent of respondents in rural areas and 5 percent of respondents in urban areas tell that awareness camp related to wetland areas are organized by the government. In Ropar wetland, 5.41 percent of respondents of rural and 28.17 percent of urban areas respondents say that awareness camp organized by the wildlife sanctuary department. In Nangal wetland, 51.85 percent of respondents of urban areas and 57.63 percent of respondents of rural areas respondents say that awareness camp organized by the department of wildlife.

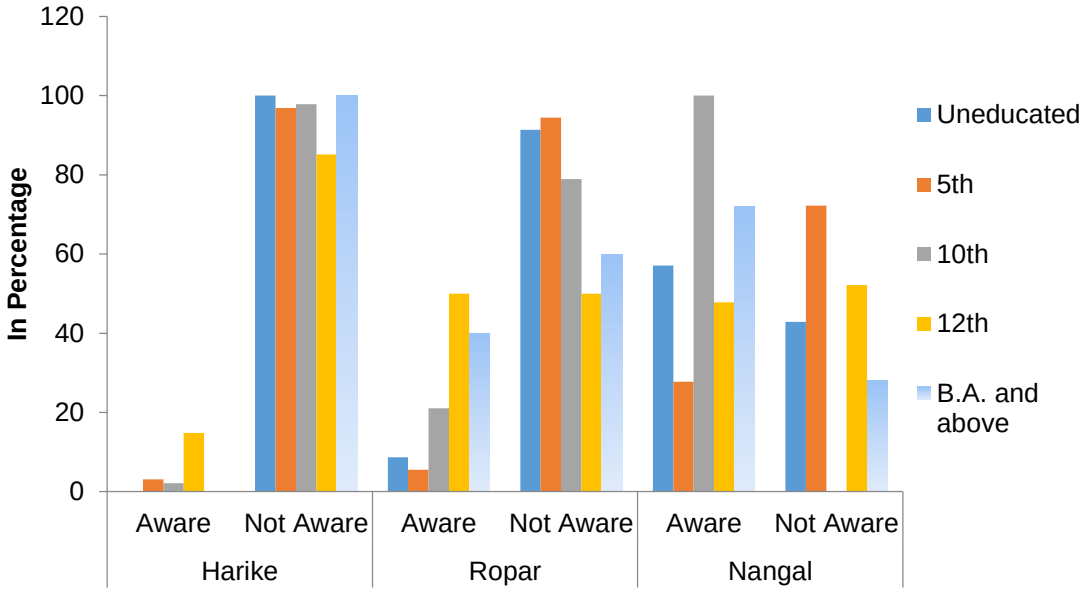
Figure 4.19: Rural-urban Variation in Awareness regarding Government Policies for Wetland



Source: Data was collected during field survey, 2016-17 & 2017-18

The respondent's awareness about conservation and management changed with respect to each wetland. In Harike wetland, only 3 percent of respondents of rural areas and no respondents in urban are aware of the conservation and management policies adopted at the Harike wetland. This trend of awareness changed in Ropar wetland, as 15.49 percent of respondents of urban areas and 5.41 percent of rural areas know about conservational and management policies. In Nangal wetland, 55.56 percent of urban respondents and 15.25 percent of rural areas are aware of the conservational and management policies. The level of awareness of respondents changed greatly from Nangal to Harike areas as respondents in Nangal areas are more educated as compared to Harike areas. In addition, the respondents are more close to nature and they use the wetland areas for a recreational purpose such as walking, exercise, bird watching etc.

Figure 4.20: Relationship between Education and Awareness in Harike, Ropar and Nangal Wetlands



Source: Data was collected during field survey, 2016-17 & 2017-18

The respondents of Harike wetland areas are aware of rules of a wildlife sanctuary that human interference is not allowed in the sanctuary areas. About 96.92 percent of respondents of rural areas and 100 percent respondents of urban areas response that access of human being is banned in the Harike Wildlife sanctuary. In Ropar wetland areas, 100 percent respondents of both rural and urban areas say that entrance of human being is allowed, as Ropar wetland does not lie under the sanctuary areas. In Nangal wetland, 100 percent respondents of urban areas and 89.83 percent of rural areas are aware that their entry without a permit from the wildlife department, as areas declared as a wildlife sanctuary in the year 2009, is not allowed.

4.13 Status of demarcation of wetland areas

The demarcation of boundary or limits of wetland areas plays a dynamic role in the conservation and management of wetland areas. The sufficient demarcation of wetland areas halts the illegal encroachment of areas for agricultural, livestock, building, landfilling, mining etc. In another way, demarcation of wetland areas also play a constructive role in the surrounding areas, as protection of crops from the bad impact of wildlife mainly by the wild boar and Neelgai. The status of the demarcation

and fencing of wetland areas is estimated through the observation and view of respondents living in nearby wetland areas. From the field observation, it has been known that there has been no provision of wetland demarcation and fencing around all three wetlands namely Harike, Ropar and Nangal.

In Harike wetland, 96.62 percent of respondents of rural areas and 100 percent of urban areas say that wetland areas are not covered by any fencing or building structure. The Harike wetland was declared as a bird sanctuary in 1992 by the government of India and wildlife sanctuary notification in 1999. Even after the declaration of the Harike wetland as a wildlife sanctuary, no demarcation of the areas has been done by the government official. The same situation in the Nangal wetland areas, where 93.22 percent of respondents of rural areas and 55.56 percent of respondents of urban respondents told that the wetland is not covered by the fencing. About 90 percent of Nangal sanctuary areas lies permanently under the water. The land of sanctuary areas with Khasra number are clearly notified by the Department of Forest and Wild Life Preservation. The Nangal Wetland areas only face the problem of no fencing around the sanctuary areas. The respondents of surrounding areas told that the numbers of wildlife increased after the declaration of wildlife sanctuary and the wildlife damages their crops due to a shortage of food for them. This problem has become more severe in the last few years due to no fencing around the wetland. In Ropar wetland, 98.65 percent of respondents of rural areas and 76.06 percent of respondents of urban areas responded that no demarcation of the wetland has been done.

4.14 NGO: Non-Governmental Organizations play a dynamic role in the management and conservation of environmental resource or wetland areas. The availability of NGO in any region render the interest or importance of wetland areas to the local people. In other words, the presence of NGO in the region may work for increasing the awareness among the local people about the benefits of wetland areas and may also motivate people for activate participation in the conservation of wetland areas.

In Harike Wetland areas, about 99.23 percent respondents' response that there has been no NGO existed in the region. The 22.35 percent respondents of Ropar wetland answered that NGO existed in the region. The main work of NGO is to maintain and conserve the parks around the Ropar headworks. In Nangal Wetland, 58.32 percent

of respondents responded that two NGO work for conservation and management of wetland areas.

4.15 Three Dimensional matrix analysis of Management

A three-dimensional matrix has been calculated by using 7 indicators of management related observation of local people to wetlands areas. The total score for each indicator is calculated on the response of respondents about the implementation of management plans and their respective weightage. The index reveals the performance of management plans in the selected wetland areas (Model 3, Table 3.16).

4.15.1 Harike Wetland: Concerning the perception about management in Harike wetland, the results show that all the respondents are aware about removal of hyacinth by the concerned authorities'. But, during the field survey, it was observed that large amount of hyacinth existed in some parts of Harike wetland. The respondents also perceived that interference of human being in the sanctuary areas declined with the construction of check posts along with the sanctuary areas (Figure 4.21 & 4.22).

4.15.2 Ropar Wetland: Concerning, the perception about the management in Ropar wetland, the results show that all the removal of silt was identified by the respondents because it is a major management action plan of Ropar wetland. The perception index also reveals that the human interference in wetland areas has restricted by the wildlife authority (Figure 4.23 & 4.24) but practically this is not happening on the ground. The land use map of Ropar wetland (map 4.3) shows that a large part of wetland is under agricultural land.

4.15.3 Nangal Wetland: As regard to the perception of respondents about the management and conservation activities in the Nangal wetland, the results revealed that suitable conservation drive worked in the Nangal areas. The respondents are aware about the demarcation of sanctuary areas and ecological importance of wetlands. Such as, a local NGO 'Jagriti' is working from last many years under Prabhat Bhatti to spread awareness about flora and fauna in Nangal area. The siltation in the wetland areas has been cleared by the opening of the gate during the rainy season (Figure 4.25 & 4.26).

Figure 4.21: Perception of Management/action Plan taken up in and around Harike Wetland

