WETLANDS IN GEOGRAPHICAL CONTEXT: A CASE STUDY OF KANJLI WETLAND, PUNJAB

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY

in

Geography

By

Komal Sharma

Registration Number: 41800858

Supervised By

Dr. Rajesh Jolly (26775)

Associate Professor

Department of Geography

School of Liberal and Creative Arts

(Social Sciences and Languages).

LOVELY PROFESSIONAL UNIVERSITY, PUNJAB

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DECLARATION

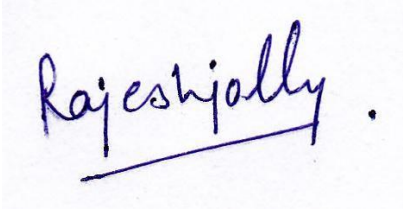
I, hereby declared that the presented work in the thesis entitled **"Wetlands In Geographical Context: A Case Study of Kanjli Wetland, Punjab"**in fulfilment of degree of **Doctor of Philosophy (Ph. D.)** is outcome of research work carried out by me under the supervision of Dr. Rajesh Jolly working as Associate Professor in the Department of Geography, School of Liberal and Creative Arts (Social Sciences and Languages) of Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.

Name of the scholar: **KOMAL SHARMA**

Registration No.: 41800858
Department/school: Department of Geography,
School of Liberal and Creative Arts (Social Sciences and Languages).
University: Lovely Professional University, Punjab, India.

CERTIFICATE

This is to certify that the work reported in the Ph. D. thesis entitled **"Wetlands In Geographical Context: A Case Study Of Kanjli Wetland, Punjab"** submitted in fulfillment of the requirement for the award of degree of **Doctor of Philosophy (Ph.D.)** in the Department Of Geography, School of Liberal and Creative Arts (Social Sciences and Languages) of Lovely Professional University, Punjab, (India), is a research work carried out by Komal Sharma, Registration No.) 41800858, is bonafide record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.



Name of supervisor: **DR. RAJESH JOLLY**

Designation: Associate Professor
Department/school: Department of Geography,
School of Liberal and Creative Arts (Social Sciences and Languages).
University: Lovely Professional University, Punjab, India.

Abstract

This study focuses on the Kanjli Wetland in Punjab, renowned for its rich biodiversity, which has suffered adverse impacts from recent construction endeavors. Habitat loss from infrastructure development has decreased species diversity and overall ecosystem health. Furthermore, pollution from industrial effluents and agricultural runoff has compromised the wetland's natural filtration capacities, impacting water quality and human health. Human activities, including tourism, have accelerated the wetland's destruction, disrupting the natural habitats of indigenous fauna and jeopardizing their survival. Construction projects have also adversely affected the cultural heritage of nearby villages reliant on the wetland for sustenance and livelihood.

The study aims to address various issues about the Kanjli Wetland, including changes in land use, ongoing development initiatives, impacts of degradation on neighboring communities, and governmental responses to emerging challenges. An extensive literature review spanning global, national, and regional contexts has identified gaps in existing research specific to the Kanjli Wetland. Despite numerous studies on the importance of large-scale wetlands, degradation, and conservation efforts, a comprehensive examination of the unique complexities of the Kanjli Wetland remains lacking.

Drawing insights from the literature review and identifying research lacunae, the study formulates several objectives: 1) to assess changes in land use patterns of the Kanjli Wetland from 1990 to 2022, 2) to examine the impacts of development activities on the wetland, 3) to analyze the repercussions of wetland degradation on local livelihoods, and 4) to evaluate existing conservation policies and propose recommendations for enhanced wetland management and conservation.

To address these objectives, the study poses specific research questions aimed at understanding the dynamics of land use changes, assessing the impacts of development activities, examining the socio-economic implications of wetland degradation, and evaluating existing conservation policies for the Kanjli Wetland. Through comprehensive research and analysis, this study endeavors to contribute to the understanding and conserving of the Kanjli Wetland and inform policy and management decisions for its sustainable future.

This study adopts an objective-driven approach to fulfill its aims. Satellite images spanning 1990, 1999, 2010, and 2022 were utilized to address the first objective. These results were analyzed alongside on-site investigations to elucidate the factors influencing changes in land use. For the second objective, an evaluation was conducted to gauge the impact of development activities on the Kanjli wetland, utilizing both primary and secondary data sources. Primary data was gathered through extensive fieldwork encompassing 411 households across eleven villages within the study area.

The third objective assessed the perception of Kanjli Wetland degradation on local livelihoods through surveys conducted among 411 households in 11 villages. The results, outlined in Chapter 4, explore themes such as wetland degradation, its underlying causes, and the socio-economic and cultural significance of wetlands to local communities.

To achieve the fourth objective, the various threats, challenges, and conservation methods concerning the Kanjli wetland were examined. Issues such as declining water inflow, weed proliferation, overgrazing, deforestation, and encroachments were identified. Government reports, policy documents, research papers, and fieldwork were analyzed to address these concerns under the Threats, Conservation, and Management categories.

The study is structured across six chapters, with Chapter 1 providing an introduction, conceptual framework, literature review, research objectives, and methodology. Chapter 2 delves into the land use dynamics of the Kanjli Wetland, examining changes over 32 years using satellite imagery. Notably, cropland emerged as the predominant land use, followed by shifts in vegetation and built-up areas due to urbanization and population growth. These changes reflect environmental and socio-economic impacts, necessitating mitigation measures such as pollution control, sustainable agriculture, habitat restoration, and community involvement.

This study underscores the importance of comprehensive land use management strategies to safeguard the ecological integrity and socio-economic resilience of the Kanjli Wetland and similar ecosystems.

The third chapter of this study, titled "Impact of Development Activities on Kanjli Wetland," delves into the effects of various developmental undertakings on the

wetland ecosystem. Organized into sections covering General Information about the Households, Development Activities in the Wetland, Positive and Negative Impacts of Development Activities in the Wetland, and Respondents' Perceptions, this chapter sheds light on the ongoing transformations within the Kanjli wetland due to developmental interventions. Infrastructure development, agricultural practices, aquaculture ventures, tourism initiatives, flood control measures, and restoration projects are among the activities currently underway. While these endeavors offer potential benefits such as economic prosperity, job opportunities, improved transportation, and financial stability, they also pose significant challenges to wetland ecosystems. Infrastructure expansion, for instance, has encroached upon other land uses, underscoring the need for responsible and sustainable development practices. Adherence to environmental guidelines, meticulous planning, and vigilant monitoring are imperative to mitigate adverse impacts and ensure the long-term health of wetland ecosystems.

The fourth chapter, "Impact of Wetland Degradation on People's Livelihood," addresses the repercussions of wetland degradation on local communities. This segment delves into topics including the degradation observed in the Kanjli Wetland, its root causes, the socio-economic and cultural significance of wetlands to local inhabitants, and the detrimental effects of degradation activities on livelihoods. Human-induced activities such as water extraction, agricultural expansion, and waste disposal have severely damaged the Kanjli Wetland, significantly impacting the lives of those dependent on it. Diminished fish stocks, attributed to water scarcity and pollution, have adversely affected the income of local fishermen, while reduced water availability for irrigation has impeded agricultural productivity and farmer incomes. Pollution has further exacerbated water quality issues, posing health risks to human residents and wildlife. Biodiversity loss, exemplified by dwindling bird populations, has also had a detrimental effect on the local economy, particularly the tourism sector. Addressing these challenges necessitates holistic conservation efforts to safeguard the ecological integrity of wetlands and the well-being of local communities.

Chapter 5 of this study, titled "Conservation and Management of Kanjli Wetland," investigates the various threats faced by the Kanjli Wetland, including urbanization, industrialization, pollution, invasive species, and climate change, all of which

jeopardize its delicate ecological equilibrium and biodiversity. Collaborative initiatives involving government agencies, environmental organizations, and local communities have been initiated to mitigate these challenges. These endeavors encompass a range of strategies, such as water hyacinth control, afforestation, pollution monitoring, and public awareness campaigns. Additionally, international agreements like the Ramsar Convention and national programs like the National Wetland Conservation Program play pivotal roles in wetland preservation. Emphasizing the importance of community engagement, public-private partnerships, and grassroots projects underscores the significance of involving local populations in conservation endeavors. Proposed measures for the restoration and protection of the Kanjli Wetland encompass afforestation, wildlife preservation, water quality surveillance, fisheries conservation, scientific research, economic valuation, and public education. These holistic approaches aim to safeguard the wetland ecosystem, benefiting wildlife and local communities while advancing long-term conservation objectives.

Therefore, this study provides a decadal analysis of land use and land cover changes in Kanjli Wetland, offering insights into its evolving ecological landscape. However, several limitations constrain the comprehensiveness and applicability of the findings. Firstly, the decadal analysis might overlook finer-scale variations or events within each decade, warranting a more frequent and detailed examination to capture nuanced changes accurately. Additionally, the absence of interdisciplinary collaboration with experts from fields such as ecology, sociology, or hydrology may result in overlooking critical dimensions of the issue. Furthermore, the specific time frame for data collection and analysis limits the study's ability to comprehensively capture long-term trends and development impacts.

Moreover, the retrospective nature of the research focusing on historical changes overlooks the importance of a forward-looking approach to anticipate future trends and threats to Kanjli Wetland. Additionally, while the study touches upon various impact dimensions, such as food security, water availability, and cultural identity, other relevant variables, like psychological and social impacts, remain underexplored. Furthermore, relying solely on the perspectives of local households neglects valuable insights from governmental bodies, industries, and other stakeholders involved in wetland degradation.

Furthermore, the study briefly mentions government initiatives without delving into the implementation challenges, hindering the formulation of effective conservation strategies. Similarly, while community-level initiatives are acknowledged, their effectiveness and associated challenges are not thoroughly explored, overlooking valuable insights into community dynamics and the success of conservation efforts. Lastly, the study does not deeply explore the potential impacts of climate change on Kanjli Wetland, which is crucial for devising adaptive conservation strategies. Addressing these limitations could enhance the study's relevance and contribute to more informed wetland conservation and management strategies.

To ensure the long-term sustainability of Kanjli Wetland amidst various challenges, a comprehensive set of recommendations and suggestions has been proposed. These include fostering community engagement to plant diverse evergreen trees around the wetland, which enhances habitats and supports fish reproduction while mitigating soil erosion. Wildlife protection measures such as fixing fences, setting up barriers, and constructing wooden nests are recommended to safeguard the diverse fauna. Innovative solutions like using fake birds to maintain a balanced bird population are also suggested. Furthermore, various methods, including conveyor belt removal and biological management, are advised to control water hyacinth infestations effectively. Establishing a robust water quality monitoring program over the next five years is essential to inform decision-making and protect the ecosystem.

Additionally, supporting further research to enhance understanding of Kanjli Wetland's flora, fauna, and resource utilization by local communities is recommended. Determining the economic value of the wetland through a comprehensive three-step process will integrate environmental conservation and income generation considerations into future planning. Increasing awareness about the importance of wetlands through media campaigns, educational materials, and community events, along with encouraging community participation in conservation efforts, is crucial. It is also proposed to engage Punjabi NRIs and the Diaspora to invest in the wetland's conservation, emphasizing its cultural significance. By collectively implementing these recommendations, a sustainable plan can be developed to ensure the health and vitality of Kanjli Wetland for wildlife, the environment, and local communities alike.

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CHAPTER – 1
INTRODUCTION

1.1 Introduction

Wetlands are one of the most important natural resources found on the earth. It constitutes both abiotic and biotic elements. So, the two major components of the wetland system are biotic and non-biotic that includes plants, animal species and soil, land, river etc. (Kumar G, 2019). Wetlands are of great importance from the earlier times. Most of the civilizations were nurtured along the wetlands near Indus, Tigris and Mekong rivers etc. (Kumar G, 2019). These wetlands provide drinking water, pastureland, transport, fisheries etc.

Wetlands have been described both as 'the kidneys of the landscape', because of the functions performed by wetlands in the hydrological and chemical cycles, and as, biological supermarkets' because of the extensive food webs and rich biodiversity they support (Mitsch & Gosselink,1993). Due to their uniqueness among other ecosystems and nourishment of a large variety of flora and fauna in the wetlands are also considered as a biodiversity hotspot. Significance of wetlands was recognized with time. Earlier due to lack of technology wetlands were considered a hindrance in cultivation and development. With the passage of time perception of people about wetlands has also been changed. As awareness and understanding of wetlands grow, their importance is increasingly recognized by the public, serving as a driving force for conservation efforts (Woodward, 2001). Wetlands provide a range of products for our livelihood in direct or indirect ways. Especially in the developing countries like India, the wetlands are of great importance as their major occupational structure is related to the primary sector i.e. agriculture, fishing, plantation etc.

Wetlands are of biological and physical importance. Besides it, wetlands are also important from a socio-economic perspective. Wetlands contribute to tourism by offering opportunities for recreational activities such as fishing, leisure, and enjoying lovely weather (Folke 1990; Groot, 1992; Government of Punjab, 2003; Mwakubo& Obare, 2009;). With the increase in the demand for natural resources, there is a great need to develop the resources. Wetlands occupy approximately seven percent of the Earth's surface geographically, yet they contribute about 45% of the world's

ecosystem resources (ISRO: Indian Space Research Organization, 2011). Wetlands can be proved as a greater booster to our national economy with sustainable development as it also boosts tourism.

So, with the ongoing status of the destruction of wetlands development Sustainable development is required. In its broadest sense, the strategy for sustainable development aims to promote harmony among human beings and between humanity and nature (WCED, 1987). “Human development is a process of enlarging people's choices. In principle, these choices can be infinite and change overtime. But at all levels of development, the three essential ones are for people to lead a long and healthy life, to acquire knowledge and to have access to resources needed for a decent standard of living. If these essential choices are not available, many other opportunities remain inaccessible” (UNDP, 1990).

In the light of such significances of the wetlands, many studies have been held at world and different regions or countries level. In India also many studies on the conservation of wetlands have been done to find out the problems related to wetlands and measures to control it. India is one of the developing and agrarian countries. So, there is enormous importance of wetlands in India. Punjab is an agrarian state of India. So, it has the vast importance of wetlands.

There are 12 natural and 9 artificial or constructed wetlands are present in Punjab. Its six wetlands i.e. Harike, Ropar and Kanjli, Keshopur, Nangal and Beas are the Ramsar sites. All the wetlands are very important for the state of Punjab as it is an agrarian state. But these wetlands are facing some types of changes. Some of which are not favourable. Out of which Kanjli wetland is selected for the study. Earlier it was a tourist place but now it has lost its value as a tourist place. As in the case of Kanjli wetland main problems are weed growth, grazing that is resulted into soil erosion and deforestation, reduced inflow and encroachment of adjoining areas (Punjab State Council for Science and Technology). This development is no doubt good but with the same it is also decreasing the area of wetland. This study approaches towards the development versus Decrease in the area of this wetland and impact of land use on wetland area. It tries to find out its socio-economic effects and ways towards sustainable development.

1.2 Study Area

Kanjli wetland is situated in Kapurthala district of Punjab, India. It is manmade wetland that comeinto the category of reservoir or barrage. It is declared as a Ramsar site in 2002. Its coordinates are 31°25' North Latitude and 75°22' East Longitude. Its altitude is 210 metres with a total geographical area of 183 hectares. The Kanjli Lake is replenished by the Kali Bein rivulet, originating from the Budha Barkat regulator near Dhanoa village in Hoshiarpur district. After flowing for a considerable distance, it passes Bakarke village, approximately 10 kilometers from the Harike Pattan regulator, before merging with the Beas River. Situated approximately 20 kilometers northeast of Harike, the wetland holds a crucial position in the region.

The present study initially delineates a buffer zone extending 3 km around Kanjli Wetland, encompassing the vicinity of Kanjli Lake. This buffer zone comprises all the villages situated within its perimeter. Specifically, the study area includes Kapurthala city and 37 villages: Abdulahpur, Boot, Beja, Badshahpur, Bajola, Bhila, Bishanpur, Chuharwal, Dialpur, Dham, Dainwind, Duburji, Gaura, Hamira, Hambowal, Kanjli, Khangah, Khukhrain, Kokalpur, Lakhan Kalan, Lakhan Khurd, Mudowal, Murar, Mustafabad, NurpurRajputan, Nawanpind, Nazampur, Paharipur, Phulewal, Ramidi, Randhawa, Rupanpur, Seenpur, Sheikhupur, Subhanpur, Tajpur, Thikriwala, and ThehKanjla. Map No. 1.1 illustrates the demarcated study area for the current research, providing a visual representation of the selected buffer zone.

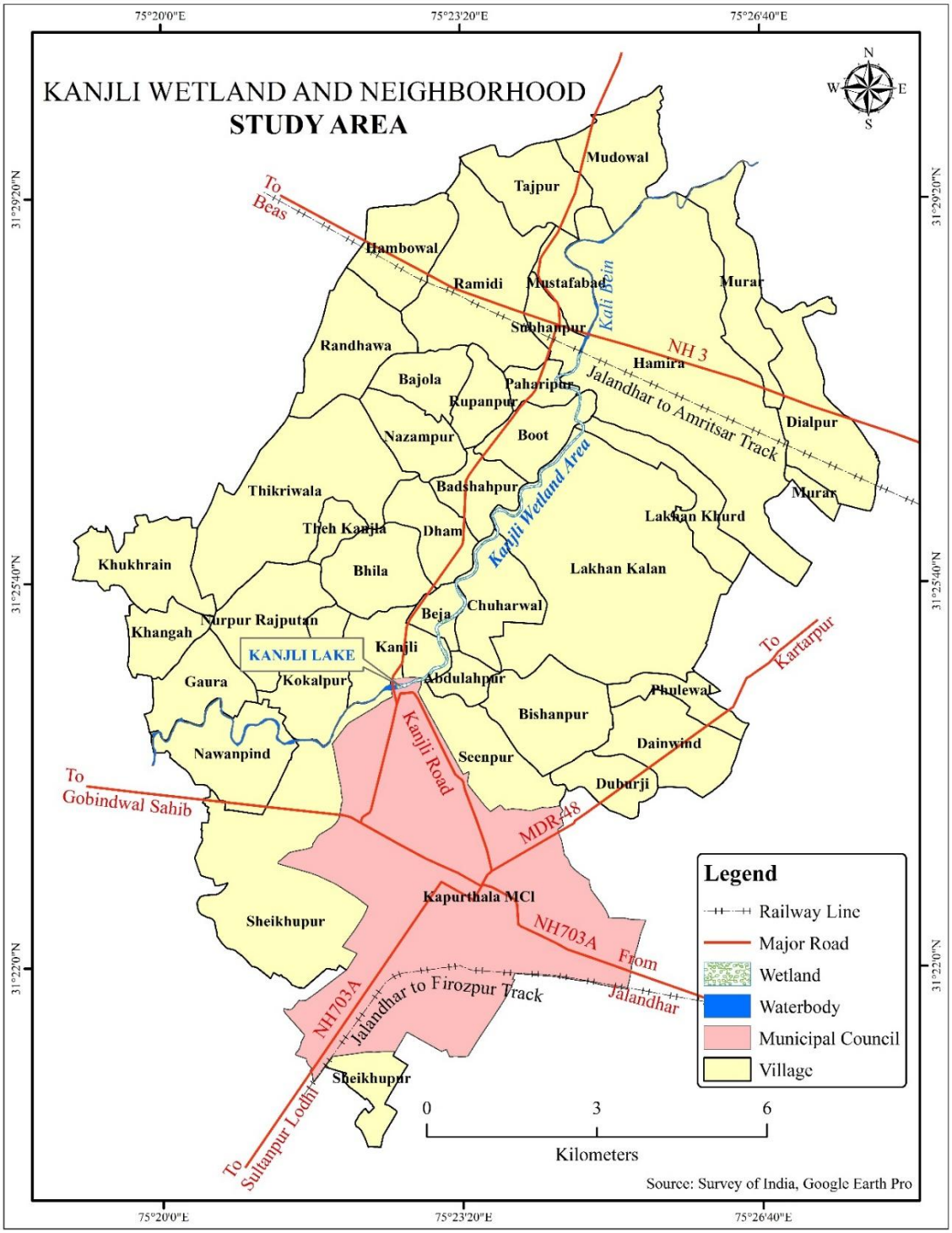
The selection of a 3 km buffer zone surrounding Kanjli Wetland aims to capture the ecological and environmental dynamics in the immediate vicinity of the wetland. By including all the villages within this buffer zone, the study seeks to comprehensively analyze the land use patterns, socio-economic activities, and environmental factors that influence the wetland ecosystem and its surrounding areas.

The villages identified within the buffer zone serve as critical components in understanding the interplay between human activities and the natural environment. Through spatial analysis and data interpretation within this delineated area, the research aims to provide insights into the relationship between human settlements, agricultural practices, and wetland conservation efforts.

Overall, the delineation of the buffer zone and the inclusion of surrounding villages in the study area facilitate a holistic assessment of the ecological, socio-economic,

and environmental aspects pertinent to Kanjli Wetland and its immediate surroundings. This comprehensive approach enhances our understanding of the complex interactions shaping the wetland ecosystem and informs management and conservation strategies tailored to the specific needs of the region.

Map 1.1
Delineated Study Area



Kanjli wetland has many biological features i.e. flora and fauna, diverse kinds of food webs and food chains. Various species of birds, fish, and zooplankton inhabit this region. The catchment area is primarily used for agriculture due to the presence of alluvial soil. The water depth ranges from 10 to 25 feet, fluctuating with the seasons and water inflow. It reduces the number of floods, improves the water quality etc. About 26-hectare area of Kanjli is under species of native trees. It also has religious importance as Kali Bein that joins it, is associated with Shri Guru Nanak Dev Ji.

Earlier it was famous for picnic, boating and tourism. But with the time ii lost such significances due to decreased quality of water. The area under Kali Bein, its surrounding marshy area and area under forests are owned by the state government of Punjab. Whereas the surrounding area are under private sectors and being practised under agriculture. The Ministry of Environment & Forests, Government of India (MoEF, GOI), designated Kanjli wetland as one of the wetlands earmarked for protection. In 1987, a state-level committee was established to oversee the conservation efforts for this wetland. The Government of Punjab also initiated programs aimed at its development. (Times of India, 12 February 2019)

To resolve the problems related to this wetland many steps were taken i.e. weed control, Afforestation, Pollution Monitoring, public awareness etc. but still these steps are incomplete, though detailed research on the socio-economic impacts on the wetlands has not been done well.

1.3 Review of Literature

It has to be regrettably admitted that Indian geographers have made inadequate attempts to study in detail development around wetlands without any destruction to wetlands ecology. There has been conspicuous neglect of wetland ecology for the socio-cultural development around them. Many towns and cities were developed around wetlands as they considered otherwise these swampy lands will convert into a breeding ground of mosquitoes. The degradation of wetlands progresses through three main stages: first initiated by colonial settlements from 1600 to 1800, followed by expansions in agriculture from 1800 to 1900, and ultimately propelled by technological advancements and innovations (Kumar, 2019). Wetlands have social, economic, aesthetic, recreational, ecological and religious importance also. For

example, Kanjli wetland in Punjab is associated with Guru Nanak dev ji so it has religious importance along with the economic importance.

Study of Wetlands in the World and India

1.3.1 *Wetlands have been studied on Socio-economic basis and religious beliefs*:

Reimold *et al.* (1980) discussed thesocio-cultural values of wetlands. The study ensures wetlands are appreciated and protected by the general public as it is imperative that these areas are recognized for their values beyond purely economic ones. This paper develops a conceptual framework for assessing the educational, aesthetic, recreational, anthropological, and/or theological functions and values of wetlands. The significance of these considerations is evaluated, along with the long-term benefits that wetlands provide to humanity and the biosphere.

Barbier *etal.* (1997) discussed the wetlands services and functions, their degradation and valuation of their services. They also revealed the role of economic valuation of wetlands in decision making along with the discussion of the functions and services of wetlands. They suggest the ways to improve wetland management through proper economic valuation by giving step by step economic valuation techniques.

Turner *et al.* (1997) attributed that non proper evaluation of the wetland services caused loss of wetlands. People prefers their personal benefits in spite of social benefits economic choices are based on private valuation of cost and benefits and therefore may not reflect social costs and benefits. The cost of wetland degradation will be much larger for the society as compared to individual.

Novitzki*etal.*(1997) preferred on valuation of wetlands. They observed that whenever the study about development of wetland is done it is mostly done on the basis of choice between two wetlands rather than between upland and wetland.

Das *etal.* (2000) has made similar observations in the area of the study on non-coastal wetlands. The changes of wetlands are often justified on the basis of development grounds, but the later impacts of wetland degradation i.e. low water quality and loss of bio diversity nullify the benefits of such changes.

Jeena (2002) studied the economic as well as institutional factors affecting the use and the management of wetland resources in Cochin Backwaters of Kerala. The

study evaluated the value of Cochin backwater especially the impact of area reduction, depth and pollution. They are usually considered wastelands due the lack of proper knowledge of its real value. Market failure, lack of proper institutions i.e. property rights main reasons for its degradation. However, assignment of property rights is not a practical solution as the wetlands have many uses and are indivisible. The study found that 60 % of the fishermen did not possess government license which reveals that state regulation is not so effective.

Stuip*et al.* (2002) studied the case studies of the Socio-economic uses of different wetlands related to various developing countries and divided them into two categories use and non-use values. Use values consist direct use values i.e. food, transportation, agriculture, and indirect use values i.e. protection from floods, groundwater recharging etc. The non-use values associated with wetlands include biodiversity conservation, ecological preservation, and cultural heritage. Various stakeholders derive different benefits from these values due to the diverse range of wetland characteristics.

Gopikuttan*et al.* (2004) studied the conversion of paddy fields in Kerala, highlighting the irreversible transformation of fragile wetland ecosystems. This micro-level study, focusing on the Ullannor micro-watershed in Southern Kerala, found that private landowners benefit from these conversions, while social costs rise. The study revealed that the conversions are driven by the non-profitability of agriculture, high population density, demand for residential buildings and infrastructure, inadequate rule enforcement, and an aversion to manual labor. Major impacts include unemployment among farm and subsidiary workers, loss of low-cost food items, and water scarcity. The economic loss due to these conversions is substantial, and the study concludes that stakeholders lack awareness of the true value of wetlands.

Abraham (2004) evaluated the economic value of Kerala's coastal wetlands, specifically the Cochin wetland ecosystem, by assessing direct, indirect, use, and non-use benefits. The study highlighted the exploitation of these ecosystems by modern resource users, adversely affecting the livelihoods of traditional users, particularly fisherfolk. It examined the fish wealth and ecological services of the wetlands, as well as property rights and the rights of traditional fishermen. Using

market-based methods, travel cost methods, and contingent valuation methods, the study estimated the net value of traditional wetlands at Rs. 9479 lakhs, compared to Rs. 1721 lakhs for modern resource users.

Nonga*et al.* (2010) emphasized the significance of comprehending adjoining environment, land use systems, and potential threats to wetlands in assessing their socio-economic significance. The livelihoods of people residing near wetland areas largely depend on agricultural activities. Additionally, wetlands are utilized for grazing and tourism, leading to the construction of hotels in these areas. However, this development negatively impacts wetlands through the dumping of waste materials, excessive water usage for irrigation, and rapid urbanization.

Rajsekhar*et al.* (2012) highlighted the case study of Keshopur Chamb that how this wetland converted to the commercial area from an ecological area which is the place for some international migratory birds. Some parts of this wetland have been changed into fishing ponds which results into the destruction of ecology. The changes in the wetland cause heavy rain and improper drainage due to which paddy field could not be sown. Urbanization and industrialization are counted as other threats to these wetlands.

Verschuren (2014) revealed the religious and spiritual importance of wetlands. For example, the people of India, Nepal and Tibet worship Manasarovar Lake in the Himalayan region of Tibet. Because they believe that a person can get relieve from his sins by bathing and drinking of its water.

Mehta (2014) explained the historical evolutions of Keshopurwetlands,Punjab. It is the first reserve of the India to be declared under Wildlife Protection Act, 1972. This paper also discussed objective of management and steps to be taken along with the legal and administrative measures for its conservation.

Bhuyan (2016)aimed to investigate the impacts of Hnahilabeel on the socio-economic lives of the people, drawing on data from both primary and secondary sources. The study identified the need for improved management of Hnahilabeel for long-term effectiveness, emphasizing the necessity of participation and involvement of the local community. While Hnahilabeel has experienced a loss of biodiversity in both flora and fauna, the conservation of existing species can contribute to the preservation of associated ecological, economic, cultural, and social values.