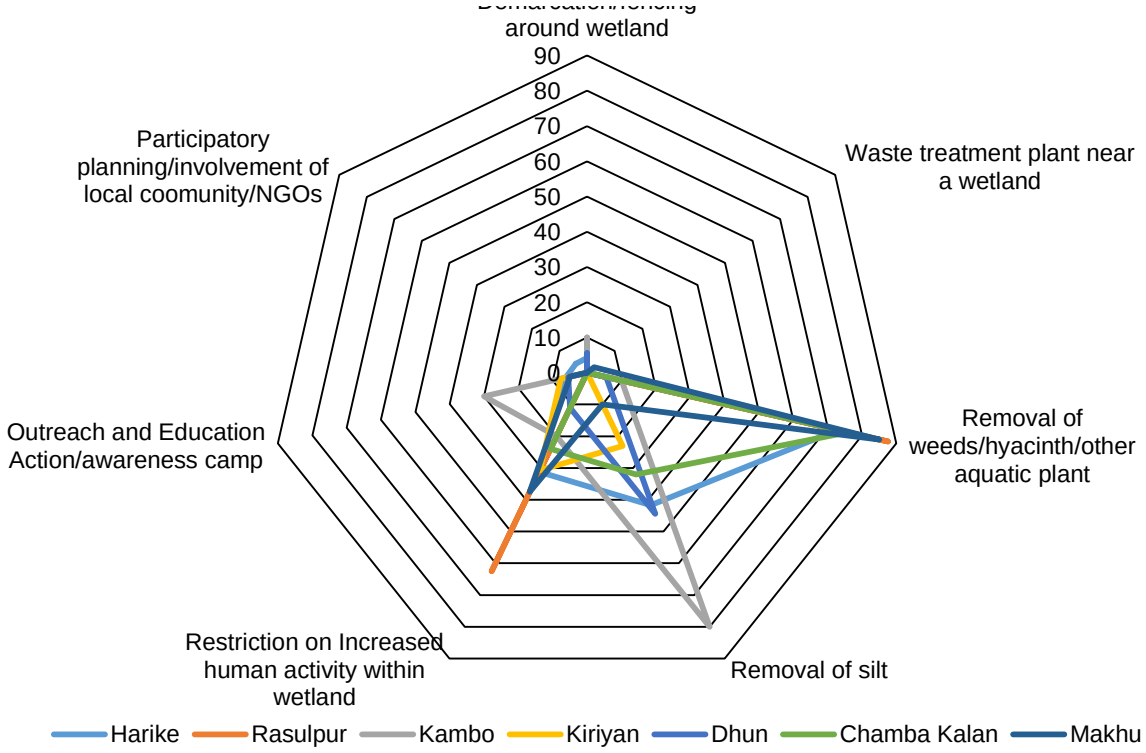


Figure 4.22: Perception Index for Management/action Plans in Harike Wetland

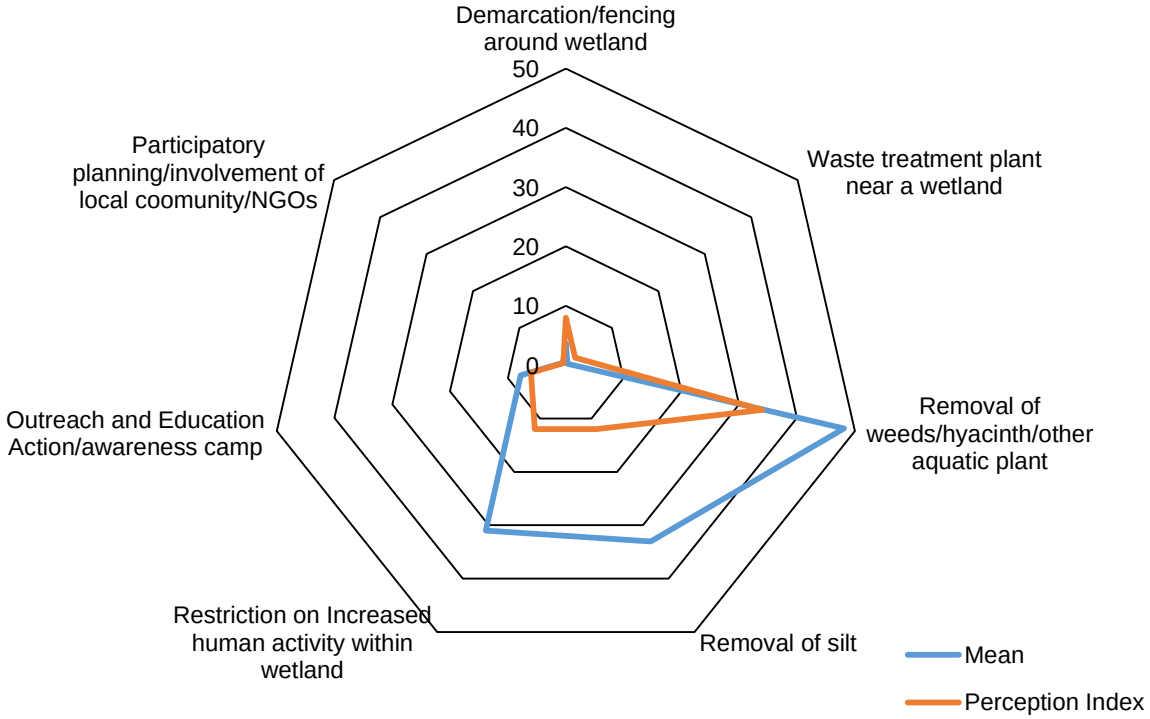


Figure 4.23: Perception on Management/action Plan taken up in and around Ropar Wetland

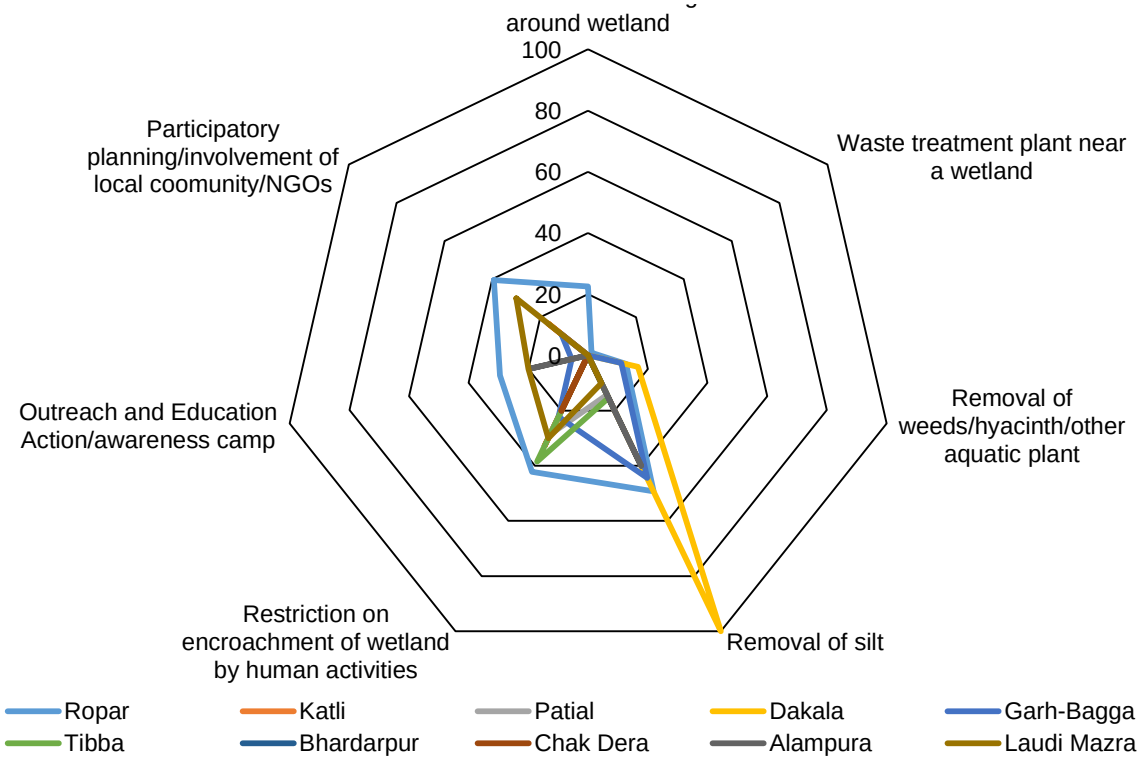


Figure 4.24: Perception Index for Management/action Plans in Ropar Wetland

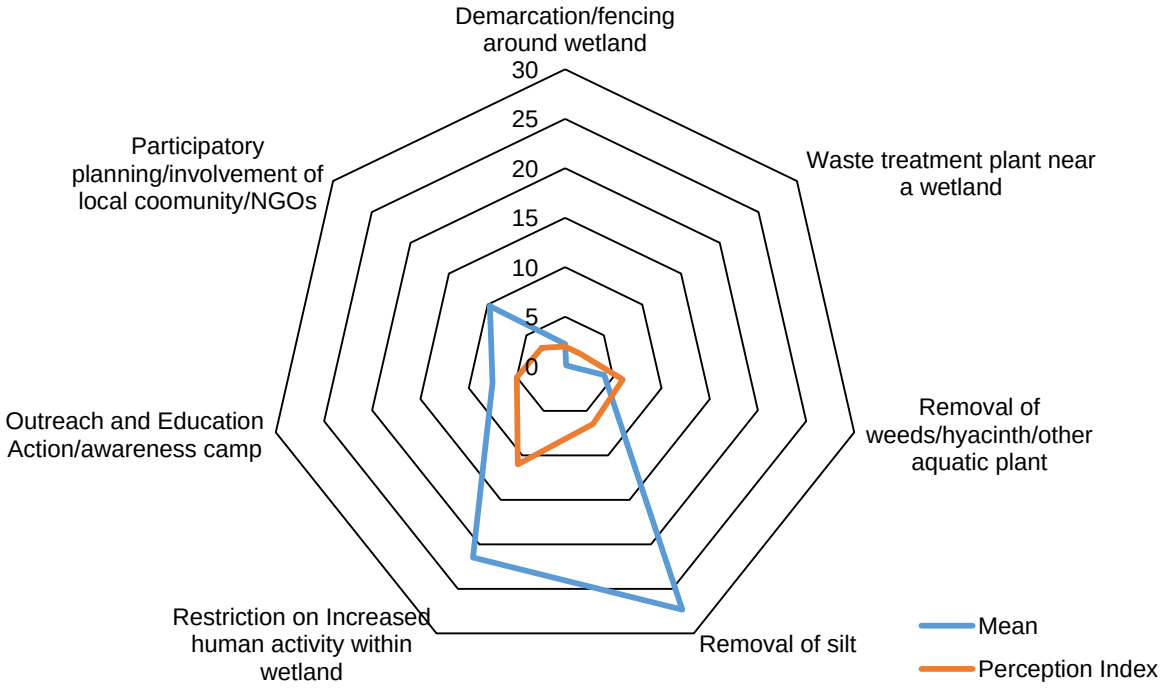


Figure 4.25: Perception on Management/action Plans taken up in and around Nangal Wetland