O'Donnell *et al.* (2018) approached to the use of legal settlements to save water system by granting the legal rights to rivers. It plays great rolls for the development of environmental laws and water resource management. For this study three countries i.e. Australia, New-Zealand and India which provide legal rights for rivers. It reveals that how the laws legal right are being created and enforced. It also suggests that there should be legal body which should create legal rights and management for rivers.

Kumar (2019) studied the socio-economic and geographical aspects of three wetlands of Punjab i.e. Harrike, Ropar and Nangal. It concludes that non-commercial values of wetlands cause the neglect of wetlands by local people. So the attempts were made to understand more profits of these wetlands.

Ondiek (2020) illustrated the gradual transformation of wetlands in East Africa into agricultural land to address food security issues. Their research focuses on the conversion of wetlands in the Anyiko wetland of Kenya from 1966 to 2018, utilizing high-resolution panchromatic and color photographs. Additionally, they examine the socio-economic factors influencing changes in land use/cover in the Anyiko wetland. A decision tree approach is utilized to analyze the drivers of wetland conversion. The results revealed a 55% reduction in wetland area between 1966 and 2018, primarily attributed to agricultural expansion. Households were more inclined to cultivate the wetland if they did not utilize papyrus for artisanal products, were headed by males, and lacked alternative sources of income.

Leka-Oscar *et al.* (2023) explored the socio-economic effects of wetland conversion in Port Harcourt municipality, using data from primary and secondary sources. Four reclaimed wetland sites were selected, with 280 household heads from eight nearby communities participating. The findings revealed both positive and negative impacts: while wetland conversion provides essential land for development and urban services, it also destroys livelihoods, natural heritage, and conservation areas. The study advocates for sustainable wetland management and wise resource use to preserve the essential services wetlands provide to human environments.

Liu et al. (2023)examined the effects of China’s wetland conservation and restoration projects on ecosystem health in the Hengshui Lake Wetland Nature Reserve. The results showed that conservation and restoration efforts increased ecosystem health

by 34.6% over 19 years, offsetting the negative impacts of socio-economic development. While conservation efforts improved ecosystem health in most areas, population growth decreased it in residential and transportation regions, highlighting spatial heterogeneity. The study provided practical conservation strategies targeting areas with low health indices. These findings offer critical insights for managing large-scale wetland ecosystems undergoing degradation due to socio-economic activities.

Mulatu *et al.* (2023)assessed the socio-economic importance of wetlands in the East Harerghe zone, using data from 220 respondents. Analysis via SPSS version 20 and multiple regression revealed that annual incomes from Lake Langie and Lake Adele were 56,196.8 birr and 54,662.6 birr, respectively, influenced by land size and proximity to farmland. Respondents indicated that 53.2% of wetlands are highly degraded, with agricultural expansion, population pressure, and poor law enforcement as major causes. Most respondents are willing to engage in conservation efforts, particularly soil and water conservation and tree planting, to mitigate degradation.

Bhattacharjee *et al.* (2024) examined the wetlands of Assam, highlighting their critical role in local livelihoods and the management issues they face. By analyzing field surveys, remote sensing data, socio-economic assessments, and existing literature, the research reveals the wetlands' substantial economic contributions, particularly through fisheries and agriculture, and the potential of eco-tourism. The study calls for integrated management strategies that balance ecological conservation with socio-economic development, recommending community-based approaches, stronger policies, and increased awareness to ensure the wetlands' sustainable contribution to local economies and ecosystems.

Kundu *et al.* (2024) reviewed systematically 1,270 records and 350 studies from 1990 to 2023 shows annual wetland health declines of 0.02% to 3.14%, driven by urban expansion, agriculture, climate change, and pollution. Developing countries experience the most severe degradation, with negative correlations between wetland health and indicators such as the SDG Index, Environmental Performance Index, Income Classification, and Human Development Index. The study underscores the need for enhanced conservation strategies and integrated approaches to improve

socio-ecological conditions and achieve SDGs, urging policymakers to address the broader impacts of wetland health in their decisions.

Lamboni & Belem (2024) assessed the vulnerability of these wetlands by analyzing climatic data from 1970 to 2021 and mapping land use from 1987 to 2019 in the Oti plain, a Ramsar site. It identifies degradation factors and socio-economic impacts on local populations, revealing a substantial decline in natural land-use units over the past three decades. Climate fluctuations, including decreased rainfall and higher temperatures, along with human activities, have negatively affected the socio-economic status of the communities. Using the Participatory Analysis of Poverty and Livelihood Dynamics (PAPOLD), farmers were categorized into Poor, Moderately Well Off, and Well Off classes. These findings provide essential insights for sustainable, participatory wetland management in the Oti plain.

Mohanty *et al.* (2024)overviewed comprehensively the Ramsar sites globally, examining their significance and designation while integrating the use of Unmanned Aerial Vehicles (UAVs) for monitoring. It includes a comparative analysis of Ramsar site coverage worldwide and employs Scientometric analysis from Scopus, featuring maps and trends. The research emphasizes the connection between wetlands and several Sustainable Development Goals (SDGs), including SDGs 6, 12, 13, 14, and 15, by exploring relevant targets and indicators. It reviews policies and regulations supporting these SDGs and underscores the essential role of wetlands in advancing these global goals, providing valuable insights for future research and policy development.

Pandey & Bhart (2024) aimed to address research gaps by conducting a thorough analysis of Bihar's wetlands and exploring their social and environmental benefits. The study examines the challenges faced by these wetlands, stemming from human activities and environmental changes. Beyond the ecological perspective, this study delves into the socio-economic conditions of communities residing near these valuable wetlands. It critically evaluates their dependence on wetland resources and the repercussions of wetland degradation on their well-being. Furthermore, the research provides policy recommendations to promote the sustainability of wetlands.

1.3.2*Wetlands have been studied with environmental approach*:

Barbier (1994) highlighted that thevarious research indicates that tropical wetland systems could significantly contribute to economic development. The study offers an examination of these potential benefits, employing cost-benefit analysis as the primary method for evaluating the value of wetlands. By assessing the trade-offs between preserving or converting tropical wetlands, it is revealed that considering the opportunity cost of wetland loss results in less conversion. Furthermore, the paper explores the applicability and constraints of the production function approach in valuing nonmarketed wetland benefits.

Thomson K.T. (2004) observed the socio-economic issues aroused due to degradation of wetlands in the study of Cochin backwaters. The focus of the study was on the nature and causes of biodiversity loss found in Cochin backwaters. A multidisciplinary approach was adopted to identify the traditional as well as modern resource use pattern of Cochin backwaters along with its continuous stress on the ecosystem. The study has suggested market loss as the major cause of degradation of its biodiversity.

Singh D (2005) studied the threat to different wetlands of Punjab by finding their pollution level. Mostly the anthropogenic activities are the major reason for it. This study also finds various conservative measures.

Verhoeven *et al.* (2008) investigated the interconnection between wetlands and water quality on both regional and global scales. Their research emphasized how nutrient runoff from agricultural activities significantly degrades water quality in numerous stream catchments and river basins. Water resource managers worldwide are investigating the capacity of riparian zones and floodplain wetlands to enhance stream-water quality. Research indicates that wetlands play an effective role in removing nutrients from flowing water. Additionally, the study explored the water purification function of wetlands at both local and catchment levels and suggested strategies to address these challenges.

KSCSTE studied wetlands of Kerala and its findings were published in the State of the Environment Report (2007). It revealed the major issues of preservation and organisation of wetlands. It examined the status of three Ramsar sites and other major wetlands in Kerala. The study discussed the major management issues related

to wetlands i.e. pollution, encroachment, reclamation, mining and loss of biodiversity.

According to Kokkal*et al.* (2008) high population density of Kerala caused high pressure on its wetlands, which further leads to the major changes in environment of the wetlands of Kerala by changing its geological, physical, chemical and biological structure. The wetlands are decreasing due to improper construction of bunds, reclamation of wetlands due to many other purposes. Growth of real estate sector is another cause for wetland degradation.

Chatterjee *et al.* (2010) dealt with importance of wetlands that has been recognized in recent years i.e. hydrologic, to control floods, to purify water, aquatic productivity and microclimatic regulations. Wetlands also give shelter to fishes, birds and wildlife. This study has taken the Bir community of Keshopur wetland in district Gurdaspur, Punjab from January 2013- June 2014 this wetland is an important biodiversity corridor which permits movement of migratory birds.

Verhoeven & Setter (2010) examined the interplay between wetlands and agriculture to assess the effectiveness and challenges of agricultural practices across various wetland types. The study highlights that the intensive farming on drained or reclaimed peatlands has been linked to significant issues due to soil oxidation and subsidence. The development and adoption of crop varieties with enhanced flood tolerance could contribute to the sustainable utilization of floodplain systems. Leveraging wetlands for agriculture without extensive reclamation and minimizing fertilizer and pesticide use could potentially integrate food production with other wetland services while preserving biodiversity.

Kumar (2012) revealed the reason for change in wetland ecosystem. The changes in wetland have been estimated from 1991 to 2001 which results into the evaluation of decreasing income from the wetlands. In this study five states are included i.e. Gujarat, J&K, Kerala, Rajasthan and West Bengal the reason are change in forests coastal and cultivated land.

Rey *et al.* (2012) pointed out that although saltmarsh mosquitoes have not been linked to disease outbreaks in Florida's history, their high numbers have had a significant impact on the health of residents and visitors. Wetland management along Florida's coast has been ongoing since the 1920s, involving activities like ditching,

dredging, and filling. The study identified two organizations spearheading environmentally friendly mosquito control efforts through research, interagency cooperation, and public acquisition of coastal wetlands, facilitating the adoption of best management practices in these ecologically sensitive areas.

Singh *et al.* (2017) analysed physic-chemical parameters i.e. Water Quality Index, Heavy Pollution Index of Kanjli lake of Kapurthala district, Punjab. Water quality index of Kanjli wetland contained medium quality water. Heavy Pollution Index exceeds critical pollution index value 100 during monsoon season. This study suggests planned spatial, temporal and periodic monitoring of wetland using Water Quality index and Heavy Pollution Index.

Xu*et al.* (2019) reviewed the wetlands of international importance and found out that a majority of these sites, accounting for 55%, are impacted by three or four factors, with pollution, biological resource use, natural system modification, and agriculture and aquaculture being the most significant contributors. Land area and environmental quality are the primary objects affected across 75% and 69% of the sites, respectively. Notably, river and lake wetlands are most affected by land area occupation, while marine/coastal and river wetlands experience the greatest impact on the environment. Approximately one-third of wetland sites have undergone artificial reconstruction.

Nayak & Bhushan (2022)assessed long-term environmental trends for tropical wetlands, projecting their future until 2025. Many tropical nations lack the economic, scientific, and administrative capacity to address challenges posed by population growth and economic globalization sustainably. Most countries lack detailed wetland inventories and sustainable management plans within integrated watershed management frameworks. Despite regional variations, a continental ranking reveals South America, Africa, Australia, and Asia in decreasing order of wetland integrity, with Australia showing the most advanced efforts to mitigate human impacts. Policy deficiencies, inadequate planning, limited information, and institutional weaknesses are primary administrative causes of wetland degradation.

Mohibul*et al.* (2023) seek to examine the determinants impacting wetland well-being and their dynamics within the Kolkata Metropolitan Area (KMA) using the Driving Force-Pressure-State-Impact (DPSI) framework. Seventeen primary indicators, along

with four sub-indicators, were employed to gauge wetland health. Findings highlighted notable alterations in water, vegetation, and built-up categories within the condition assessment, with "healthy" emerging as the predominant classification, trailed by unhealthy and poor. Key contributors to declining wetland health encompassed population and road densities, per capita generation of water and solid wastes, along with various water quality parameters such as biological oxygen demand, dissolved oxygen, pH, and total coliform levels.

Shah *et al.* (2023) evaluated the performance of eight constructed wetlands near Beijing, China, regarding their provision of ecosystem services, cost savings associated with human health, operational costs, and adverse effects using an emergency-based assessment methodology. Findings indicate that all wetlands effectively treat wastewater, lowering nutrient levels such as total nitrogen, total phosphorus, and total suspended solids. Additionally, constructed wetlands provide advantages like flood control, groundwater replenishment, preservation of wildlife habitats, and carbon storage similar to natural wetlands.

Abdullah *et al.* (2024) examined the historical and future spatiotemporal dynamics of wetlands and LST trends in Dhaka. Findings reveal a 69% wetland loss and LST increase of 3.44°C to 9.35°C from 1990 to 2020. An environmental Kuznets curve analysis indicates that economic development has not yet fed back into environmental sustainability. Predictions show wetland losses of 74% under Business as Usual (BAU), 90% under development, and 66% under conservation scenarios by 2050. Restoring wetlands to their 1990s condition appeared highly challenging, underscoring the need for preservation efforts as a nature-based solution for sustainability and climate change mitigation.

Halder *et al.* (2024) examined the changing dynamics of the East Kolkata Wetlands over a span of three decades amidst rapid urbanization. The research reveals a 46% increase in urban development, resulting in reduced vegetation coverage and modifications to land surface conditions. Correlation analysis underscores a significant association between urbanization, climatic response, and environmental risk. Decadal ERA highlights a noticeable escalation in high-risk zones, indicating a deteriorating trend. Quantitative evaluations underscore the necessity for targeted

conservation efforts, underscoring the imperative of addressing environmental risks to protect the EKWT.

Kiruba-Sankar & Barman (2024) reviewed the potential of citizen science for sustainable management and advocates for its broader adoption to preserve the coastal wetlands of Andaman and Nicobar Islands (ANI). These wetlands face threats from human activities, development, and natural hazards, leading to significant area loss and ecosystem service disruption. Effective management is hindered by the vast and scattered geography of the islands, necessitating innovative approaches.

Msaki& Kessy (2024) examined the evidence and economic contributions to wetland degradation in the Ruvu riverine wetland area of Kibaha and Morogoro rural districts in coastal Tanzania. The study concluded that anthropogenic activities, compounded by low awareness of wetland values, lead to significant degradation with serious economic costs to local communities and the government. It recommends introducing alternative income-generating activities with minimal environmental impact to prevent further wetland degradation.