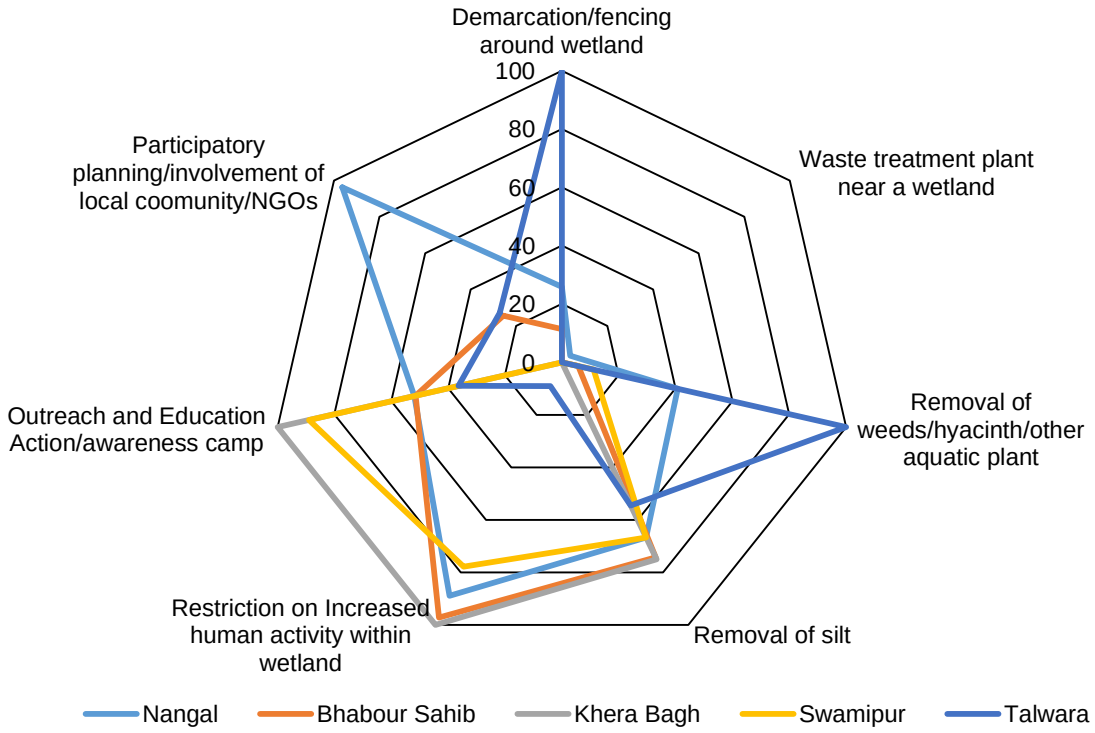


Figure 4.26: Perception Index for Management/action Plans in Nangal Wetland

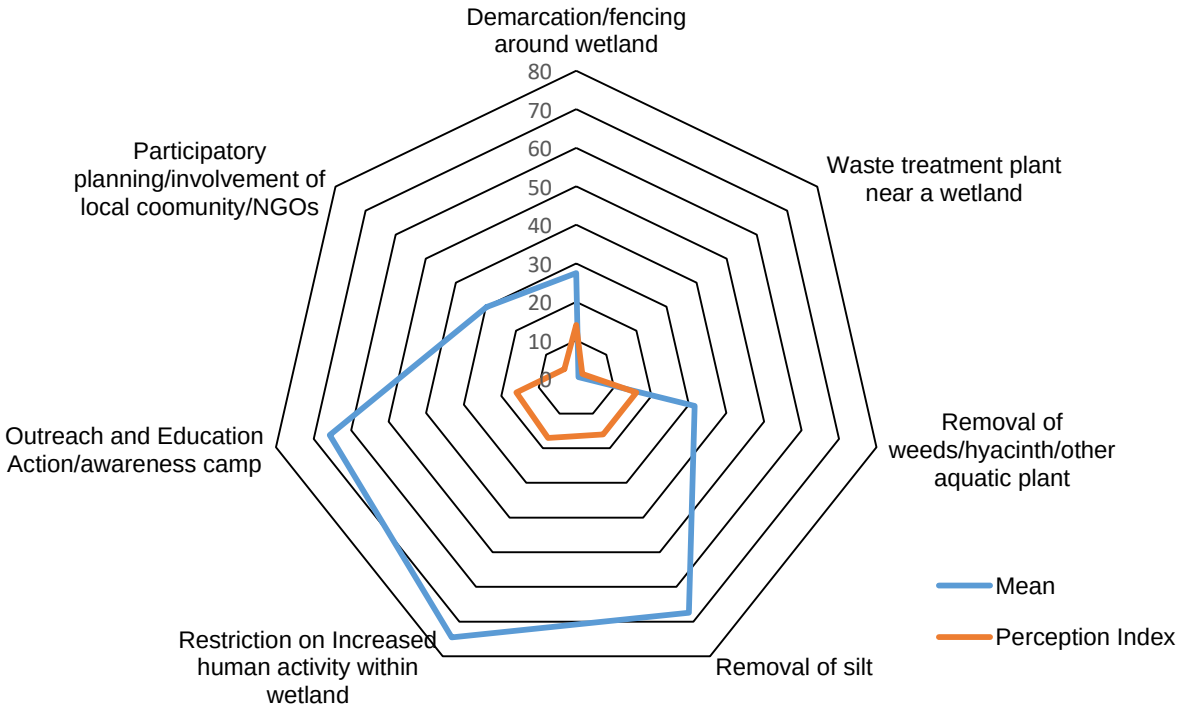


Table 4.27: Matrix Analysis for Management in Harike Wetland

Sr. No	Respondents observation on management to wetland	Weightage	Harike		Rasulpur		Kambo		Kiriyan		Dhun		Chamba Kalan		Makhu		Total Score
			Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	
1	Demarcation/fencing around wetland	2	1	2	1	2	1	2	0	0	1	2	0	0	0	0	8
2	Waste treatment plant near a wetland	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
3	Removal of weeds/hyacinth/other aquatic plant	2	3	6	4	8	1	2	0	0	1	2	4	8	4	8	34
4	Removal of silt	1	2	2	0	0	4	4	1	1	2	2	2	2	1	1	12
5	Restriction on Increased human activity within wetland	1.5	2	3	3	4.5	1	1.5	2	3	1	1.5	1	1.5	2	3	18
6	Outreach and Education Action/awareness camp	1	1	1	0	0	2	2	1	1	1	1	0	0	1	1	6
7	Participatory planning/involvement of local community/NGOs	0.5	1	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0.5

Source: Data was collected during field survey, 2016-17 & 2017-18

Table 4.28: Matrix Analysis for Management in Ropar Wetland

Sr. No	Respondents observation on management to wetland	Weightage	Ropar		Katli		Patial		Dakala		Garh Bagga		Tibba		Bhardarpur		Chak Dhera		Alampura		Laudi Mazra		Total Score
			R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	R*	S*	
1	Demarcation/fencing around wetland	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2	Waste treatment plant near a wetland	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3	Removal of weeds/hyacinth/other aquatic plant	2	1	2	0	0	0	0	1	2	1	2	0	0	0	0	0	0	0	0	0	0	6
4	Removal of silt	1	2	2	0	0	1	1	4	4	2	2	1	1	0	0	0	0	2	2	1	1	13
5	Restriction on Increased human activity within wetland	1.5	2	3	2	3	2	3	0	0	1	1.5	2	3	0	0	1	0	0	0	2	3	16.5
6	Outreach and Education Action/awareness camp	1	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	5
7	Participatory planning/involvement of local community/NGOs	0.5	2	1	1	0.5	0	0	0	0	1	0.5	0	0	0	0	0	0	0	0	2	1	3

Source: Data was collected during field survey, 2016-17 & 2017-18

Note: R* means rank and S* means score

Table 4.29: Matrix Analysis for Management in Nangal Wetland

Sr. No.	Respondents observation on management to wetland	Weightage	Nangal		Bhabour Sahib		Khera Bagh		Swamipur		Talwara		Total Score
			Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	
1	Demarcation/fencing around wetland	2	2	4	1	2	0	0	0	0	4	8	14
2	Waste treatment plant near a wetland	2	1	2	0	0	0	0	0	0	0	0	2
3	Removal of weeds/hyacinth/other aquatic plant	2	2	4	1	2	0	0	1	2	4	8	16
4	Removal of silt	1	3	3	4	4	3	3	3	3	3	3	16
5	Restriction on Increased human activity within wetland	1.5	4	6	4	6	4	6	4	6	1	1.5	25.5
6	Outreach and Education Action/awareness camp	1	3	3	3	3	4	4	4	4	2	2	16
7	Participatory planning/involvement of local community/NGOs	0.5	4	2	2	1	0	0	0	0	2	1	4

Source: Data was collected during field survey, 2016-17 & 2017-18

4.16 Perception of people: According to the respondents, lack of political will is a major constraint in the management and conservation of Harike Wildlife Sanctuary. The respondents reported illegal poaching, grazing, fuel collection as well as agricultural practices can be seen in the sanctuary area. In addition, the negative attitude of local respondents is also becoming a hurdle in management practices. During the field observation, it was observed that tree plantation has been done by the Forest and Wildlife Preservation Department in Ropar. But, the range officer said that this plantation was damaged by local residents who had encroached the wetland. The management and conservation practices have been affected due to miss-communication or gapping between the interlinked departments. For example, ownership of land nearby the banks of river or wetland is with Irrigation and Canal departments. But the management practices over the wetland areas are being performed by the wildlife department.

4.17 Willingness to Pay: The Willingness to Pay (WTP) by using the contingent valuation method (CVM) is commonly used for the conservation and management of wetland area especially in the developing countries (Lamsal et al., 2015b). The CVM is used to understand the behaviour or the attitude of people toward the wetland (Siew et al, 2015; Kagunda, 2003). The recent study by Siew et al. (2015) found that bid and income affect the willingness to pay for the conservation and management of wetland area. Another study by Lamsal et al. (2015b) found that income earned from the wetland area, age of head of household and agricultural income affect the WTP for the managing of wetland.

4.17.1 Impact of Education, Income and Occupation on WTP: Since the wetland area is used for grazing and agricultural activities by the local people, willingness to pay (WTP) for the conservation and management activities were asked. Three variables: education, income and occupation are selected and the impact of education over the response of WTP is evaluated. In Harike Wetland, 3.85 percent of uneducated respondents are willing to pay for the conservation and management practices around the wetland areas. The level of participation of respondents in conservation and management activities increased with increasing the level of education. As, 8.51 percent of respondents who have studied up to 10^{th} standard, 18.52 percent studied up to 12^{th} standard and 58.33 percent graduated and above qualified respondents are ready to pay. Besides, WTP is also greatly affected by the

occupation of individuals. Respondents engaged in the agricultural and livestock activities are less likely to pay for conservation and management activities. The reason behind the conservation and management of wetland affect their occupation, fencing of the areas prohibits illegal agricultural and livestock activities. The 12.5 percent of fishermen and 34.62 percent of businessmen are ready to pay for the conservation and management activities. In addition to this, the family income also affects the willingness of respondents. Respondents with less than 5000 rupees monthly income are not ready to pay for the management of wetland areas. The 8.54 percent respondents belong to 5000-15000, 10.71 percent belong to 15000-25000, 16.67 percent belong to 25000-35000, 12.5 percent belong to 35000-45000 and 60 percent respondents belong to 45000 monthly income are ready to pay for the conservation and management activities (Table 4.30). Apart from monetary help, respondents want to participate in conservation activities as voluntary participation.

In Ropar Wetland, about 19.75 percent uneducated respondents are ready to pay for the conservation activities. The participation or willingness of respondents is positively affected by increasing the level of education. As 24.12 percent studied up to 10^{th} standard, 75 percent studied up to 12^{th} standard and 73.33 percent graduated and above are ready to pay. The WTP for the management and conservation of wetland areas has been affected by the occupation of the respondents. Such as, respondents involved in the primary activities are less likely to pay for the management activities as compare to secondary activities. Such as 13.89 percent involved in agriculture and 17.86 percent respondents engaged in the livestock activities were ready to pay for the conservation activities. In comparison, 72.22 percent engaged in business, 36.33 percent in fishing activities and 36.96 percent engaged in tertiary activities were WTP for the management practices around the Ropar wetland. In addition, the family income of the respondents also affects the WTP for management activities. The 11.11 percent respondents belong to income group less than 5000, 25 percent respondents belong to 5000-15000 & 15000-25000, 35.71 percent belong to 25000-35000, 42.86 percent to 35000-45000 and 62.5 percent belong to 45000 and above were ready for WTP.

In Nangal wetland, 50 percent uneducated respondents, 47.22 percent studied up to 10^{th} standard, 60.87 percent studied up to 12^{th} and 80 percent studied up to

graduation and above were ready to pay for the conservation and management practices. The scenario of WTP had changed in occupation as compare to Harike and Ropar wetland. Such as 100 percent respondents engaged in the livestock and fishing activities are ready to pay for conservation. In addition, 61.54 percent and 59.63 percent engaged in business and jobs are respectively ready to pay for conservation of wetland areas. The WTP for the conservation and management of wetland is affected by the family income of the respondents. It was analysed that as the family income of the respondents increased their willingness to pay for conservation activities also increased (Table 4.30).

Table 4.30: Perception of Respondents for Willingness To Pay for the Conservation of Area

Variables		Harike (Respondent=170)		Ropar (Respondents=145)		Nangal (Respondents=86)	
		Ready	Not Ready	Ready	Not Ready	Ready	Not Ready
Education	Uneducated	3.85	96.15	19.75	80.25	50.00	50.00
	5th	0.00	100.00	16.67	83.33	44.44	55.56
	10th	8.51	91.49	31.58	68.42	50.00	50.00
	12th	18.52	81.48	75.00	25.00	60.87	39.13
	B.A. and above	58.33	41.67	73.33	26.67	80.00	20.00
Income	<5000	0.00	100.00	11.11	88.89	16.67	83.33
	5000-15000	8.54	91.46	25.00	75.00	55.56	44.44
	15000-25000	10.71	89.29	25.00	75.00	60.71	39.29
	25000-35000	16.67	83.33	35.71	64.29	63.64	36.36
	35000-45000	12.50	87.50	42.86	57.14	83.33	16.67
	Above 45000	60.00	40.00	62.50	37.50	100.00	0.00
Occupation	Agricultural	6.33	93.67	13.89	86.11	40.00	60.00
	Business	34.62	65.38	72.22	27.78	61.54	38.46
	Wages and Salary	4.00	96.00	36.96	63.04	59.62	40.38
	Livestock	0.00	100.00	17.86	82.14	100.00	0.00
	Fishing	12.50	87.50	33.33	66.67	100.00	0.00
	Other	7.69	92.31	25.00	75.00	61.54	38.46

Source: Data was collected during field survey, 2016-17 & 2017-18

From table 4.31, the mean results for ready to pay for the conservation of wetlands in Harike, Ropar and Nangal wetland have changed with education, income and occupation of the respondents.

Table 4.31: Average Numbers of Respondents Ready to Pay for the Conservation and Management of Wetland Area

	Harike	Ropar	Nangal
Education	17.84	43.27	57.06
Income	18.07	33.70	63.32
Occupation	10.86	33.21	70.45

Source: Data was collected during field survey, 2016-17 & 2017-18

Table 4.32: Results of Chi-square for the Willingness To Pay for the Conservation of Area

		Education	Income	Occupation	Caste
Harike	Chi square value	33.88	17.45	18.92	6.38
	P value	0.00*	0.00*	0.00*	0.04**
Ropar	Chi square value	29.93	10.35	21.63	3.24
	P value	0.00*	0.03**	0.00*	0.20
Nangal	Chi square value	6.84	8.87	1.23	4.69
	P value	0.14	0.06***	0.87	0.10***

Source: Data was collected during field survey, 2016-17 & 2017-18

* 1 percent, ** 5 percent and *** 10 percent level of significance

The results reveal that education and occupation are influencing factors for the willingness of the respondents for the conservation and management activities in the Harike and Ropar wetlands. Whereas, in Nangal wetland, the willingness of respondents is not affected by education and occupation, because these people are more aware or concerned about the conservation of areas than respondents of the Harike and Ropar wetlands. Besides this, WTP of the respondents is directly or indirectly varies with the income and caste.

4.17.2 Probit Model for Willingness to Pay for the conservation and management of wetland areas: The simple probit model has been used for the exploring the determinants of Willingness to Pay (WTP) for the conservation and management of Harike, Ropar and Nangal Wetlands.

The result of the econometric model (probit model) is presented in the table. The results show that social variable .i.e. religion, age and caste of the respondents are not significant, as the p-value for this variable is higher than 10 percent level. The results for the gender dummies i.e. had been significant at 1 percent level and the male was negatively and less likely to pay for the conservation and management of the wetland areas. The male population around wetlands is engaged in agricultural

and livestock activities and the conservation and management policies restrict locals to do such primary activities in wetland areas, so male population is not willing to pay for conservation and management activities. It means reference dummies i.e. females are more likely to pay for the conservation activities. The reason behind this is that the female is close to nature and depends on wetland areas for collection of fuel and material for handicrafts. The management and conservation policies are not very restricted towards fuel and handicraft material collection.

People engaged in primary activities are not willing to pay. The sign of positive coefficients for the people engaged in the secondary and tertiary activities (Business and Job) are highly WTP for the preservation of wetland areas. In a Harike wetland, illegal agricultural activities within the boundary of wetland areas also affect the response of people, because they do not want more restrictions through conservation activities. Besides this, all other being constant, the occupation of the respondents have also influence the WTP for the management of wetland areas. As, in the Nangal Wetland, respondents do their job in BBMB (Bakhra Beas Management Board) and NFL (National Fertilizer Limited) are interested in enjoying the beauty of wetland and willing to pay for the enhancement of scenic beauty through management. The respondents involved in the business (mainly fish fishing) are in favour of conservation and management of wetland areas because any kind of pollution in wetland areas lead to a decline in the fish population. The recent incident in May 2018 of Beas River is the example of this concern. The leakage of '*Sira*' (wastage from sugar industry) from the *Afghan Kiriayn sugar mill* located on the bank of Beas River, greatly affects the aquatic life and death of thousands of fishes (Singh, 2018). The death of fishes in Beas River leads to decline in number and quality of fish in Harike Wetland. Therefore, for the conservation of wetland areas, there is a need to think first about the stakeholder. As stakeholder participation will be necessary for the success of any kind of policy.

Among the education dummies, the results reveal that education plays a positive role in response to the willingness to pay for conservation and management activities. Higher education higher is the willingness to pay and vice-versa. Such as, the respondents studied up to 5^{th} standard are negatively and less likely for WTP. As declining the numbers of year influence on the willingness to pay for the conservation of areas. However, education dummies (graduation and above) have

a positive influence on the WTP for the conservation practices. Hence, it could be argued that increasing education among the respondents would like to increase the contribution of the respondents for the conservation of wetland areas.

Table 4.33: Simple Probit model for Willingness To Pay for Conservation and Management of Harike, Ropar and Nangal Wetlands

WTP	Model 1			Model 2		
	Coef.	**Z**	**dy/dx**	**Coef.**	**Z**	**dy/dx**
Religion Dummies (Reference Category: Other)						
Sikh	-0.31	-0.80	-0.07	-0.38	-0.95	-0.08
Hindu	0.04	0.11	0.01	0.04	0.09	0.01
Caste Dummies (Reference Category: SC/ST)						
General	0.15	0.61	0.03	0.11	0.43	0.02
OBC	-0.04	-0.16	-0.01	-0.11	-0.40	-0.02
Gender Dummies (Reference Category: Female)						
Male	-0.88	-2.98*	-0.19	-0.74	-2.46*	-0.15
Age Dummies (Reference Category: Less than 35)						
35 to 49	-0.14	-0.68	-0.03	-0.17	-0.76	-0.03
50-64	-0.22	-0.89	-0.05	-0.22	-0.86	-0.05
Above 64	-0.01	-0.02	0.00	-0.01	-0.04	0.00
Education Dummies (Reference Category: Illiterate)						
Primary	-0.40	-1.40	-0.08	-0.56	-1.90***	-0.12
Middle	-0.10	-0.37	-0.02	-0.14	-0.49	-0.03
Secondary	0.16	0.53	0.03	0.08	0.25	0.02
Graduation and above	0.60	1.91**	0.13	0.52	1.63***	0.11
Income Dummies (Reference Category: Quintile 1)						
Quintile2	------	------	------	1.09	2.51*	0.23
Quintile3	------	------	------	1.13	2.76*	0.23
Quintile4	------	------	------	0.93	2.18**	0.19
Quintile5	------	------	------	1.10	2.32**	0.23
Occupation Dummies (Reference Category: Agricultural)						
Livestock and fishing	0.21	0.64	0.04	0.25	0.73	0.05
Business	0.97	3.64*	0.21	0.93	3.40*	0.19
Labour and other	-0.15	-0.45	-0.03	0.06	0.17	0.01
Job	0.53	1.66***	0.11	0.57	1.79***	0.12
Respondent income	0.00	3.33*	0.00	0.00	3.37*	0.00
Per capita family income	0.00	1.00	0.00	-------	------	------
Wetland Areas Dummies (Reference Category: Harike Wetland)						
Nangal Wetland	1.24	4.45*	0.26	1.21	4.17*	0.25
Ropar Wetland	0.75	3.13*	0.16	0.72	2.87*	0.15
_cons	-1.26	-2.16**		-2.11	-3.05*	
Pseudo R Square	0.3639			0.3826		
No. of Observation	401			401		

Source: Data was collected during field survey, 2016-17 & 2017-18

* at 1 percent level, ** at 5 percent level and *** at 10 percent level

Other variable being constant, the income of the respondents has a positive and significant influence over the WTP. The positive coefficients for the income dummies

mean that people with more income are more willing to pay. The decision of the respondents was greatly affected by the income that they earned. Furthermore, all other being constant, income earned by the respondents has a positive and significant influence on the participation in the conservation of wetland areas.

From the results, it can be illustrated that the respondents of Nangal wetland areas have more willingness to pay for the conservation of wetland areas than that of Ropar wetland and Harike wetland, where people are not much likely to pay for conservation. The number of respondents from rural areas varies among three selected with respect to three wetlands. In a Harike wetland, most of the respondents belong to rural areas due to the sampling method because only one km buffer zone areas were selected in the sample. In Ropar and Harike sample, the occurrence of major cities within the one km buffer zone leads to more respondents from urban areas. The respondents from rural areas are engaged in primary activities, therefore they are negatively or less likely to pay for conservation of areas. As mentioned above, education and occupation of respondents influence the willingness to pay for the conservation and management of the wetland areas.

4.17.3 Ordinary Least Square (OLS) Regression

During fieldwork, the question regarding willingness to pay for the availability of land around wetland areas for grazing purpose was asked. In a Harike wetland, out of 130 respondent's only one respondent is willing to pay. The other respondents consider grazing land as a natural resource which should be given them free of cost. As respondents claim that wetland belongs to them and uses of wetland areas for grazing purpose is their right. In Ropar wetland, 25.68 percent in rural areas and 22.54 percent respondents in urban areas are ready to pay for grazing activities, if ranching or meadows is provided. Most of the respondents denied paying for it because they have no time for only grazing of livestock at the commonplace. In Nangal wetland, 22 percent of respondents are willing to pay for grazing activities.

Model 5 is OLS used to calculate the relation or impact of the individual socio-economic demographic characteristics over the willingness to pay for the grazing activities. In Harike wetland, only one factor, education, appears to be a significant predictor $\alpha=0.0943$ levels because the p-value for education is 0.0943 and is less than .010 (Table 4.34).