Nzvere*et al.* (2024) examined the impact of human activities on urban development and wetland degradation in Harare and Chitungwiza, Zimbabwe. The study investigates the influence of urban development on environmental sustainability through qualitative interviews with 30 households. Findings reveal reasons for residence, farming, and waste disposal in wetlands, highlighting residents' limited environmental awareness and policy gaps. The study concludes that prioritizing immediate needs like food and shelter often overlooks environmental consequences, jeopardizing individual health and wetland services.

Pishdad*et al.* (2024)enhanced understanding of anthropogenic and urbanization impacts on The Zeribar wetland in Marivan, western Iran, using a Bayesian belief network (BBN) approach, integrating factors such as human-induced influences, economic conditions, policy context, and socio-cultural issues. The BBN model, built from literature, interviews, observations, simulations, and expert input, was validated through stakeholder workshops. Results show that policy and economic factors are key to wetland management, with fourteen alternative scenarios revealing that comprehensive improvements can significantly enhance management effectiveness. This research provides a valuable tool for decision-makers to manage

the wetland sustainably, addressing socio-economic and anthropogenic dynamics comprehensively.

1.3.3*Wetlands have been studied with the use of Mapping techniques*:

Manju *et al.* (2005) conducted a study to map the wetlands in the east Champaran district of Bihar, India, utilizing IRS ID LISS III data. Analysis of pre and post-monsoon season data was undertaken, and wetlands were qualitatively characterized based on turbidity and aquatic vegetation status. The findings reveal that inland wetlands make up 2.7% of the surveyed area, of which 1.8% are subject to waterlogging. The research emphasizes the effectiveness of remotely acquired data for mapping, monitoring seasonal variations, and characterizing wetlands.

Murphy *et al.* (2007) utilized GIS to compare two provincial wetland maps concerning their spatial agreement across different ecoregions in New Brunswick. The first map comprised discrete wetland units derived from aerial photo interpretation, while the second map included wet areas delineated using a newly developed depth-to-water index. The continuous model identified a greater area of wetlands, including riparian zones and numerous small wetlands that were not captured by aerial photo interpretation. Unlike the discrete map, the continuous model illustrated the hydrological connectivity of wetlands across the landscape.

Panigrahy*et al.* (2012) discusses the results of a nationwide wetland inventory conducted using Indian Resourcesat-1 having sensor LISS-III data from 2006-07. They utilized a hierarchical classification system based on Ramsar definitions, comprising 19 classes to categorize wetlands across India. The study offers detailed findings at the state level and analyzes the status of surface water , aquatic flora, and water turbidity in wetlands during both seasons.

Rajsekhar D. *et al.* (2012) assesses the loss due to sewage- irrigated soils in relation to transfer of trace elements to rice and wheat grains. For it some sample of sewage effluent, groundwater, soil and plants were collected and GPS coordinates of selected area were taken. The study reveals that amount of toxic elements are more than limit in this water.

Mitra *et.al.* (2014) the impact of Assam's southern railroad on wetland and Beel ecosystem. This railroad bisected the wetland into two subsystem which result into

the segregation of forest ecosystem of this wetland. These forests are house of Asiatic elephants with other birds and animals. Due to segregation of wetland habitats of elephants and many other wild creatures has been disappeared and they died due to the collision with traffic. GIS and HIS modeling were used to reveal this study.

Kumar D. *et al.* (2014) study the geospatial analysis of long-term morphological changes in Coachin estuary of SW coast of India. Geospatial information has been collected since 1967 to evaluate the changes. Topographic sheets of 1967 and satellite imageries of 2004 - 2011 were also interpreted. It was found that width of inner island segment and estuary is decreasing. It will affect the dynamic process of estuaries

Blankespoor Brian *et al.* (2014) reveals the spatio-temporal changes in the wetland of Great Rann of Kachchh, India various GIS techniques were used for overlaying and post- classification comparisons. Land Sat (1977,1990 and 1999) and RSP6 (2006,2008-2012) were used to get satellite time-series data. Normalized Difference Water Index was evaluated year to year. The study found that the water spread generally increases during September. This study also found the manmade threats due to the expansions of salt pans and biological invasion of specific birds.

Garg (2015)critically examines the efforts in India regarding wetland conservation and management employing geospatial techniques. In India, remote sensing data from orbital platforms have been extensively utilized for wetland inventory, monitoring, and conservation planning. The first scientific inventory of wetlands was conducted in 1998 by the Space Applications Centre (ISRO), Ahmedabad, using indigenous IRS data from 1992–93.

Reddy C. S. *et al.* (2016) reviews the paper focusing high altitude wetlands. It reveals that water towers found at the highlands of Himalaya are more sensitive to climatic change. Due to vast areas, they have great importance from environmental, ecological and sociological. They are affected by east and SW Asian monsoons during summer and westerly monsoon during winter WWF suggested to start many programs for the conservation of wetland with regional collaboration. GIS techniques were used in it.

Kaplan &Avdan (2017) investigate the potential of Sentinel-2 for mapping and monitoring wetlands. The proposed method suggests using object-based classification to delineate wetland boundaries and Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) for classifying contents within these boundaries.

Panigrahy (2017) outlines the methodology, along with the advantages and limitations of remote sensing technology in wetland mapping. By leveraging spectral indices such as NDWI, MNDWI, NDVI, and NDPI, a methodology was developed for wetland mapping, enabling delineation of wetland boundaries and characterization of structural components like water extent, aquatic vegetation, and turbidity. The approach also facilitated qualitative assessment of water quality. The methodology was applied nationwide at a scale of 1:50,000 using LISS III imagery.

Singh N *et al.* (2017) explains the impact of one meter rise in the sea level of coastal wetlands in 86 developing countries. About 68 % coastal wetland of all of these countries are at risky level.it used GIS to show the area of wetlands and coastlines of these countries were taken from world vector shore line at a scale of 1:250000. It was found that loss of coastal wetlands exceeded $703 million per year. The study suggests further research on the potential impact of sea level rise by the individual.

Singh(2017) monitored changes in the water quality of Kanjli wetland, Punjab for it seven sub-parts of Kanjli wetland were selected. It is suggested that the quality of water is being decreased by time due to domestic, industrial waste etc.

Sinha*et al.* (2017) distinguishes riverine wetlands from other floodplain water bodies like waterlogged areas, a mapping and classification system was developed and applied to the wetlands in Begusarai district, located in the north Bihar plains of India. The proposed hydro-geomorphic classification system is hierarchical, simple, and robust, facilitating quick processing of satellite images with minimal additional resources.

Muthusankar*et al.* (2018) dealt with the impact of industrialization and urbanization in coastal area of Coro Mandal coast which results into uninhabitable wetlands.it also increase the coastal erosion and adverse climatic events. With the help of GIS software transformation were marked at fines cales for a specific time interval. It

demonstrates that ocean-climatic changes become more severe during North East Monsoon season.

Berhanu *et al.* (2023)examined the application of Landsat TM and OLI imagery alongside SRTM DEM for wetland mapping, achieving an accuracy of 86.66%. The study indicated an annual reduction of 21,400 hectares, resulting in notable disparities in water quality and groundwater levels between degraded and non-degraded regions. Given that many rivers in the watershed originate from wetlands, their existence is closely tied to hydrological functions. Wetland degradation is primarily driven by climate change and agricultural practices. The geospatial techniques used in this study effectively simplify and enhance wetland monitoring and visualization.

Demarquet*et al.* (2023) reviewed 351 articles and revealed that the Landsat archive effectively tracks global changes in wetland areas, structures, and functions; advancements in AI and machine learning enhance data analysis; many unexplored wetlands can be studied using this archive; and new cloud-computing tools enable large-scale processing of dense time-series data. Future research should focus on using AI and cloud computing to study changes in wetland functions.

Mohseni *et al.* (2023)produced a wetland map of the GL using Sentinel-1/2 datasets on the Google Earth Engine (GEE) cloud computing platform. An object-based supervised machine learning (ML) classification workflow with two main steps was employed. Initially, non-wetland classes like Barren, Cropland, and Open Water were identified and masked using a trained Random Forest (RF) model. Subsequently, wetland classes (Fen, Bog, Swamp, Marsh) and non-wetland classes (Forest, Grassland/Shrubland) were classified. The method achieved an overall accuracy of 93.6% and a Kappa coefficient of 0.90 for GL classification. Wetland classes were classified with 87% accuracy and a Kappa coefficient of 0.91, while non-wetland classes showed higher accuracy (96.62% overall and a Kappa coefficient of 0.95).

Maddheshiya*et al.* (2024) seeks to identify, outline, and reconstruct hydro-geomorphological characteristics within the Ganga and Sai Rivers' interfluve, examining their association with the extant Bakulahi River. Utilizing remote sensing data, the study concludes that these hydrogeomorphological features were once part of the Bakulahi River, and merging with the Sai River at Khajurni village in

Pratapgarh district. Shifts in river dynamics over time, likely influenced by factors such as changes in energy levels, sediment accumulation, deforestation, and neo-tectonics, resulted in the Bakulahi River's discontinuity.

Mahapatra *et al.* (2024) sought to evaluate the influence of urbanization on wetlands in Gautam Buddh Nagar and its environs. Temporal scrutiny unveiled a 16.36% decline in wetlands exceeding 10 hectares since 2010 in the Gautam Buddha Nagar district. Land-Use/Land-Cover (LULC) analysis highlighted notable urbanization effects on 5 out of the 8 sites, showcasing wetland contraction and alterations in land use within their drainage basins.

van Tol (2024)utilized advanced Digital Soil Mapping (DSM) techniques and remote sensing to map and assess wetland coverage and degradation in northern Maloti Drakensberg, achieving high accuracy rates of 96% for training and 92% for validation, with Kappa statistics of 0.91 and 0.83. Significant positive correlations were found between terrain wetness index (TWI), valley depth (VD), and wetland coverage, while gully density analysis highlighted terrain attributes as primary drivers of degradation, challenging traditional views that primarily blame external forces. The resulting sensitivity map could inform Integrated Catchment Management (ICM) projects and facilitate tailored conservation strategies. Future research should expand to other highland areas, incorporate additional covariates, and categorize wetlands by hydroperiod and degradation sensitivity. This study demonstrates the potential of DSM and remote sensing for accurately assessing and managing wetland ecosystems, essential for sustainable resource management in alpine regions.

1.4 Research Gap

1. Lack of research findings in the wetland regions especially Kanjli.
2. In Kanjli wetland no study covers the proper temporal changes of land uses in Kanjli by using proper mapping and identification of the part of wetland area which is now being used for other purposes i.e, settlements, agriculture, various infrastructures.
3. There is a lack of comprehensive ecological impact assessments to understand the consequences of human activities, such as agricultural runoff, urbanization, and

industrialization, on the biodiversity, water quality, and overall health of the wetland ecosystem.

4. There is a dearth of studies that involve local communities and stakeholders in the research process, such as traditional knowledge holders, government agencies, NGOs, and local residents, whose insights and perspectives are essential for developing sustainable management strategies.

5. There has been limited focus on examining the current policies, laws, and governance frameworks related to Kanjli Wetland. Research in this area can help identify gaps in policy implementation and recommend policy reforms for better protection of the wetland.

.1.5 Research Questions

- How do the changes in land use affect the areas of Kanjli?
- What are the adverse impacts of development activities on the degradation of the wetland area?
- What are the socio-economic effects of decrease in the area of Kanjli wetland?
- What are the measures adopted to minimize the environment related problem in the Kanjli wetland?

1.6 Objectives of the Study

- To examine the changing land use of Kanjli wetland from 1990 to 2022.
- To study the impact of development activities on the Kanjli wetland.
- To assess how the degradation of the Kanjli wetland area affects the livelihoods of local communities.
- To examine the conservation policies and to propose recommendation for preservation and management of wetland.

1.7 Methodology

The methodology employed in the present research integrates both primary and secondary sources of data to comprehensively evaluate the study area spatially and temporally. Under primary data collection through field observation, interview (Questionnaire method), satellite images, Messabi maps and Jamabandi of villages from village Patwaris and Secondary data collection from Punjab State Council for

Science and Technology, department of water resources Punjab, is included. The agriculture development, tourism and infrastructure are studied as main indicators of development in selected villages. The details are as following:

Firstly, the area of Kanjli wetland to be studied is delineated:

Punjab is selected for the study of wetlands at meso level, Doaba region is mostly developed region in Punjab. It has negative and positive impacts on wetlands also. At micro level Kanjli wetland is selected for study. Surrounding areas of Kanjli is also facing various type of development i.e. construction of roads and railways, agricultural activities.