Table 4.34: Estimates of Factors Influencing Willingness To Pay for Grazing Activities in Harike Wetland

Model 1	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
Constant	1.97	0.02	94.72	0.00
Education	0.01	0.01	1.68	0.09**
Income	-0.00	0.00	0.50	0.50
Occupation	0.00	0.00	0.23	0.23
Model Summary R^2=0.02, F=1.20, No. of Observation =170				

Source: Data was collected during field survey, 2016-17 & 2017-18

Table 4.35: Estimates of Factors Influencing Willingness To Pay for Grazing Activities in Ropar wetland

Model 1	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
Constant	1.91	0.12	15.85	0.00
Education	0.01	0.03	0.51	0.61
Income	-0.05	0.03	-1.90	0.06**
Occupation	-0.00	0.03	-0.19	0.85
Model Summary R^2=0.03, F=1.28, No. of Observation =145				

Source: Data was collected during field survey, 2016-17 & 2017-18

In this table, only one factor, income, appears to be a significant predictor α=0.059241 levels because the p-value for education is 0.059241 and is less than .010

Table 4.36: Estimates of Factors Influencing Willingness To Pay for Grazing Activities in Nangal wetland

Model 1	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
Constant	1.88	0.16	11.65	0.00
Education	0.02	0.04	0.50	0.45
Income	-0.26	0.04	-0.59	0.56
Occupation	-0.03	0.03	-0.76	0.45
Model Summary R^2=0.01, F=0.37, No. of Observation =86				

Source: Data was collected during field survey, 2016-17 & 2017-18

In the case of Nangal, no variables have a significant impact on the willingness to pay for the grazing activities in the wetland area, as p-value is higher than the 5 percent and 10 percent level.

4.17.4 Probit Model for Willingness to Pay for livestock grazing near wetland areas: The simple probit model has been used for exploring the determinants of Willingness to Pay (WTP) for grazing facilities near Harike, Ropar and Nangal Wetlands.

The result of the econometric model (probit model) is listed in the below table. The results show that social variables i.e. religion and caste of the respondents are not significant, as the p-value for this variable was higher than the 10 percent level. The results for the gender dummies i.e. had been significant at 1 percent level and the male was negatively and less likely to pay for the grazing facilities near wetland areas. Remaining other variable constant, respondents belong to age dummies 35 to 49 are negatively and significantly willingness to pay for the livestock grazing near or within the wetland areas.

The willingness to pay of respondents for the livestock grazing has changed with respect to the occupation of respondents. Such as respondents engaged in secondary and tertiary activities are positively and significantly willing to pay for the conservation activities, but it was changed for willingness to pay for the management of ground for livestock grazing purpose. The respondents involved in business and job are negatively and less likely to pay for the conservation of grazing activities. This is mainly due to the nature of dependency as the respondents engaged in the secondary and tertiary sector are less dependent on livestock grazing. Therefore, it influences the willingness of respondents to pay for maintenance of wetland areas for grazing activities. The respondents of Harike wetland are not willing to pay for the grazing activities within the wetland areas, because they think that it is their right over wetland areas. Being other variables remaining constant, the income of the respondents is positive and significant for the willingness to pay for grazing activities. The people with more income level are more willing to pay for this. In addition these, per capita family income also influence the willing to pay for the grazing of livestock. The results for the year of schooling is non-significant for the willingness to pay for the managing of livestock grazing, which is significant for the willingness to pay for the management of wetland areas.

Table 4.37: Simple Probit model for Willingness To Pay for Grazing Facilities near Harike, Ropar and Nangal Wetlands

Livestock Grazing	Model 1			Model 2		
	Coef.	**Z**	**dy/dx**	**Coef.**	**Z**	**dy/dx**
Religion Dummies (Reference Category: Other)						
Sikh	0.26	0.53	0.04	0.40	0.78	0.06
Hindu	0.21	0.43	0.03	0.40	0.78	0.06
Caste Dummies (Reference Category: SC/ST)						
General	0.19	0.68	0.03	0.19	0.67	0.03
OBC	0.08	0.27	0.01	0.03	0.10	0.00
Gender Dummies (Reference Category: Female)						
Male	-0.99	-3.03*	-0.15	-0.99	-2.92*	-0.15
Age Dummies (Reference Category: Less than 35)						
35 to 49	-0.42	-1.74	-0.07	-0.41	-1.66***	-0.06
50-64	-0.31	-1.07	-0.05	-0.29	-1.00	-0.04
Above 64	-0.73	-1.60	-0.11	-0.67	-1.43	-0.10
Education Dummies (Reference Category: Illiterate)						
Primary	0.14	0.46	0.02	0.03	0.11	0.00
Middle	0.20	0.62	0.03	0.19	0.59	0.03
Secondary	-0.15	-0.36	-0.02	-0.16	-0.38	-0.02
Graduation and above	-0.53	-1.25	-0.08	-0.45	-1.09	-0.07
Income Dummies (Reference Category: Quintile 1)						
Quintile2	------	------	------	1.04	1.73***	0.16
Quintile3	------	------	------	0.99	1.83***	0.15
Quintile4	------	------	------	1.13	2.03**	0.17
Quintile5	------	------	------	1.33	2.25**	0.20
Occupation Dummies (Reference Category: Agricultural)						
Livestock and fishing	-0.07	-0.19	-0.01	0.12	0.32	0.02
Business	-0.85	-2.23**	-0.13	-0.79	-2.04**	-0.12
Labour and other	-1.38	-3.29*	-0.21	-1.26	-2.85*	-0.19
Job	-0.85	-2.21**	-0.13	-0.81	-2.09**	-0.12
Respondent income	0.00	0.20	0.00	0.00	0.32	0.00
Wetland Areas Dummies (Reference Category: Harike Wetland)						
Nangal Wetland	2.54	5.10*	0.39	2.38	4.82*	0.36
Ropar Wetland	2.08	4.84*	0.32	2.03	4.68*	0.31
Per capita family income	0.00	2.18**	0.00	------	------	------
_cons	-2.03	-2.77*		-2.84	-3.11*	
Pseudo R square	0.3101			0.3162		
No. of Observation	401			401		

Source: Data was collected during field survey, 2016-17 & 2017-18

* at 1 percent level, ** at 5 percent level and *** at 10 percent level

The sign coefficient for Nangal and Ropar wetlands reveals that respondents of these areas are positive and significantly willing to pay for the preservation of cattle ranching grounds near or within wetland areas. However, the respondents of Harike wetland are not willing to pay for the grazing activities, as wetland areas were declared as a wildlife sanctuary. In addition, respondents believe that it is their traditional right to use the wetland areas of grazing activities.

4.17.5 Probit Model for Willingness to Pay for management of government water supply project of wetland areas: The simple probit model has been used for the exploring the determinants of Willingness to Pay (WTP) for management of water supply of Harike, Ropar and Nangal Wetlands.

From the results, it is revealed that the male respondents are negatively and less likely to pay for the use of wetland water for irrigation and household uses. Because the respondents living near the wetland areas more depends on groundwater for irrigation due to the free power supply is given by Punjab state government to the farmers. In past times, female used to go long distance for fetching water for the household needs. The attitude of respondents regarding the conservation of water resources has changed due to the invention of new technology. Such as in the present times, every household living in rural areas have their personal pumping system for the extraction of water from the ground. During the field survey, it was observed most of the people living in rural areas use groundwater for domestic uses because there is no restriction or limit for how much water can be extracted. Besides this, the degradation of water resources through the dumping of solid and liquid wastage into the river is also responsible for changing the choice of the human being for the use of water for household uses.

Among the occupation dummies, respondents engaged in the labour activities are negatively or less likely to pay for the use of water for household and irrigation purposes, because they do not have enough money to pay for use of water resources. The respondents belong to this group are more dependent on wetland areas for water needs. Such as respondents living nearby the Ropar wetland areas use the wetland water for drinking, bathing, washing and for cattle. Besides this, being other variable constant, year of schooling of the respondents have a positive and significant influence over the willingness of respondents for pay for the maintenance of the water supply for irrigation and domestic usages. The positive

estimated coefficient for the year of schooling for the secondary and graduation level respondents means that respondents belong to this group are more willing to pay for such activities. It also means that educated people are more concerns towards the preservation of environments and its associated products likes water, flora and fauna.

Furthermore, being constant other variable, income earned by the respondents influence the willingness of respondents to pay for the use of wetland water for irrigation and household uses. The sign of the positive estimated coefficient for the respondent's income indicates that they are more likely to pay for such activities. Besides this, the willingness of respondents for pay for the use of wetland water has changed with respect to each income dummies. The positive coefficients for the income quintile 2, 3 and 5 indicates that respondents belong to this group are more likely to willing to pay for the use of water from the wetland areas.

More importantly, the willingness to pay for the use of wetland water for domestic and irrigation usages varied with respect to each wetland. Among the three wetlands, the coefficients for wetland dummies indicate that respondents belonging to Nangal wetland areas are more likely to pay for the use of wetland water for irrigation. During the field survey, respondents of Nangal communicate that there was no facility of irrigation provided by the government for irrigation purposes. The respondents state that they are ready to pay for the use of wetland water if irrigation facility will be provided by the government. In the case of Ropar wetland, respondents are more dependent on the pumping of groundwater or water from wetland areas with the help of diesel engine and electric pump. Therefore, the respondents of Ropar wetland are less likely willing to pay for irrigation as compare to respondents of Nangal wetland.

Table 4.38: Simple Probit model for Willingness To Pay for Management of Government Water Supply Project for Irrigation and Domestic Uses near Harike, Ropar and Nangal Wetlands

Govt. Water Supply	Model 1			Model 2		
	Coef.	**Z**	**dy/dx**	**Coef.**	**Z**	**dy/dx**
Religion Dummies (Reference Category: Other)						
Sikh	0.30	0.63	0.06	0.30	0.62	0.06
Hindu	0.31	0.67	0.06	0.38	0.79	0.07
Caste Dummies (Reference Category: SC/ST)						
General	0.21	0.78	0.04	0.13	0.46	0.02
OBC	0.23	0.82	0.04	0.10	0.36	0.02
Gender Dummies (Reference Category: Female)						
Male	-1.16	-3.75*	-0.22	-1.08	-3.39*	-0.20
Age Dummies (Reference Category: Less than 35)						
35 to 49	-0.28	-1.27	-0.05	-0.35	-1.58	-0.06
50-64	-0.25	-0.97	-0.05	-0.32	-1.21	-0.06
Above 64	-0.52	-1.26	-0.10	-0.67	-1.50	-0.12
Education Dummies (Reference Category: Illiterate)						
Primary	0.06	0.21	0.01	-0.02	-0.05	-0.00
Middle	0.11	0.37	0.02	0.13	0.42	0.02
Secondary	0.58	1.72***	0.11	0.62	1.79***	0.11
Graduation and above	0.55	1.66***	0.10	0.54	1.59	0.10
Income Dummies (Reference Category: Quintile 1)						
Quintile2	------	------	------	1.41	2.50**	0.26
Quintile3	------	------	------	0.89	1.66***	0.16
Quintile4	------	------	------	0.65	1.19	0.12
Quintile5	------	------	------	1.05	1.80***	0.19
Occupation Dummies (Reference Category: Agricultural)						
Livestock and fishing	-0.34	-0.97	-0.06	-0.45	-1.26	-0.08
Business	-0.14	-0.46	-0.03	-0.25	-0.82	-0.05
Labour and other	-0.86	-2.34**	-0.16	-0.89	-2.30**	-0.16
Job	-0.44	-1.32	-0.08	-0.51	-1.51	-0.09
Respondent income	0.00	2.09**	0.00	0.00	1.78***	0.00
Wetland Areas Dummies (Reference Category: Harike Wetland)						
Nangal Wetland	1.20	3.72*	0.23	1.33	3.90*	0.24
Ropar Wetland	1.51	5.33*	0.29	1.67	5.43*	0.30
Per capita family income	0.00	0.07	0.00	------	------	------
_cons	-1.50	-2.38**		-2.37	-2.95*	
Pseudo R Square	0.2534			0.2829		
No. of Observation	401			401		

Source: Data was collected during field survey, 2016-17 & 2017-18

* at 1 percent level, ** at 5 percent level and *** at 10 percent level

Chapter V Conclusion and Discussion

Wetland is the most dynamic and productive ecosystem which provides 45 percent services to the world while occupying seven percent geographical area of the world (Indian Space Research Organisation, 2011a). Wetlands being habitat support many species of flora and fauna and have many opportunities for the livelihood of human beings. Human's dependency on wetlands in terms of its religious, recreational, water supply, agricultural, fuel, livestock grazing and fishing can be traced from the literature of ancient times. The importance of wetland services and products has changed from the passages of time and geographical location. In present times, the status of wetlands is negatively affected by human activities as these activities stressed the available natural resources in wetland areas. The countless benefits of wetlands are well recognised. Several studies have also revealed that the over exploitation of wetland to meet the demand of human-beings put a lot of pressure on limited resources. This study is juxtaposed three wetlands Punjab state i.e. Harike, Ropar, and Nangal to probe wetlands in a socio-economic and geographical context. The present study has demonstrated, from field survey and data analysis, that the tendency to treat the wetland as common property resource is the reason for its exploitation. The study concludes that market failure or non-commercial value of the wetland services and products are the major reason behind the encroachment or ignorance of wetlands by local people. To know exactly the pressure on wetlands, it requires the commercial value of the natural resources.

For calculating the socio-economic values of the wetland ecosystem, the value was broadly divided into two types; direct and indirect values. The direct use of products and services provided by wetland include fishes, fuel, water, agricultural land, religious places and recreational activities. Indirect values include flood control, heritage values, purification of water resources, ecological process and aesthetic appreciation. Therefore, attempts have been made to better understand the values of the three wetlands. The first and basic objective of the study has focused on making an inventory of extent and variability of the water body in each wetland. In the second objective, the socio-economic values of each land use for the Harike, Nangal and Ropar wetlands have

been calculated through the estimation of agricultural production, milk production, income generated through fishing, the wetlands used for religious and recreational purposes, etc. Another section of the study analysed that how the natural habitats of wetland ecosystem are affected by human activities, road infrastructure and other developmental work. The discharging of solid or liquid waste from household, industrial and agricultural activities affect the aquatic life as well as the entire wetland ecosystem. The study analysed that local people living on the banks of Sutlej River are suffering from water borne diseases, because the river water is polluted by waste water from industries, agricultural fields, slaughter houses, dairies and households through the Budha Nallah. The attitude and awareness of locals were analysed by calculating their Willingness to Pay (WTP) for the conservation and management of wetland areas.

For the mapping and study the change of land use remote sensing data of Landsat 7 Enhanced Thematic Mapper (ETM) + for 2003 and Landsat 8 Operational Land Imager (OLI)/Thermal Infrared Sensor (TIRS) for 2017 had been used. The change of land use of Harike, Ropar and Nangal wetland areas is detected by remote sensing data for the years of 2003 and 2017. The 2003 year had been selected for the base year and change occurring until 2017 has been determined. The study analysed that areas under agricultural land within the boundary of Harike wetland have increased from 255 hectares in 1970 to 1268.90 hectares in 2017. The major changes have occurred in those areas which were under grasslands previously but now those areas having cleared and being used for agricultural purpose. Similarly, in Ropar wetland, the area under grassland decreased due to the encroachment of area for growing of crops. According to the engineer of Ropar Headworks, about 97.04 hectares area of Ropar wetland was encroached by the residents of Katli, Bhadahupur and Alampura Villages. The situation is completely different in Nangal wetland, about 95 percent of Nangal wetland area is under wildlife sanctuary and water resources, therefore a minor area is left which is encroached by locals for the horticulture and livestock farming.

The NDWI image has been generated for the Harike, Ropar and Nangal Wetlands for 2003 and 2017. The NDWI makes use of visible green light and reflected near-infrared radiation (NIR) to enhance the presence of waterbody. The NDWI image of Harike

wetland shows a remarkable change occurred in the central and south-eastern parts of wetland. In addition, areas under the waterbody decreased in the north and north-eastern region. About 31.07 percent areas under the water resource declined from 2003 to 2017. The major reason for massive changes is unchecked growth of hyacinth in the wetland areas, responsible for changes in the ecology for Harike wetland by the way of blocking. The NDWI for Ropar wetlands shows that no or very low changes occurred because the level of water in Ropar wetland is maintained by the construction of headworks. Another, no or very low change occurred in water resources due to the location of areas. Similarly, very few changes occurred in the surface water body of Nangal wetland, due to the nature of wetland as a dam. A fixed amount of water in Nangal wetland is released from the Bakhara Dam and from Nangal wetland, a fixed amount of water has been discharged into Nangal Hydel and Anandpur Sahib Hydel channels.

Wetlands play an ecological role in the environment but have socio-economic significance to the people who are living around it. Three selected wetlands are in Punjab state of India whose economy is dependent upon agricultural activities. Agriculture and allied activities are major occupations of most of the population residing in Punjab as well as near the study area. After surveying the 1 km buffer area around Harike wetland, which includes both urban and rural areas, it has been observed that visit to Gurudwara Sahib for worshipping and to celebrate festivals, cremation ground around wetland areas, to throw the ashes after the cremation of a dead body are the major socio-religious activities. Except that wetland water and woods are being used for household purposes also. Wetland areas are also placed for social gathering, 93.53 percent people visit wetland for religious purposes, walking and exercising. Harike wetland is very far from the industrial towns of Punjab, so, people around this wetland are engaged in primary activities i.e. agriculture, livestock and fishing. Among urban areas around Harike wetland 37.50 percent people got their livelihood from secondary and tertiary activities, but among rural areas 70.30 percent people are getting their livelihood from agriculture and allied activities. These activities have contributed to the economic value of the wetland for the year 2017. About 3700 acres of land within the wetland boundary is being used for agriculture activities by the rural people. The total

economic value of 3700 acres land is 5.55 crore rupees. Mixed agriculture can be observed nearby Harike so the livestock is fully dependent upon wetland for feed, drinking and bathing, ultimately contributing to the economic values of wetland i.e. calculated 32.92 crore Indian rupees per annum. Wetland has the abundant potentiality to have different species of fishes and fishing is also a major living of people for household consumption and for commercial purposes. The total per annum income from the fishing activities is rupees 8 crore. Harike sanctuary is visiting areas of migratory birds so recreational and tourism activities also contribute to its economic values. These activities belong to the tertiary sector and people who are working in these areas are categorized under tertiary activities. About 8.46 percent people are engaged in recreation and tourism activities. The total annual income from these activities nearby Harike wetland was 70.5 Lakh Indian rupees in the year of 2017. Such a way, the total economic value of the Harike wetland by analysing 1 km buffer zone economic activities and dependency upon wetland is 47.84 crore rupees for the year of 2017.

Ropar wetlands do not have sanctuary area but non-availability of fencing around the wetland area leads to the movement of local people into wetland areas for socio-economic activities. People who are living within the 1 km buffer zone of Ropar wetland area visit the wetland for religious visits like Gurudwara is situated on the bank of wetland. Many cremation grounds are there on the bank of Ropar wetland, even people use woods from wetland areas for cremations. Ropar city is located on the east bank of the Ropar wetland, and urban people visit wetland area for exercise, walking and recreation. About 85.51 percent people of the selected areas visit wetland for such activities. There was a boating club on the bank of Ropar run by the government but it is closed now. Boating is done for educational purposes only. 50.35 percent respondents of the study area of Ropar wetland are engaged in primary activities. Ropar wetland area has open space and land cover with trees near its banks, which are actually the land under wetland boundary, but, this land is being used by rural local people for agricultural purposes. There is a legal conflict between local people and wetland authority over this land of Ropar wetland. Around 1286.12 acres wetland area is being used for agriculture which has 5.78 crore economic values for the year 2017.

Fishing is openly allowed in Ropar wetland which is done through the tender system between government and contractors. The total income from fishing was about 26 lakhs in 2017. About 6.89 percent people are running restaurants and shops to serve the visitors which could be enlisted in the Tertiary sector. The total income for the year of 2017 from these tertiary activities performed by the people living within 1 km buffer zone of Ropar wetland was 20 lakhs. In this way, the total economic value of the Ropar wetland for the year of 2017 was 52.94 crore rupees.

Table 5.1: A comparative picture of Harike, Ropar and Nangal wetlands

	Harike	**Ropar**	**Nangal**
Area (in hectare)	8600	1365	289.68
Land use			
Agriculture	1268.9	520.48	303.9
Marshy and Shrubs	4054.33	185.44	--------
Waterbody	2115.37	518.3	463.52
Forest	--------	128.85	21.7
Change in area under water body from 2003 to 2017			
Areas under water body	-31.07 %	-0.44%	7.55%
Others	15.68 %	0.25%	-0.59%
Economic valuation for 2017 (Direct use value) in crores			
Agriculture	5.55	5.78	------
Fish	8.00	0.96	1.26
Livestock	32.98	44.50	1.20
Tourism	0.61	------	-------
Restaurants	0.70	0.20	1.04
Sand mining	------	0.86	1.2
Kayaking training	------	0.24	------
Commercial plantation	------	0.48	------

Nangal wetland is a part of Nangal dam and includes the wildlife sanctuary located on its bank. Bhabour Sahib and Nangal are the two major cities within 1km buffer around the wetland area. The wetland area is the most important component of the social life of the respondents living nearby it, as to provide a space for relaxing, recreational, aesthetic and spiritual. The pleasant weather and beautiful scenery of wetland attract tourists as well as locals. Every urban resident visits the wetland areas for bird watching, relaxing, walking, exercising, and to take a rest from busy life. About 72.09

percent people visit the religious places situated on the bank of Nangal wetland i.e. Bhabour Sahib Gurdwara, Brahma Temple, Mahadev Temple, Julfa Mata Temple, and others. The locals used the wetland woods and land for cremation purposes and throw of ashes in the water body of the wetland area. In Nangal wetland areas, only 9.3 percent people earned their livelihood from the Primary activities i.e. agriculture, fishing, and livestock rearing. Majority of the locals around Nangal wetland are dependent on the secondary and tertiary sector, as maximum agricultural land had been acquired by the Bakhra Beas Management Board (BBMB) and National Fertilizer Limited (NFL). Therefore, local residents worked in the BBMB, NFL and other industries. The total economic value of the Nangal wetland for the year of 2017 was 4.70 crore rupees.