The spatial aspect of the study tries to include all the facets playing in the surroundings of the Kanjli wetland. For delineating the study area, Messabis, Topographical maps and Survey of India maps are studied. Based on this, the area is delineated. As mentioned earlier a 3-km buffer zone is selected to mark the spatial extent of the area; it includes Kapurthala city and 37 villages. For an effective temporal aspect, the study focuses on the period of 32 years i.e. from 1990-2022. The start year is being selected in view of liberalisation of markets in India which brough massive changes on its physical landscape. The temporal aspect roughly focuses on an interval of a decade to thoroughly understand the changes of land use. The availability if the satellite images impact the one-year variation in under 1990-1999. And for the last decade, just to capture the recent scenario of the study area the last year was shifted from 2020 to 2022. Therefore, the study includes into three periods:

1. From 1990-1999
2. From 1999-2010
3. From 2010-2022

Secondly, after the collection of spatial data related to the study area, the land use is classified:

It includes the image processing of the procured satellite images. The study area shapefile has then been used to determine the satellite images of 1991 and 2022. The clipped area of the satellite images was subjected to Maximum Likelihood Supervised Classification Method under ArcGIS software. The six-land use and land cover classes have been classified; these are: Built-up, Cropland, Fallow land, Mixed

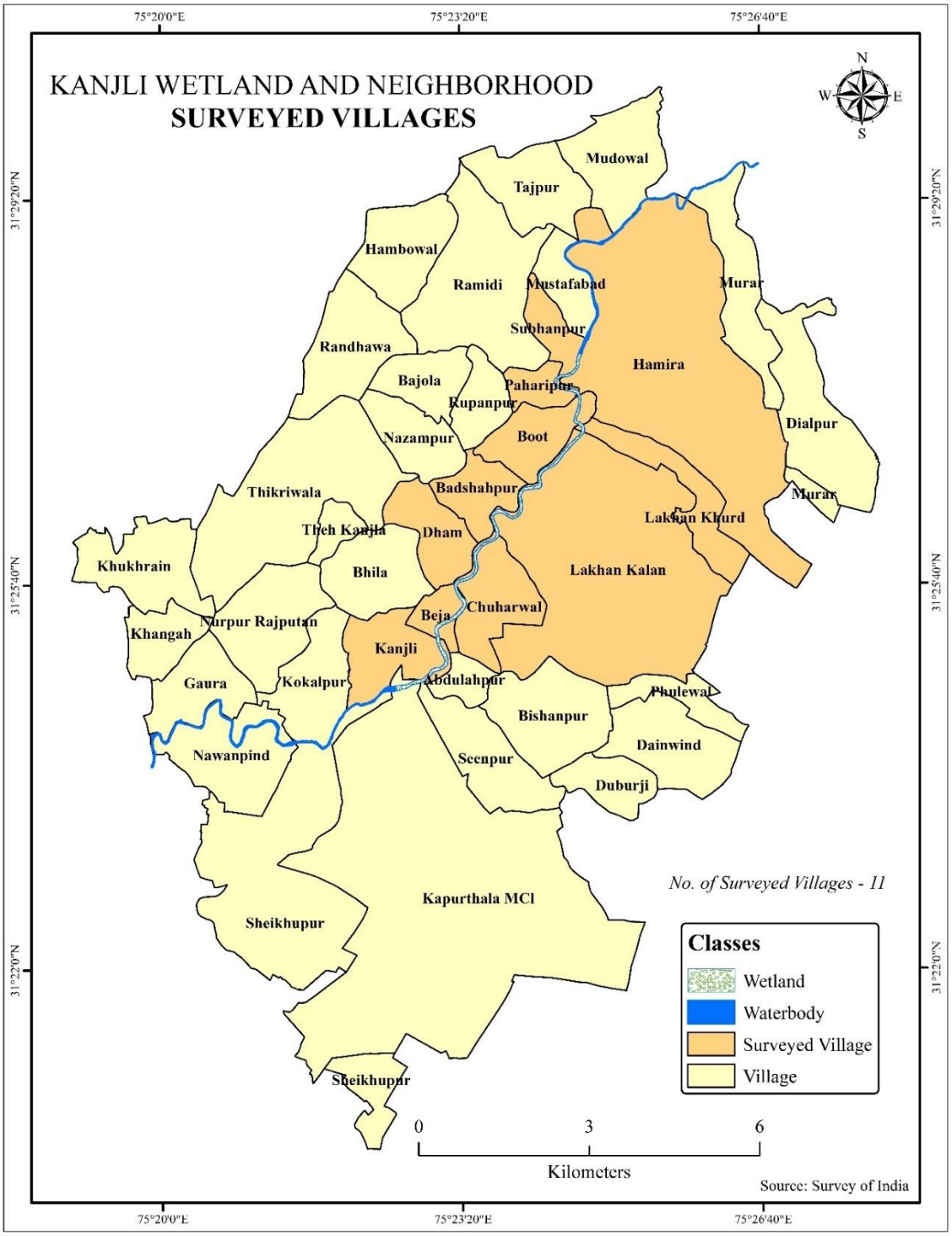
Land use, Vegetation and Waterbody. The classification of these classeshas been subjected with the field data as well as information about land use from the Messabi maps and Jamabandi of villages. It is followed by the accuracy assessment of the 2022 satellite classified image. The analysis comprises the area composition of the classes, area change and transformation between the classes. It is followed by assessing drivers, natural and anthropological, of land use change.

Thirdly, field-based evaluations on the impacts of development activities on Kanjli wetland, impact of degradation on Native peoples' Livelihood of Kanjli wetland and preservation and management of Kanjli wetland is followed, further:

The assessment of the impact of land use changes, any degradation and changes in the livelihood of the villagers has been studied through field-visits to the study area. For the propose of field visit 11 villages making the periphery of the Kanjli wetland or Kali Bein embankments are selected; these are Badshahpur, Beja, Boot, Chuharwal, Dham, Hamira, Kanjli, Lakhan Kalan, Lakhan Khurd, Paharipur, and Subhanpur. Map 1.2 shows all the surveyed villages of in the study area. The sample size was selected at 10 percent (411 households) of the total households. The data is collected based on the prepared questionnaire (Annexure 1.1). The collected data was analyzed in the SPSS. The hypothesis was also designed for the study and tested to validate the results. The collected data related to agriculture, infrastructure and tourism and other facets related to land use change in the area.

In the last, the conservation and management efforts have been assessed and recorded, followed by concluding remarks and recommendations on the present state of affair prevailing in the study area.

Map 1.2
Surveyed Villages in the Study Area



The selection of these 11 villages for the field survey is based on the following rationale:

- These villages are located in the upstream area of the Kanjli Wetland, making them significant for understanding the influence on the wetland's hydrology.

- The selected villages encompass the demarcated area of the Kanjli Wetland as designated by the Ramsar Convention, ensuring the inclusion of relevant stakeholders and geographic areas.
- Preliminary pilot surveys indicated that villages adjacent to the Kali Bein River have a direct impact on the waterbody, highlighting their importance in the study.
- These villages utilize water from the Kali Bein River for irrigation, emphasizing the interconnectedness between agricultural practices and wetland health.
- Villagers situated further from the Kanjli Wetland displayed limited concern for its benefits and consequences, likely due to their lesser dependence on the wetland. Consequently, they were less inclined to participate in the survey, further justifying the focus on the closer, more impacted villages.

This selection strategy ensures a comprehensive understanding of the local interactions and dependencies affecting the Kanjli Wetland.

1.8 Significance of the Study

The research on Kanjli Wetland holds significant importance for several reasons:

- *Environmental Conservation*: Understanding the dynamics of land use and land cover change in the vicinity of Kanjli Wetland is crucial for environmental conservation efforts. By identifying patterns and drivers of land use change, the study can inform strategies for preserving and protecting the wetland ecosystem and its biodiversity.
- *Sustainable Development*: The research provides insights into the impacts of development activities on Kanjli Wetland and surrounding areas. By assessing the effects of agriculture development, tourism, and infrastructure projects, the study can contribute to the formulation of sustainable development policies that balance economic growth with environmental preservation.
- *Community Livelihoods*: Examining the impacts of land use change on the livelihoods of local communities living around Kanjli Wetland is vital. The study can shed light on how changes in land use patterns affect agriculture, employment opportunities, and overall quality of life for residents in the area.

- *Policy Formulation*: The findings of the research can serve as valuable inputs for policymakers and government agencies involved in land use planning and natural resource management. Recommendations based on the study's outcomes can help guide policy decisions aimed at mitigating negative impacts on the environment while promoting sustainable development practices.
- *Scientific Knowledge*: The research contributes to the body of scientific knowledge on wetland ecosystems, land use dynamics, and their interplay with human activities. By analyzing data over a 32-year period, the study adds to our understanding of long-term trends in land use change and the factors driving these changes.

Overall, the research on Kanjli Wetland has significant implications for environmental sustainability, community well-being, and policy formulation at the local, regional, and national levels.

1.9 Limitations of the Study

- The present study focuses on Kanjli Wetland in Punjab. Wetlands are diverse ecosystems and the impact of development activities can vary significantly based on local conditions. Therefore, the findings and conclusions drawn may not be easily generalizable to other wetlands in different regions.
- This study primarily focuses on a decadal analysis of land use and land cover in Kanjli Wetland, which might overlook smaller-scale variations or events that occurred within each decade. A more frequent and detailed analysis could provide a more nuanced understanding of the changes.
- The study of land use and land cover change often requires an interdisciplinary approach from different fields. But present study lacks collaboration with experts from relevant fields such as ecology, sociology or hydrology, it might miss critical dimensions of the issue.
- The study might have a specific time frame for data collection and analysis. This limitation could affect the ability to capture long-term trends and changes in the wetland. Development impacts may evolve over time and a snapshot might not fully represent the dynamic nature of environmental changes.
- The present research is retrospective, focusing on historical changes. A more forward-looking approach, considering potential future trends and threats to Kanjli

Wetland, could enhance the relevance and applicability of the findings for conservation and management strategies.

- While the study touches upon various dimensions of the impact (food security, water availability, income generation and cultural identity), there might be other relevant variables not explored in depth. For example, the study might not extensively cover the psychological and social impacts of wetland degradation on local communities.
- This study primarily relies on the perspectives of local households. However, it might be helpful to include viewpoints and suggestions from other parties like - governmental and non-governmental bodies industries that cause wetland degradation. A diverse and comprehensive view could help in developing well-versed conservation strategies.
- Although the research mentions government initiatives, it doesn't go into great detail about the difficulties of putting these ideas into action. Successful wetland conservation depends on an understanding of the gaps that exist between the creation of policies and their efficient application.
- The study briefly touches upon the importance of wetlands in the context of climate change but does not deeply explore the potential impacts of climate change on Kanjli Wetland. Understanding these impacts is vital for formulating adaptive conservation strategies.
- While the study mentions community-level initiatives, it may not delve deep into the effectiveness or challenges associated with community involvement in wetland conservation. Understanding community dynamics and the success of such initiatives could provide valuable insights.

1.10 Scheme of the Chapters

The current work is divided into following chapters:

Chapter 1: Introduction

This chapter provides an overview of the research study on Kanjli Wetland. It introduces the significance of wetlands as vital ecosystems and highlights the importance of studying Kanjli Wetland specifically. The chapter outlines the research objectives, scope, and methodology employed in the study. Additionally, it provides

background information on the geographical location, ecological importance, and socio-economic context of Kanjli Wetland.

Chapter 2: Land Use of Kanjli Wetland

Chapter 2 delves into the detailed analysis of the land use patterns and dynamics within the Kanjli Wetland and its surrounding areas. It examines the historical evolution of land use, identifies key land cover classes, and analyzes trends in land use change over time. The chapter employs satellite imagery, GIS mapping, and classification techniques to delineate and assess various land use categories such as built-up areas, croplands, vegetation, water bodies, and mixed land use.

Chapter 3: Impacts of Development Activities on Kanjli Wetland

This chapter investigates the effects of various development activities, including agriculture, tourism, and infrastructure projects, on the ecological integrity of Kanjli Wetland. It examines how these activities contribute to habitat loss, fragmentation, pollution, and degradation of the wetland ecosystem. The chapter also explores the socio-economic implications of development interventions on local communities and biodiversity conservation efforts.

Chapter 4: Impact of Degradation on Native Peoples' Livelihood of Kanjli Wetland

Chapter 4 focuses on assessing the impact of wetland degradation and environmental changes on the livelihoods of indigenous communities living around Kanjli Wetland. It examines how alterations in land use patterns, water availability, and ecosystem services affect traditional livelihood practices such as fishing, agriculture, and handicrafts. The chapter also explores the resilience strategies adopted by local communities to cope with environmental changes and socio-economic challenges.

Chapter 5: Conservation and Management of Kanjli Wetland

This chapter discusses strategies and approaches for the conservation, restoration, and sustainable management of Kanjli Wetland. It explores potential conservation measures, policy interventions, and community-based initiatives aimed at preserving the ecological integrity and cultural heritage of the wetland ecosystem. The chapter also highlights the importance of stakeholder engagement, institutional coordination,

and adaptive management practices in ensuring the long-term sustainability of Kanjli Wetland.

Chapter 6: Summary of Conclusions and Suggestions

Chapter 6 provides a comprehensive summary of the key findings, conclusions, and recommendations derived from the research study on Kanjli Wetland. It synthesizes the main insights and implications discussed in the preceding chapters and offers suggestions for future research directions, policy interventions, and community-based conservation initiatives aimed at addressing the challenges and opportunities associated with Kanjli Wetland management.

CHAPTER – 2
LAND USE OF KANJLI WETLAND

Land use, a fundamental aspect of human-environment interactions, has undergone significant transformations globally, shaping landscapes and ecosystems. The utilization and allocation of land for various purposes, including agriculture, urbanization, forestry, and conservation, profoundly influence socio-economic development and environmental sustainability (Lambin &Meyfroidt, 2011). Land use decisions are complex and multifaceted, influenced by a multitude of factors ranging from policy frameworks to cultural practices and technological advancements.

The dynamic nature of land use has garnered widespread attention in academic, policy, and societal realms due to its implications for resource management, biodiversity conservation, climate change, and human well-being (Foley et al., 2005; Verburg et al., 2013). Understanding the patterns, drivers, and impacts of land use changes is pivotal for devising effective strategies to balance competing demands on land while safeguarding ecological integrity and supporting sustainable development goals (Turner et al., 2007).

Over the past decades, research in land use has evolved, employing interdisciplinary approaches that integrate geography, ecology, economics, sociology, and remote sensing technologies. Studies have delved into diverse facets of land use dynamics, encompassing land cover changes, spatial patterns, drivers of change, socio-economic implications, and the efficacy of land management policies (Lambin et al., 2003; Geist & Lambin, 2002).

Wetlands, as diverse and productive ecosystems, play anessential role in providing a range of ecological services, including biodiversity conservation, water purification, flood control, and carbon sequestration (Mitsch & Gosselink, 2015; Millennium Ecosystem Assessment, 2005). However, these dynamic landscapes are increasingly susceptible to changes induced by human activities, particularly alterations in land use practices, which significantly impact their structure, functions, and sustainability (Davidson, 2014; Zedler & Kercher, 2005).

The relationship between wetlands and changing land use patterns has garnered considerable attention due to its profound implications for ecosystem health and

human well-being (Davidson, 2014; Mitsch & Gosselink, 2007). Anthropogenic drivers such as urbanization, agriculture expansion, infrastructure development, and industrial activities have led to substantial alterations in wetland ecosystems worldwide (Zedler & Kercher, 2005; Mitsch et al., 2001).

Understanding the intricate dynamics and consequences of changing land use on wetlands is imperative for effective conservation and sustainable management practices (Zedler & Kercher, 2005). The present chapter aims to examine the changing land use of Kanjli wetland from 1990 to 2022.

2.1 Methodology

The methodology employed in this study offers a comprehensive framework for assessing land use change dynamics in the vicinity of the Kanjli Wetland over 32 years. Beginning with data acquisition, Landsat satellite images from 1990, 1999, 2010, and 2022 are procured from the USGS website, ensuring data integrity and minimal cloud cover. All the images are of the March month, pre-monsoon, before the crop harvesting period begins in the region. The delineated study area, focusing specifically on the surroundings of the Kanjli Wetland, was used to clip the images with the help of the geospatial software ArcGIS. The acquired images were then preprocessed in ERDAS software to rectify radiometric distortions, enhancing their suitability for analysis. Following preprocessing, the images were subjected to supervised classification using the maximum likelihood classification algorithm, allowing for the delineation of six land use and land cover classes (Built-up, Cropland, Fallow land, Mixed Land use, Vegetation, and Waterbody) based on spectral signatures and known characteristics.