Wetland has a significant role in the ecosystem and society of the areas where it is located. But the human activities and use of wetland by a human is not in a sustainable manner. The religious, social, and economic activities by local people are degrading wetland health. Harike wetland is suffering from the various human induce threats which includes encroachment or conversion of wetland areas into agricultural fields and religious places, discharge of liquid and solid waste from point (dumping of waste into Sutlej River through Budha Nallah, Kali Bein and Chitti Bein) and non-point source (water from agricultural field) and extensive livestock grazing. In rural areas, about 68.46 perent people dump their solid and liquid waste nearby the wetland and 18.46 percent people directly dump into wetland water. The scenario is different in urban areas, where 7.5 percent people dump their solid and liquid waste near the wetland areas and 2.5 percent respondents into a wetland area. The three-dimensional matrix analysis of people perception revealed that agricultural waste and industrial waste (the wastewater comes from Sutlej River because there is no industry on the bank of Harike Wetland) are the major contributing factor for degrading of Harike Wetland. As per the report by the Department of Forest and Wildlife Preservation, the encroachment of the wetland area for agricultural uses is the major problem, but as per the people perception agricultuarl fields are not threats to wetlands because these are their source of income. The people are getting economic benefits from agricultural activities, so they don’t blame it directly for the degradation of wetland.

On the other hand, in Ropar wetland, there is no direct dumping of the household solid and liquid waste directly into wetland water. But the location of cremation grounds on the bank of wetland lead to dumping of ashes into wetland water. Wetland area is being used for the agricultural purposes responsible for discharging of extra contaminated agricultural water into a wetland area. The conversion of wetland area into agricultural land impacts the natural habitats i.e. the home of local and migratory birds. The mixing of hot water from thermal power station impacts the fish fertility rate. The cutting of forest and overuse of the area for grazing purposes are responsible for soil erosion in Ropar wetland.

Table 5.2: Comparison of threats perceived by locals to wetlands and where they dumped solid/liquid wastages

Wetlands / Threats	Harike		Ropar		Nangal	
	Rural	Urban	Rural	Urban	Rural	Urban
Major contributor responsible for degradation the water quality						
Industrial activities	50.77	97.5	31.08	25.35	22.03	33.33
Agricultural activities	35.38	0	20.27	12.68	5.08	11.11
Religious activities	2.31	0	16.21	38.03	50.85	55.55
Dumping of household wastes	10.77	0	0	2.82	0	0
Others	0.77	2.5	5.41	1.41	0	0
No degradation of water quality	0	0	27.02	19.71	22.03	0
Where locals dumped household solid/liquid wastages						
Dumped at common/own/protected plot	13.08	90	31.08	59.16	22.02	88.89
Near wetland	68.46	7.5	29.73	12.68	8.47	3.7
In the wetland	18.46	2.5	39.19	28.16	69.5	7.41

The water ecology of the Nangal wetland is affected by the dumping of liquid or solid waste from the industries. Amongst the three selected wetland areas, Nangal wetland is less suffered from the discharging of liquid and solid household and agricultural waste into it. The scenario of the dumping of liquid and solid wastage changed with respect to urban and rural areas. In rural areas, 69.5 percent people dumped their liquid wastage into wetland areas and 8.47 percent respondents near the wetland areas. Whereas, in an urban area, 7.41 percent respondents dumped their liquid or solid waste into and 3.70 percent people near the wetland areas. The location of

cremation grounds on the banks of Sutlej River and Nangal Wetland is liable for the degradation of the water quality of wetland. Apart from this, wetland areas have also suffered from siltation, as it is surrounded by the Shivalik hills.

The wetland ecosystem is an integral part of human life but is under stress due to misuse and depletion by the human being. The management and conservation of wetland area are necessary to enjoy the services and products provided by it. For the conservation of wetland area efforts have been made both at the national and the international level. The Ministry of Environment Forests and Climate Change (MoEF&CC) is the supreme body liable for the conservation and management of wetland area. There are several management plans and programmes adopted by the MoEF&CC, important ones are NWCP, Wetland Management and Conservation Rules, 2010 and Wetland Conservation and Management Rules 2017. However, each programme, plan and rule has certain limitation.

From the study, it can be revealed that the locals of Harike wetland are less aware about the functioning and importance of wetland area as compare to the locals of Ropar and Nangal wetlands. The seriousness of the departments regarding the conservation of wetland areas has been understood by the organisation of awareness camp related to use, benefits and the importance of the wetland ecosystem. In Harike wetland, only 3 percent of respondents in rural and 5 percent respondents in urban areas were aware about this. Whereas, information of awareness camp related to wetland area has increased in Ropar (5.41 percent in rural and 28.17 percent in urban areas) and Nangal areas (51.85 percent in rural and 57.63 percent in urban areas). The enactment of the Wildlife Act, 1972 can be estimated from the condition of the wetland area, as no clear demarcation for the Harike Wetland. Even in the notification of declaration of the Harike wetland as a wildlife sanctuary no records mentioned about the Khasra number of land which was covered under this, while it was mention in the case of Nangal wetland. The status of management can be understood from the present condition of the wetland area because there is no fencing available on wetland boundary. The working NGO in the Ropar and Nangal Wetlands are successful in spreading awareness about conservation and management of the wetland area to the locals. A three-dimensional matrix related

to the observation of the people related to the management of the wetland area developed with concentrated on seven parameters. According to this, a great variation occurred in the conservation and management of wetland areas within three wetlands. The political pressure and negative attitude of the people is the major hindrance to achieve the management and conservation goals. The results of Ordinary Least Square revealed that education significantly affects the Willingness To Pay (WTP) for the livestock grazing. The probit model has been applied to known the WTP for the conservation and management of wetland area. The result of probit model revealed that occupation, monthly income and level of education of respondents are influence factor for WTP for conservation and management of wetland area. The results also showed that WTP of the respondents changed within the Harike, Ropar and Nangal wetlands. The locals of Nangal and Ropar wetlands are more willing to pay for conservation of areas, because their dependency over wetland areas is more for recreational and aesthetic purposes than the locals of Harike Wetland. The livelihood of the respondents of Ropar and Nangal wetlands are more dependent on the secondary and tertiary activities than the Harike Wetland.

Limitations of the method used for valuation

The contingent and market price methods had been used for calculating the economic valuation of the wetland area. The data related to milk productivity and numbers of livestock had been collected during the field survey and economic valuation for livestock grazing had been collected. The economic value for the agricultural has been calculated by the using of income earned through the crop production by subtracting of the expenditure occurred for the growing of crops. The travel cost method had been used to calculate the value of tourists to visit the wetland area. The foremost limitation of economic valuation is that fish production data has not collected due to lack of responses from the respondents. The limitation of the travel cost method is that only travelling cost had been used for calculating tourism valuation. The travel cost method is only given estimate due to minor availability of quantitative data. Besides this, inaccessibility of Harike wetland is also a major restriction to know the different uses of the area and how locals use the wetland resources. The data related to commercial uses of the area for

selling of fuels, woods and sanghera are not explained by the people during the field survey. Even, the people did not express the way how they use wetland water for irrigation purposes. Another limitation of study is that economic valuation of wetland areas has been calculated from the activities within buffer zone 1km.

Recommendations

In line with the findings that the wetlands (study areas) provide various types of socio-economic benefits and services to the local community and are under the state of various conservation and management challenges, the following recommendations are put forward for considerations:

1. **Integration of GIS and Remote Sensing in Wetland Management Process** Conservation and management plans can be precisely formed if accurate spatial and temporal inventories are prepared for the wetlands. It was found that such inventories are available for Harike Wetland while these are not available for other two wetlands. Government departments were visited to procure future plan maps of the study areas and it was found that the maps are hand-drawn and lack any spatial information.
2. **Generation of ancillary data:** Lack of data is considered as a major constraint in performing the economic valuation of all the three wetlands. One of the major constraints in the economic valuation of the wetland area is non-availability of fish production data. During the filed survey the fish contractors refused to give data regarding the production of fish resources.
3. **Building partnership with the local community:** The participation of locals are necessary for the management of wetland areas and during the filed survey it was observed and accessed that there is a need to aware the people about the functioning and importance of the wetland areas. Even the Ramsar Convection Handbook (7), focused that the involvement and active participation are essential for the management of any wetland area. Therefore, it is necessary to aware locals about the functioning and importance of wetland area for developing a positive interest among the people for the sustainable use of wetland resources. The cooperation and discussion with the locals are

necessary to know the people's attitude, thinking about the importance of the wetland area. Locals have the traditional right for the use of wetland area for collection of fuel, livestock grazing, and water for domestic uses in a sustainable manner. It is important to give awareness to locals to take active participation in the afforestation in the wetland areas and to provide livelihood in this activity.

4. **Capacity building:** The term capacity building means to increase the ability, skill, knowledge and level of education among the people.
5. **Creating awareness among the stakeholders/ Outreach and education awareness camp**: The education and public awareness is the basic tool for the success of any management plans. To educate and aware the locals, communication and interaction between and within the individual as well as NGO/ organisation are necessary.
6. **To ensure participation of educational institutions:** Active participation of schools, colleges and university staff and students are necessary for the management and conservation of wetland area. Even the monitoring of the management plans will be regularly checked by them for effective management. Besides this, it will increase the awareness among the local people about the importance of wetland resources in life and what can be done for the conservation of the wetland area.
7. **Promotion of organic agricultural practices near wetland area:** The promotion or making policy regarding the use of no pesticides and fertilizer on the crops near the wetland area. For the implementation of organic agricultural special services can be provided by the government such as higher subsidy, interest free loan, separate Minimum Support Price for organic production etc. in addition, to aware and educate the locals to about the living in the bee keeping, fish farming, piggery, poultry farm or integrated agricultural activities.
8. **Reward/incentives to locals for their efforts to conserve wetland:** To make a policy regarding give reward/incentives to locals, if any individual, firm or industry shows a seriousness regarding the conservation of the environment through the no dumping of any liquid or solid wastage in the wetland area. In addition, special concession given both the state and the central can depend

on the environmental performance of firm or setup of necessary infrastructure related to the treatment of both liquid and solid wastages.

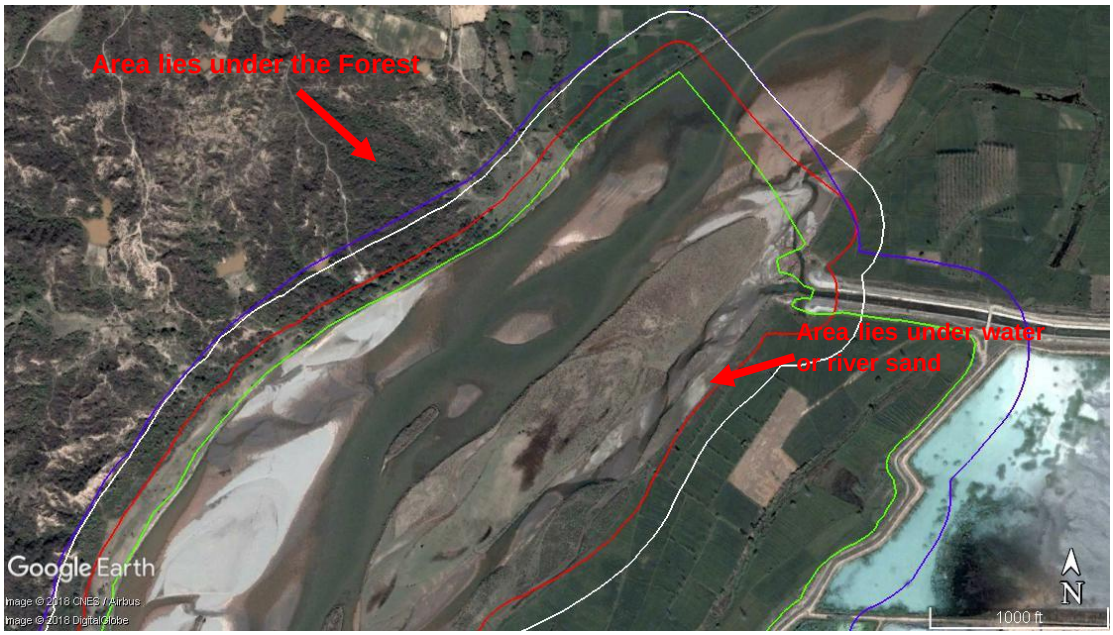
9. **Implementation of rules and regulations to check point and non-point source pollution:** The degradation of the quality of water resources becomes a major problem in the wetland area. This problem of water degradation has been resolved by the checking and stoppage of point source pollution in the River areas, direct source of water for the wetland area. Besides this, the pollution from the non-point sources, mainly from the agricultural activities has been stopped by the restriction on the use of pesticides and fertilizers within the 1km buffer zone around the river catchment/wetland area. Another, problem of the water degradation can be resolved by the setup of Sewage Treatment Plant (STP) on the point source pollution, so that treated water can be mixed with the river water rather than the degraded water.
10. **Demarcation of boundaries:** The demarcation of boundary of Harike, Ropar and Nangal wetlands are crucial for the conservation of the wetland area. It will resolve the problem of encroachment of the wetland area for agricultural uses, livestock and other uses. Besides this, fencing of wetland area also resolves the problem of encroachment as well as conservation and management of wetland area.
11. **Preparation of management plans zone wise:** To effectively achieve the goals of management plans it is necessary to divide the large area into different zones on the basis of their importance. To divide the Harike wetland into the three zones i.e. core, central and outer. The core zone is a highly sensitive area which is very susceptible to degradation and required more attention for the conservation and management. The buffer or central zone can be used for research and training activities and outer or transition zone allowed for sustainable use. The different type of fencing has been used for the demarcation of each zone so that they should be easily identified on the ground.
12. **Promotion of the concept of eco-tourism:** The economic output, as well as conservation of the wetland area, can be possible through the promotion of green or eco-tourism. Because of the promotion of this, one way giving a living

to the locals and another way it attracts the people for the conservation of the wetland area. Besides this, the wetland area can be conserved through introducing an entry fee to visit the wetland area.

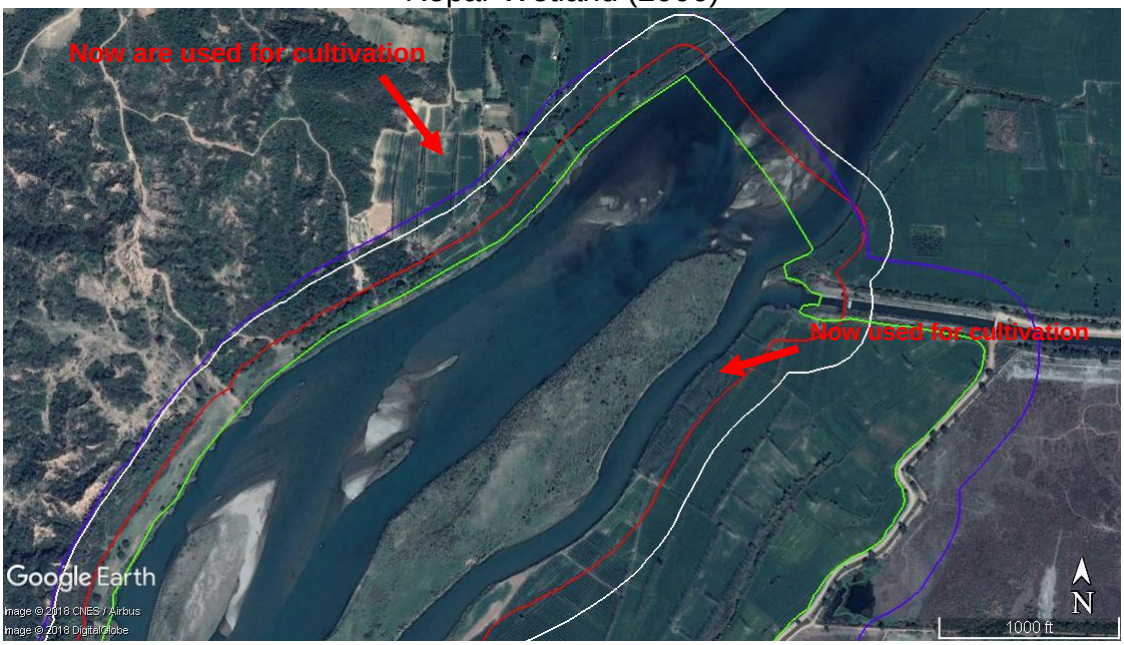
13. **To solve the Problem of aquatic plant:** The Harike wildlife sanctuary suffered from the excessive growth of aquatic plants mainly hyacinth. It is considered as one of the worst aquatic plants. The excessive growth of hyacinth in the Harike wetland responsible for several detrimental effects which include blockage of sunlight and air in the deeper parts of water, blockage, and deep roots of its also affects the aquatic flora and fauna. For the removal of hyacinth from the Harike wetland both manual and mechanical methods had been used, but the problem is remaining the same as earlier due to the high productivity of it. At present, the mechanical conveyor belt system adopted for the clearing of hyacinth is not in working conditions. The problem of water hyacinth can be solved down by the awareness of locals about the economic use of hyacinth and to give training to locals how handicraft items have been prepared from them. The women's of one village namely Sudhia involved in these activities, but the lack of market facilities and high cost for the removal of hyacinth from the water put a negative impact on the project. The problem of clearing of water hyacinth and its contribution to the livelihood of locals can be increased if the government provide a facility of the market as well as hyacinth for making of handicraft items.
14. **Control of siltation:** The Harike and Ropar wetland area suffered from the problem of accumulation of silt, which ultimately responsible for the decrease in the capacity of the wetland area. During the field survey, it was observed that the major problem of siltation occurs along the banks of Beas River. The structures developed for the control of soil conservation are now not in good condition due to lack of monitoring and repairing. Therefore, to solve the problem of soil erosion, first of all, it is necessary to develop a vegetative cover along the river banks and on the sloppy land to reduce the riverine and gully erosion. In addition, the native tree plantation and build of silt control structure like earthen check dam, earthen filed bunds and silt control measure can be

developed along the right side of Beas River to reduce the problem of siltation. Similarly, in Ropar and Nangal wetlands need to develop a forest or vegetative cover and constriction of silt control structure along the sloppy terrain.

Map shows Land use in 100 meters buffer zone from 2006 to 2018 in Ropar Wetland



Ropar Wetland (2006)

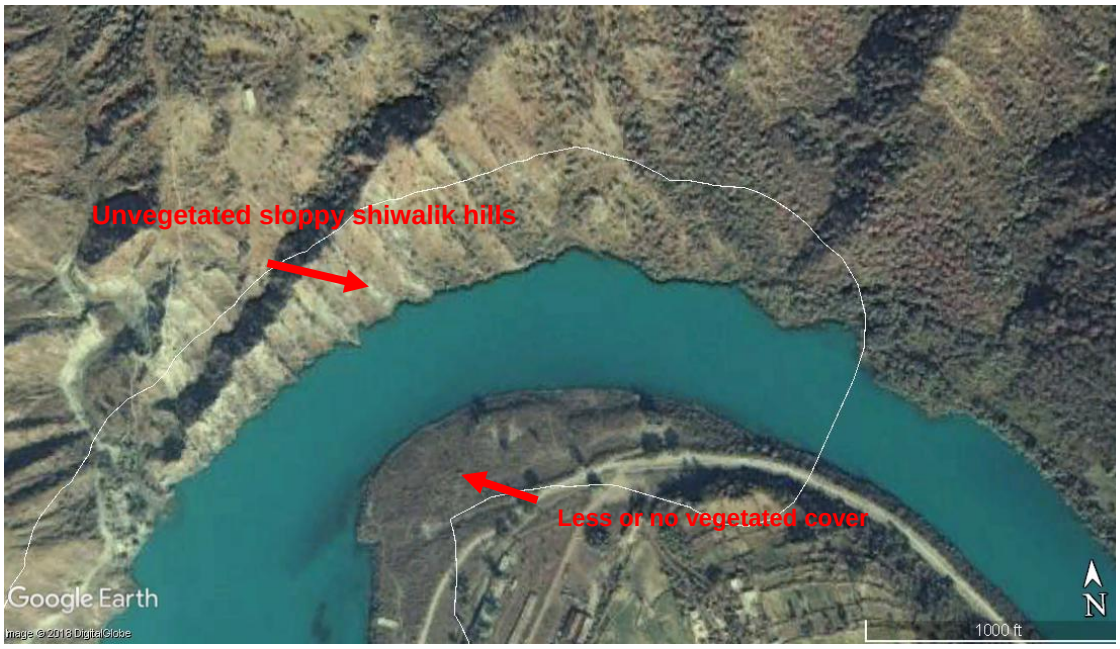


Ropar Wetland (2018)

In the comparison of the image of 2006 and 2018, it has been found that major changes occurred in the 50 meters and 100 meters around the Sutlej River that

vegetative or forest area are converted into agricultural fields. The conversion of the area can have an impact on the water region to the conversion of the area into agricultural uses.

Map shows Land use in 100 meters buffer zone from 2006 to 2018 in Nangal Wetland



Nangal wetland (2002)

Nangal Wetland (2018)

Similarly, a 100-meter buffer zone has been developed around the Sutlej River or Waterbody of Nangal dam. It was identified that vegetative covers diminishes around the Shivalik hills (right bank of Nangal dam) from 2002 to 2018, which is responsible for the increasing loads of sediments in the Nangal wetland. However, the accumulated sediments in the Nangal wetland area washed out the opening of dam gate. But, there is a need to cover the surrounding unvegetated Shivalik hills into vegetation covers, so that rate of soil erosion reduced in the Nangal wetland area.

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