An accuracy assessment is conducted on the classified image for 2022, employing ground truth data to validate the classification results and quantify classification accuracy metrics.The overall accuracy of the image came to about 89 percent, and kappa statistics for the same was 0.80. The cropland class, having maximum coverage, has the producer's and user's accuracy above 85 percent, followed by built-up above 90 percent (producer's) and 75 percent as the user's accuracy. Post-classification land use maps are generated for each year, enabling the visualization of land cover distribution and extent over time. Pairwise comparisons between selected consecutive years facilitated the quantification of land use changes, with proportional

area calculations providing insights into trends and patterns of change across the study period. Statistical analysis, especially transformation matrix and spatial visualization techniques, were employed to interpret the results, highlighting significant trends and drivers of land use change near the Kanjli Wetland.

Lastly, the implications of observed land use changes are analyzed, and recommendations are proposed to support the conservation and sustainable utilization of the wetland area, underscoring the study's contributions to ecological and socio-economic understanding and management of the Kanjli Wetland ecosystem.The study's findings will shed light on the evolving land use dynamics in the Kanjli Wetland vicinity, emphasizing the importance of informed land use planning and management strategies. The following analysis and discussion is divided into three sections. Section 1 includes the Land use land cover of each selected year; section 2 highlights the land use land cover change decade-wise in the start and overall change in the end; and section 3 elucidates the factors responsible for land use land cover changes and their subsequent consequences.

Section – I

LAND USE LAND COVER OF KANJLI WETLAND

The land use land cover of Kanjli wetland has been evaluated for four decades sequentially. It helped to assess the positive and negative changes in the selected class.

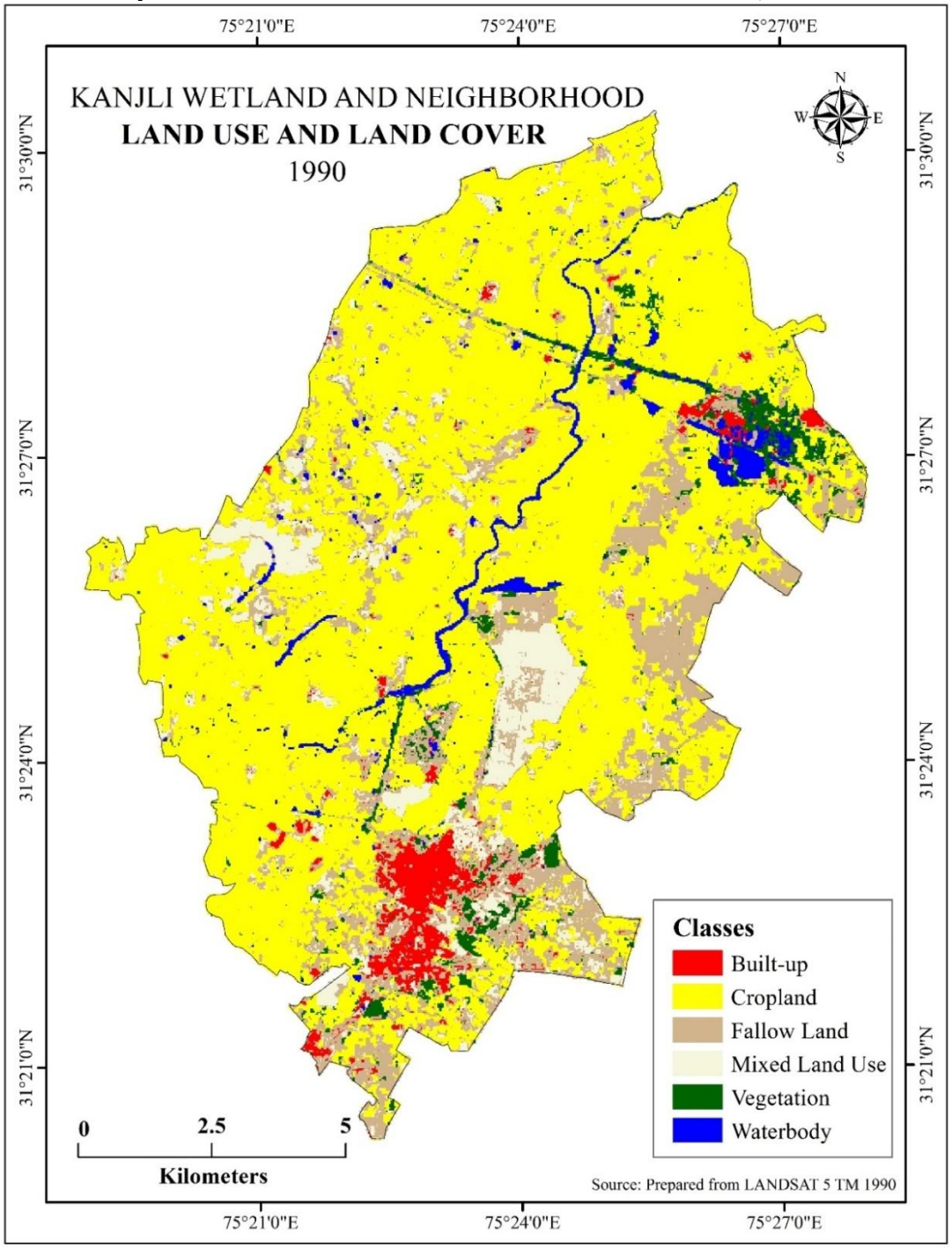
2.2 Land use land cover in Kanjli wetland in 1990

The supervised classification of the study area image of 1990 highlights the coverage of selected classes. Map 2.1 shows the spatial expansion of these classes, and Table 2.1 specifies the total area covered by these classes in the study area. The description of each category is as follows:

Table 2.1
Proportion of Land Use Land Cover Classes, 1990

CLASS	AREA (km^2)
Built-up	4.14
Cropland	86.25
Fallow Land	24.26
Mixed Land Use	10.85
Vegetation	6.49
Waterbody	1.57
TOTAL	**133.56**

Map 2.1
Spatial Distribution of Land Use Land Cover Classes, 1990



Cropland (86.25 sq. km): Cropland is the predominant land use within the Kanjli Wetland area. This category represents extensive agricultural activities typical of the Punjab Plains, characterized by the cultivation of crops, mainly wheat. The fertile soils and irrigation systems support large-scale agricultural production, making cropland the most dominant land use, covering a substantial area of 86.25 square kilometers.

Fallow Land (24.26 sq. km): Fallow Land is the second-largest land use category within the Kanjli Wetland. This area represents agricultural fields temporarily left uncultivated during specific periods or seasons. It could be part of crop rotation practices or due to factors like soil fertility management. Farmers in the Punjab Plains often practice fallowing to rejuvenate soil nutrients or manage water resources effectively.

Mixed Land Use (10.85 sq. km): Mixed Land Use encompasses areas showing a blend of various land uses, typical to the transition zones within the Punjab Plains. This category includes a combination of residential, commercial, and potentially industrial areas within the wetland vicinity, indicating human settlements or small-scale urbanization adjacent to agricultural zones.

Built-up (4.14 sq. km): The Built-up category denotes areas characterized by human infrastructure, including residential, commercial, and institutional structures. These areas are relatively small in the context of the Kanjli Wetland but represent localized human settlements, roads, and associated infrastructure.

Vegetation (6.49 sq. km): The Vegetation class comprises natural vegetative cover within the wetland area. While smaller than croplands, this category represents patches of forests, woodlands, and shrublands that are vital in maintaining ecological balance and providing habitat for various species within the wetland ecosystem.

Waterbody (1.57 sq. km): Waterbody represents natural aquatic features such as rivers, lakes, and ponds within the Kanjli Wetland area. Though relatively small in coverage, these water bodies are essential for biodiversity, irrigation, and maintaining the hydrological balance of the wetland ecosystem.

2.3 Land use land cover in Kanjli Wetland in 1999

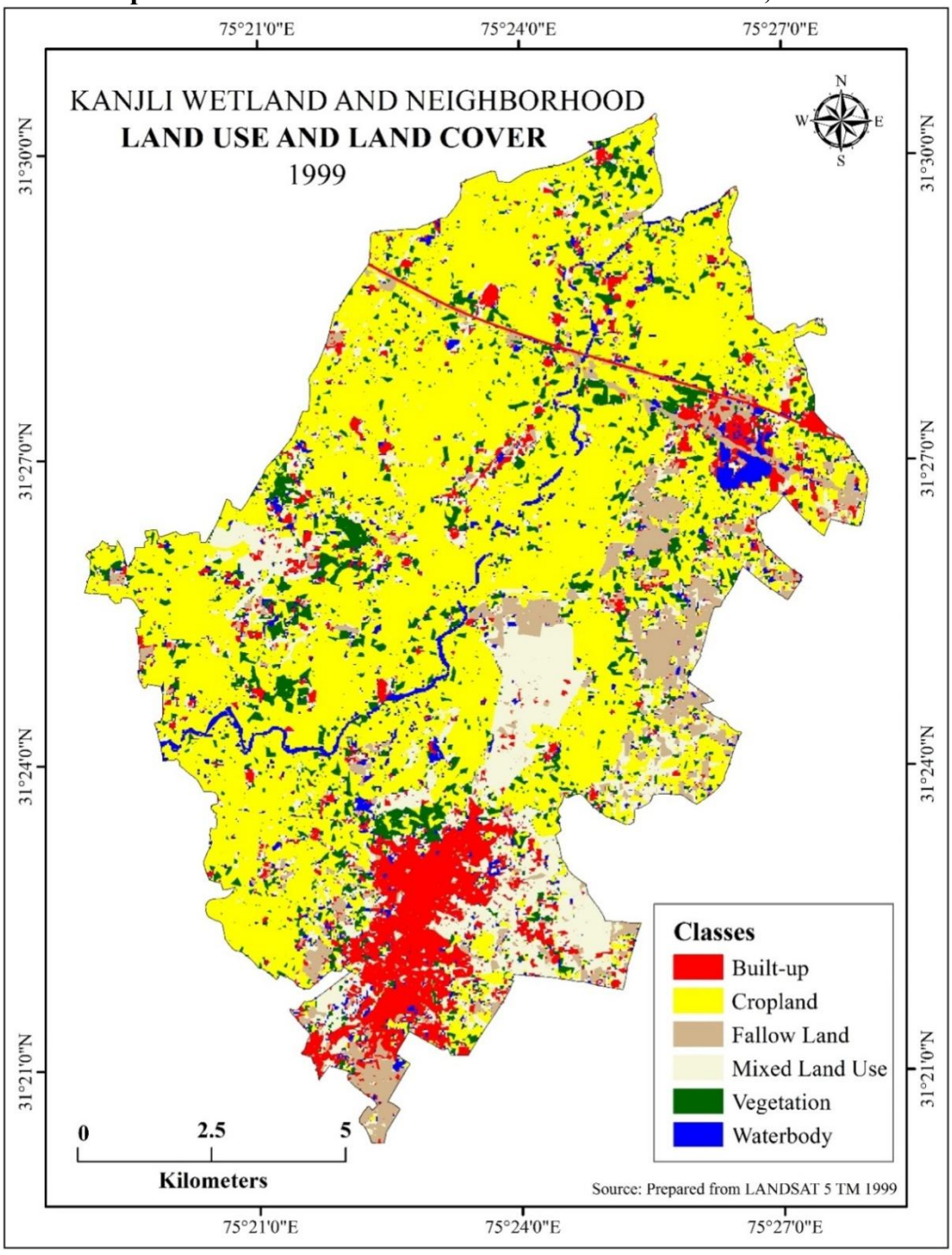
The supervised classification of the study area image of 1999 highlights the coverage of selected classes. Map 2.2 shows the spatial expansion of these classes, and Table 2.2 specifies the total area covered by these classes in the study area. The description of each category is as follows:

Table 2.2
Proportion of Land Use Land Cover Classes, 1999

CLASS	AREA (km^2)
Built-up	7.41

CLASS	AREA (km^2)
Cropland	82.29
Fallow Land	21.92
Mixed Land Use	8.41
Vegetation	12.02
Waterbody	1.51
TOTAL	**133.56**

Map 2.2
Spatial Distribution of Land Use Land Cover Classes, 1999



The scenario in 1999 remains almost the same, where agricultural land is a dominant class in the study area. It includes cropland and fallow land. Their total coverage was 104.21 km^2; cropland counted for 82.29 $km^{2,}$ and fallow land for 21.92 km^2. The vegetation coverage escalated to the third primary class in the area with an areal coverage of 12.02 km^2. It is followed by a mixed land use class, which covers an area of 8.41 km^2. The proportion of built-up has increased, but it occupied the second least class in the area with an area of 7.41 km^2. The least coverage was from waterbody only, with an area of just 1.15 km^2.

2.4 Land use land cover in Kanjli Wetland in 2010

The supervised classification of the study area image 2010 highlights the coverage of selected classes. Map 2.3 shows the spatial expansion of these classes, and Table 2.3 specifies the total area covered by these classes in the study area. The description of each category is as follows:

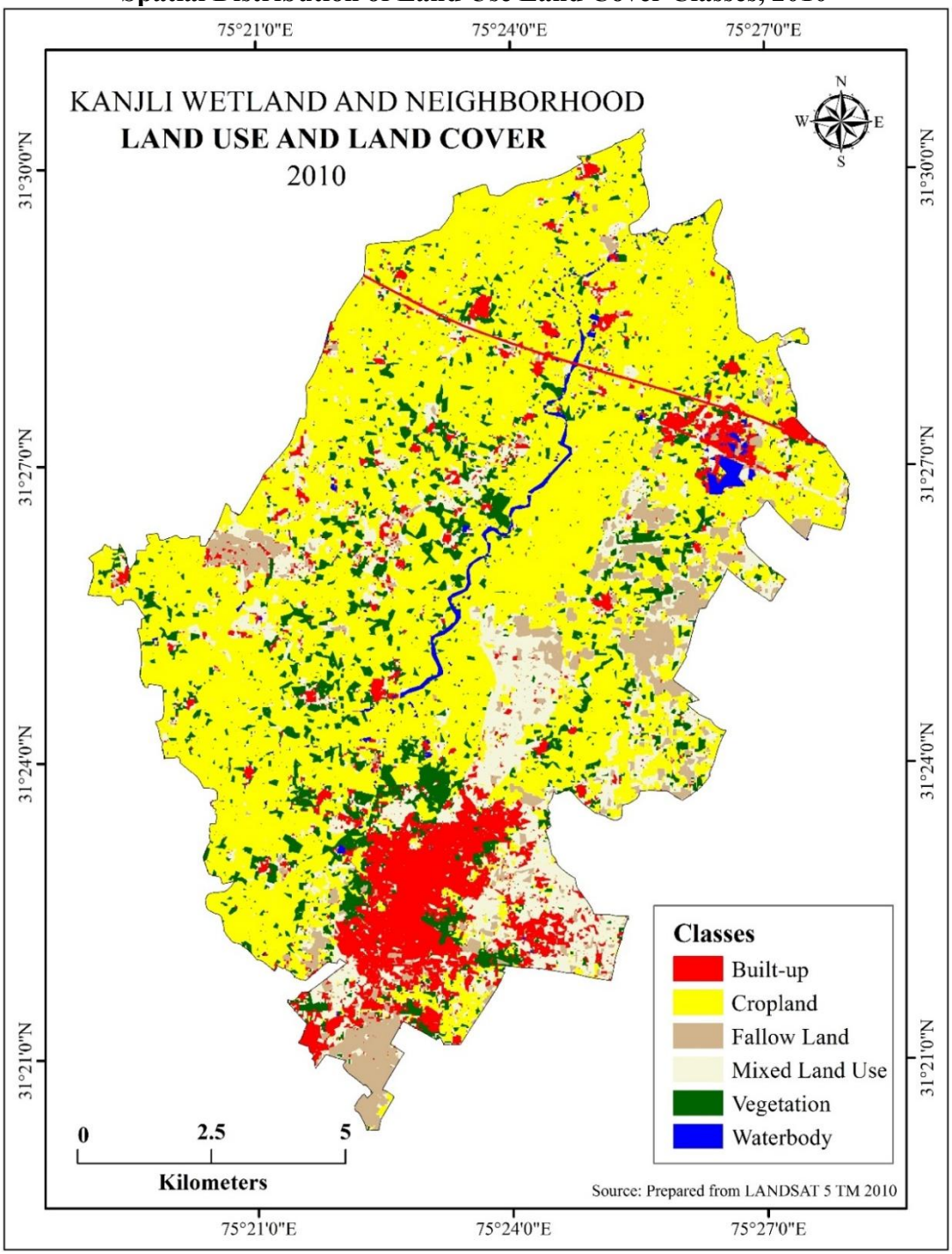
Table 2.3
Proportion of Land Use Land Cover Classes, 2010

CLASSES	AREA (km^2)
Built-up	10.02
Cropland	78.44
Fallow Land	18.56
Mixed Land Use	5.43
Vegetation	19.69
Waterbody	1.42
TOTAL	**133.56**

The land use land cover scenario in 2010 remains almost the same for agricultural land, dominating the landscape with maximum coverage. The cropland topped the list with the areal coverage of 78.44 $km^{2,}$ and fallow land with 18.56 km^2 got third place in the list. It is surpassed by vegetation in this year. The Kanjli wetland got recognition in 2002, and the following years saw an increase in the floral and faunal diversity in the study area. The LULC classification of the 2010-year image proves this fact.

Along with the vegetation, built-up has grown and came to fourth in the list with 10.02 km^2. The mixed land use class has reduced and covered 5.43 km^2 of the landscape area. The least coverage is of waterbody, with a total area of 1.42 km^2.

Map 2.3
Spatial Distribution of Land Use Land Cover Classes, 2010



2.5 Land use land cover in Kanjli Wetland in 2022

The supervised classification of the study area image 2022 highlights the coverage of selected classes. Map 2.4 shows the spatial expansion of these classes, and Table 2.4 specifies the total area covered by these classes in the study area. The description of each category is as follows:

Map 2.4
Spatial Distribution of Land Use Land Cover Classes, 2022

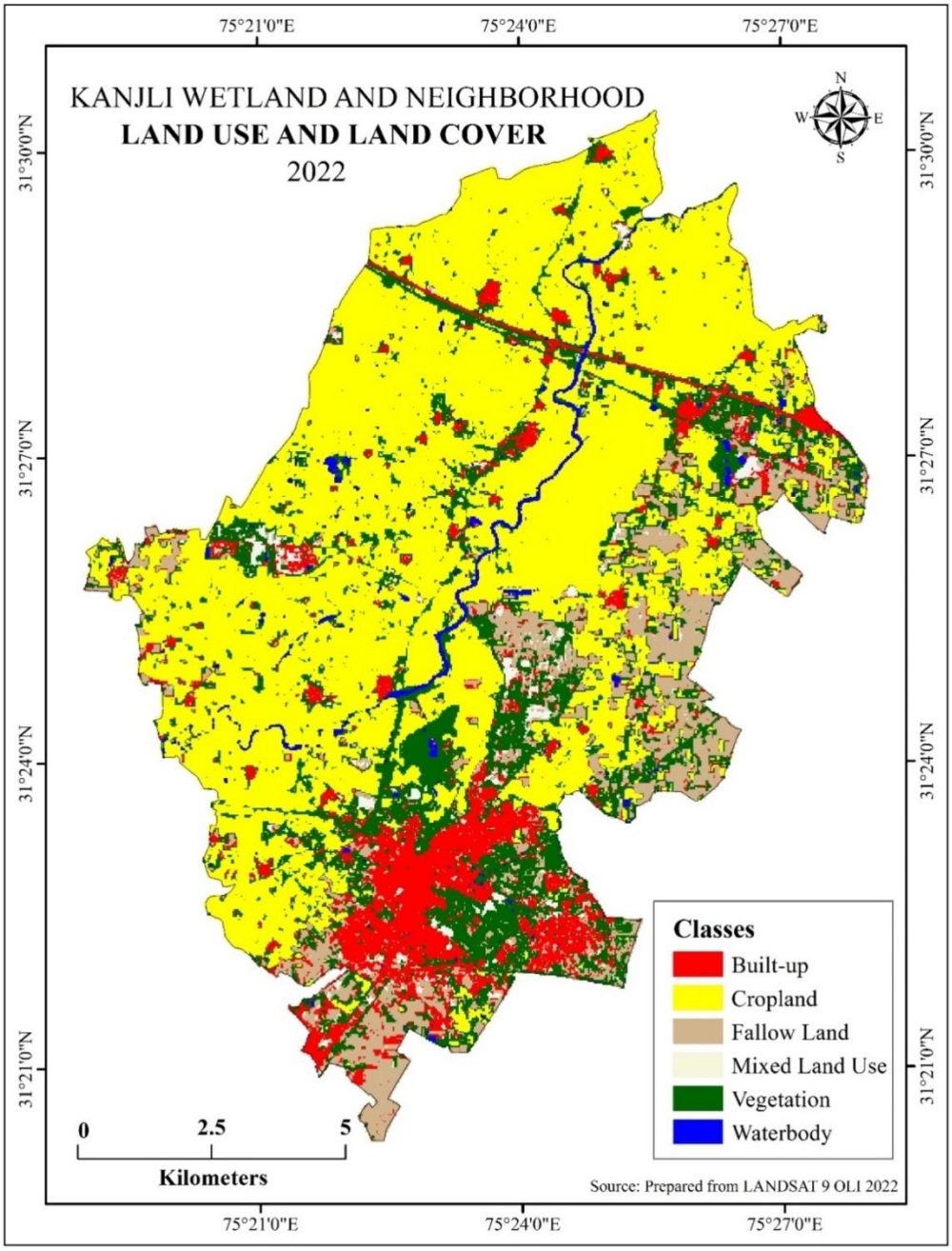


Table 2.4
Proportion of Land Use Land Cover Classes, 2022

CLASSES	AREA (km^2)
Built-up	16.65
Cropland	74.19
Fallow Land	14.36
Mixed Land Use	2.27
Vegetation	24.71
Waterbody	1.38
TOTAL	**133.56**

The land use land cover classification 2022 highlights agricultural land as the dominating class, with cropland covering 74.19 km^2 and fallow land 14.36 km^2. The vegetation class also increases its areal coverage with 24.71 km^2 of the total study area. There is an increase in the built-up class area, covering an area of 16.65 km^2. The increase of both vegetation and built-up can be seen as the factors causing fallow land in the area. The mixed land use class has fallen to 2.27 km^2. The main waterbody is still scoring the last position with an areal coverage of 1.38 km^2.

2.6 Comparative View

The analysis of detailed land use and land cover maps for each year provided imperative spatial insights into the specific proportion of each class in every year. Figure 2.1 and Table 2.5 show a comparative view of the overall but specific land use and land cover change in all six classes of the Kanjli wetland and surroundings between 1990 and 2022.

Figure 2.1
Comparison of proportional areas of Land Use Land Cover Classes, 1990-2022

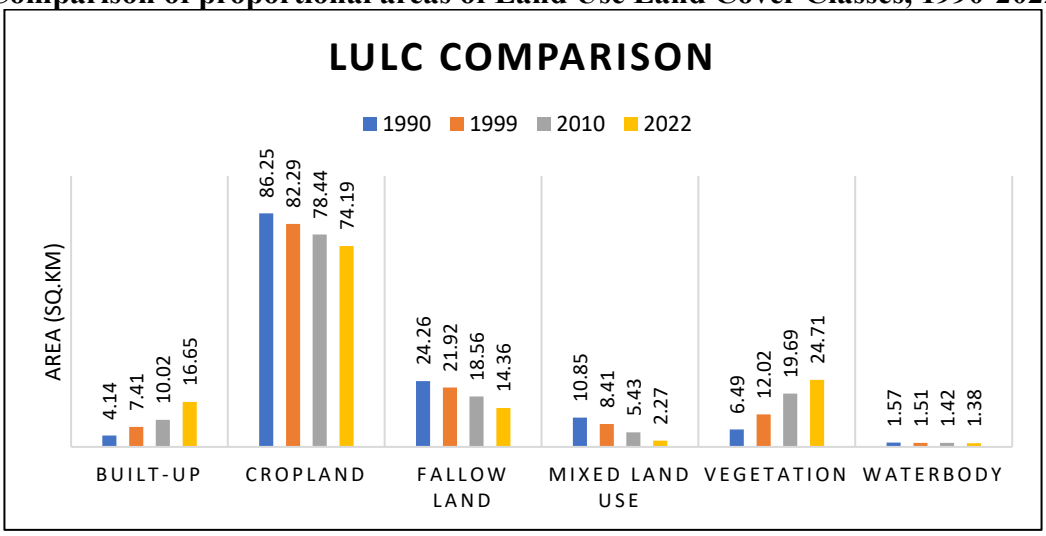


Table 2.5
Proportion of Land Use Land Cover Classes, 1990-2022

CLASSES/YEAR	1990 (km^2)	1999 (km^2)	2010 (km^2)	2022 (km^2)
Built-up	4.14	7.41	10.02	16.65
Cropland	86.25	82.29	78.44	74.19
Fallow Land	24.26	21.92	18.56	14.36
Mixed Land Use	10.85	8.41	5.43	2.27
Vegetation	6.49	12.02	19.69	24.71
Waterbody	1.57	1.51	1.42	1.38
TOTAL	**133.56**	**133.56**	**133.56**	**133.56**

The above table presents a detailed overview of the land use and land cover dynamics in and around the Kanjli wetland across the four studied years. The class-wise description of the study area is as follows:

Built-up Area:

There is a four-fold increase in the proportion of built-up in the study area. The built-up area has consistently increased over the years, from 4.14 sq. km in 1990 to 16.65 sq. km in 2022. This significant expansion is attributed to urbanization, infrastructural development, and a growing population across the region.

Cropland:

There is a 14 percent decrease in the proportion of cropland, though it remained the dominant land use over the years. It has experienced a gradual reduction to 74.19 sq. km in 2022 from 86.25 sq. km in 1990. This decline is primarily influenced by factors such as urban encroachment, shifting agricultural practices, and changes in the state's land management aspect.

Fallow Land:

Fallow land has seen the second-highest decline of 41 percent in its proportion in the study area. It has consistently decreased from 24.26 km^2in 1990 to 14.36 km^2in 2022. This decline indicates intensified land use or agricultural practices, leading to reduced fallow periods. It potentially indicates intensification of agriculture, with uncultivated lands being brought under active cultivation. The transformation of fallow land to vacant land first and then to built-up to ease the land conversion laws is attributed to the loss of fallow land in the study area.

Mixed Land Use:

Mixed land use has seen a maximum decline of 80 percent in its proportion over 32 years. The area designated as mixed land use has exhibited a steady decrease from 10.85 km^2 in 1990 to 2.27 km^2 in 2022. Changes in land management practices and the conversion of mixed-use areas for specialized purposes are contributing to this decline.It exclusively includes conversion to built-up areas and even to distinct land-use categories like cropland or vegetation.

Vegetation:

Vegetation is also the second class in the study, which saw a four-fold increase in its proportion over the studied period. The vegetation cover has progressively increased over the years, rising from 6.49 km^2 in 1990 to 24.71 km^2 in 2022. This positive trend signifies reforestation efforts, habitat restoration, or changes in agricultural practices favoring natural vegetation. There have been many plantations drives in the district, which profoundly represents this increase (Kaura, 2022)

Waterbody:

The waterbody area has witnessed a slight decrease in proportion from 1.57 km^2 in 1990 to 1.38 km^2 in 2022. Although the central pond of the wetland has increased spatially, other segregated ponds within the surrounding areas have disappeared over time. The main factors contributing to this reduction include encroachment, human interventions, or natural variations in wetland extent. Even before the wetland got its status, there was encroachment to its periphery, also for utilizing it under cropland.

A combination of natural processes and human activities likely influences land use and land cover changes over the years. Urbanization, agricultural practices, land management decisions, and conservation efforts are among the factors contributing to the observed trends. Understanding these dynamics is crucial for informed land-use planning, environmental conservation, and sustainable resource management around the Kanjli wetland. It could be effectively achieved once it is known which class had come up at the cost of which other class. This evaluation highlights the actual nature of transformation happening in the study area and validates the above reasons behind the increase and decrease of any studied class.

SECTION – 2
LAND USE AND LAND COVER CHANGE OF KANJLI WETLAND

The following analysis gives an explicit view of the transformations occured in the study area. It is one step further from the previous section of comparative change as it elaborates the change in one class into various categories of classes that brought that change or how much area of one class has been acquired by other classes. The view directly coincides with the transformational nature of the landscape and

highlights the nature of change. The part is divided into four sub-parts explaining changes between 1990-1999, 1999-2010, 2010-2022, and overall, 1990-2022.

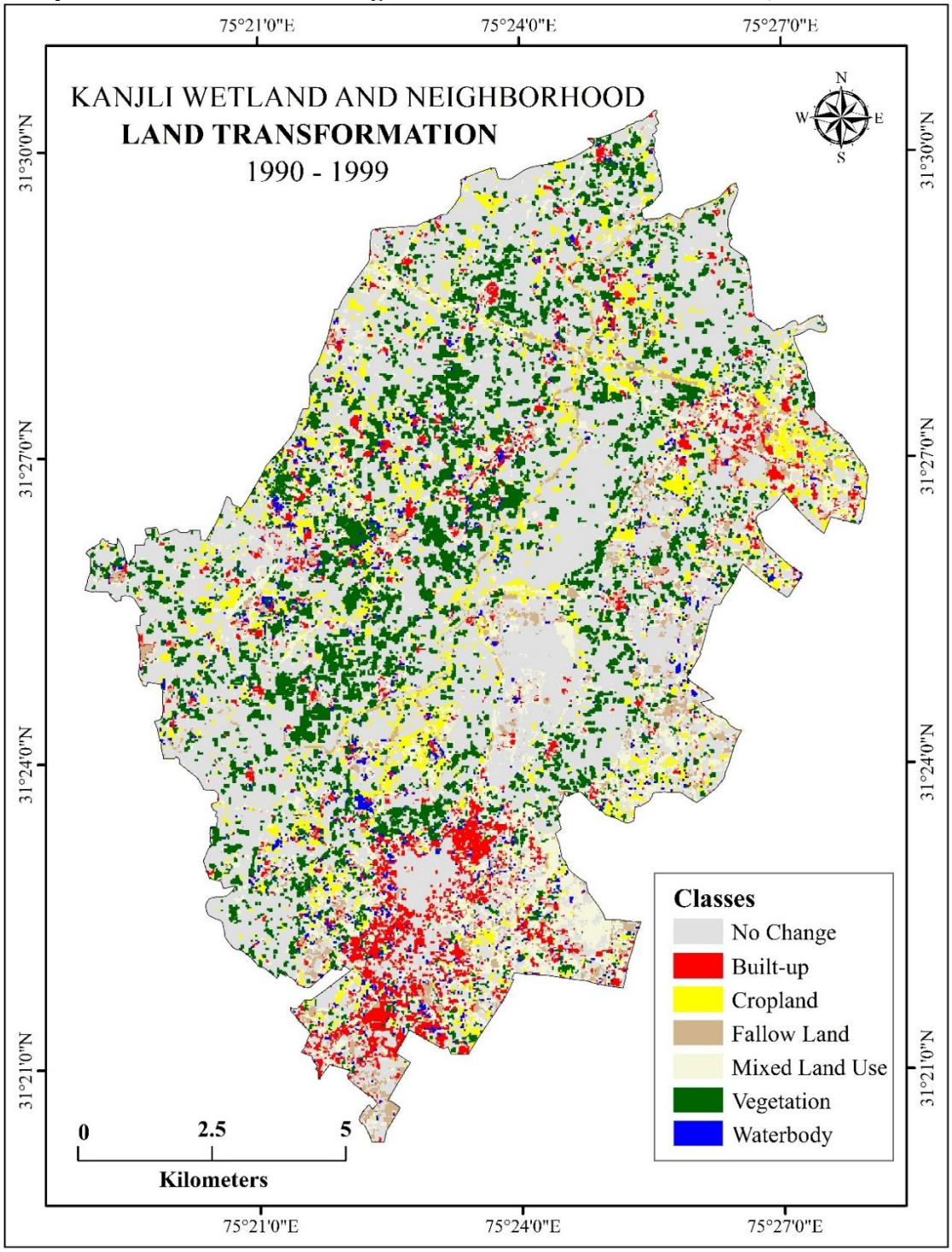
2.7 Land Use and Land Cover Change of Kanjli Wetland (1990-1999)

The land uses land cover transformation table of Kanjli wetland and surroundings gives the area (proportion) statistics in square kilometers. The table is a matrix of 9*9 rows and columns, where columns define the succeeding year, 1999, and rows define the preceding year, 1990. The first column and row mention the six classes viz. Built-up, Cropland, Fallow Land, Mixed Land Use, Vegetation, Waterbody, a total, and a row of Gain (how much proportion of land use class has gained in 1999 from 1990) and a column of Loss (how much proportion of land use class has lost from 1990 to 1999). The diagonal of the matrix shows an unchanged proportion in a class. The last row and column signify the total of studied classes. As the proportion of Gain (row) has to be equal to the amount of Loss (column), the last cell of the second last row and column remained blank. When the total number of diagonal cells is added to the sum of gain and loss, i.e., 45.47 sq. km., it gives the total area of the study area, i.e., 133.56 sq. km. The land transformation matrix of 1990-1999 is given in table 2.6.

Table 2.6
Land Use Land Cover Change Matrix, 1990-1999

	1999 (Area in sq. km.)								
1990 (Area in sq. km.)	**CLASSES**	Built-up	Cropland	Fallow Land	Mixed Land Use	Vegetation	Waterbody	Loss	**Total**
	Built-up	3.27	0.15	0.23	0.01	0	0	0.39	**3.66**
	Cropland	0.38	68.24	9.82	0.31	9.47	0.02	20	**88.24**
	Fallow Land	1.17	9.86	9.67	0.6	1.46	0.77	13.86	**23.53**
	Mixed Land Use	1.81	1.27	1.87	5.78	0.53	0.02	5.5	**11.28**
	Vegetation	0.63	2.44	0.29	1.41	0.47	0.04	4.81	**5.29**
	Waterbody	0.16	0.32	0.04	0.3	0.09	0.66	0.91	**1.57**
	Gain	4.15	14.05	12.25	2.62	11.55	0.85	45.47	
	Total	**7.41**	**82.29**	**21.92**	**8.4**	**12.02**	**1.51**		**133.56**

Map 2.5
Spatial Distribution of Changed Land Use Land Cover Classes, 1990-1999



The highest transformation occurred in the cropland class, where 20 sq. km. of the area was lost—around 10 sq. km. of cropland transformed to fallow land and 9.5 sq. km of vegetation. Even map 2.5 shows the maximum concentration of green patches on the western and north-western sides of the wetland. The second maximum transformation between 1990 and 1999 occurred in the fallow land class. A total of

13.86 sq. km. has been lost. The transformation of fallow land is primarily to cropland, which accounts for 9.86 sq. km. Such transformation can often be seen as the aftermath of the green revolution, where agriculture is seen as the flourishing business to opt for as much of a vacant portion of land as possible to be consumed for agricultural practices. A portion of fallow land has transformed into vegetation, 1.46 sq. km. and built up 1.17 sq. km.

The third class that underwent maximum transformation is mixed land use, which has lost 5.5 sq. km. of area. Around 1.9 sq. km. of mixed land use area transformed to cropland, followed by 1.81 sq. km. to built-up, and 1.27 sq. km. to cropland.

On the contrary, the cropland has gained the maximum portion of 14.05 sq. km. out of other classes. Its patches can be seen around the river body. It is followed by fallow land, which gained a portion of 12.25 sq. km. The built-up class has seen a slightest gained of 4.15 sq. km. in the study area from 1990 to 1999, and its concentration can be seen as the urban sprawl of Kapurthala city in map 2.5.

Overall, there are two classes, vegetation and built-up, which have increased in proportion between 1990-1999, which came at the cost of the area in all the remaining four classes.

2.8 Land Use and Land Cover Change of Kanjli Wetland (1999-2010)

From 1999 to 2010, the maximum transformation occurred in the cropland class. It is majorly converted to fallow land with an area of 8.78 sq. km (Table 2.7). A portion of 6.73 sq. km. of cropland in 1999 was converted to vegetation in 2010. The second largest transformation occurred in the mixed land use class, where 5.16 sq. km. was converted to agricultural land and 2.93 sq. km. was converted to built-up. The third largest transformation of 12.59 sq. km. is in the vegetation class, where 11.43 sq. km. of the vegetation has converted to cropland. Even 8.58 sq. km. of waterbody is converted to cropland (3.15 sq. km.), fallow land (2.38 sq. km.) and vegetation (1.89 sq. km).

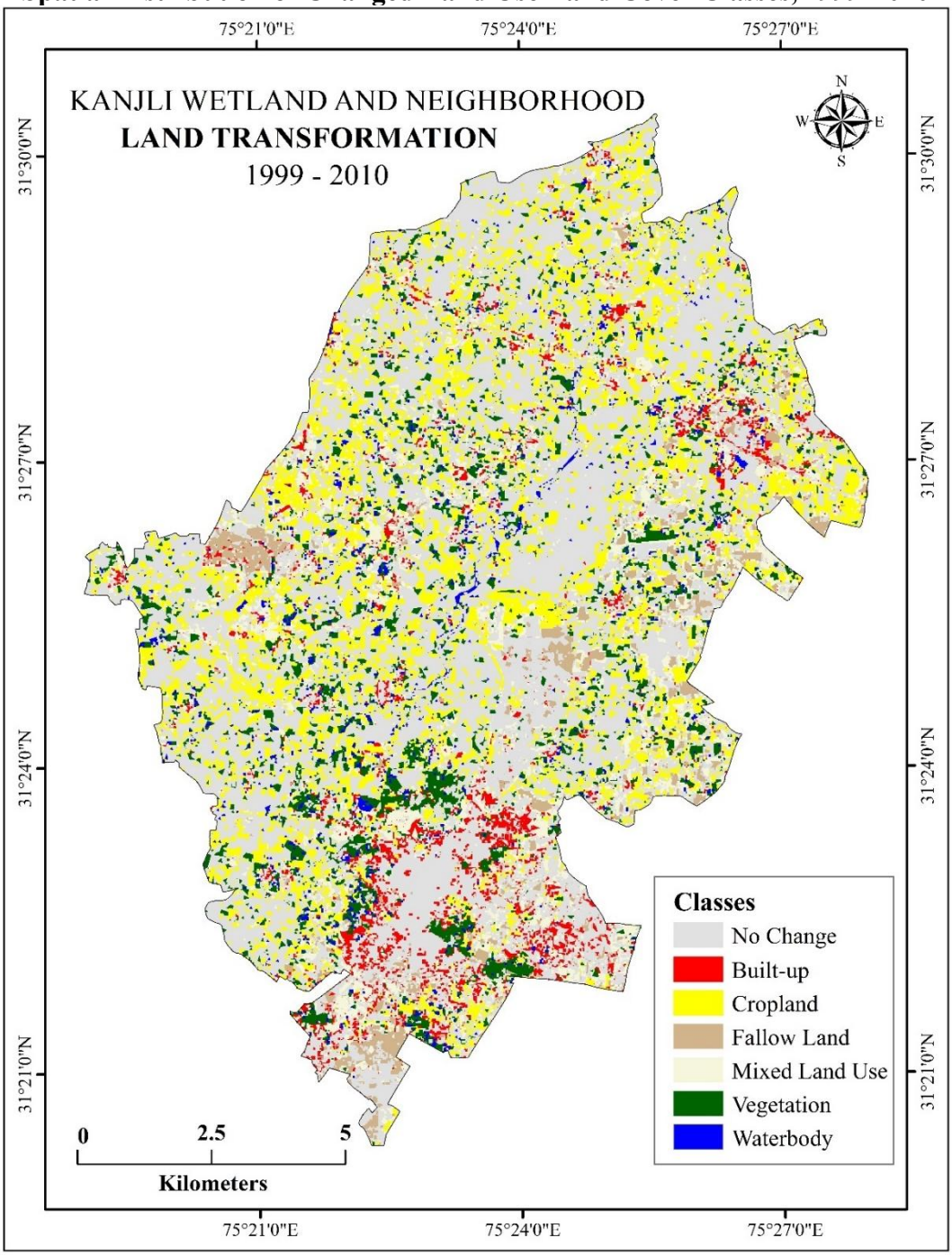
Table 2.7
Land use Land Cover Change Matrix, 1999-2010

	2010 (Area in sq. km.)								
1999 (Area in sq. km.)	**CLASSES**	Built-up	Cropland	Fallow Land	Mixed Land Use	Vegetation	Waterbody	Loss	**Total**
	Built-up	3.4	0.01	0.97	0.03	0.5	0.07	1.59	**4.99**
	Cropland	1.14	56.98	8.78	1.38	6.73	0.45	18.48	**75.46**
	Fallow Land	1.15	1.71	3.08	0.19	3.51	0.03	6.59	**9.67**
	Mixed Land Use	2.93	5.16	3.11	3.22	2.04	0.09	13.33	**16.55**
	Vegetation	0.49	11.43	0.24	0.36	5.02	0.07	12.59	**17.61**
	Waterbody	0.91	3.15	2.38	0.25	1.89	0.7	8.58	**9.28**
	Gain	6.62	21.46	15.48	2.21	14.67	0.72	61.16	
	Total	**10.02**	**78.44**	**18.56**	**5.43**	**19.69**	**1.41**		**133.56**

Map 2.6 shows the spread of yellow patches across the study area, and this compliments Table 7, where a maximum gain of 21.46 sq. km. is under the cropland class (yellow patches). It is followed by fallow land, with 15.48 sq. km. of gain; vegetation, with 14.67 sq. km. of gain; and built-up, with 6.62 sq. km. of gain. In line with these gains, the maximum loss of 18.48 sq. km. is under cropland, followed by mixed land use, with 13.33 sq. km., vegetation, with 12.59 sq. km. and waterbody, with 8.58 sq. km. The waterbody is severely affected in proportion, which has lost its maximum proportion during this decade.

Overall, fallow land has gained its maximum proportion from 1999 to 2010, followed by built-up class, vegetation, and cropland. The change has been attributed to the point of more inclination towards agricultural drive and economic development in the area.

Map 2.6
Spatial Distribution of Changed Land Use Land Cover Classes, 1999-2010



2.9 Land Use and Land Cover Change of Kanjli Wetland (2010-2022)

In recent decades, i.e., 2010-2022, the maximum transformation occurred in the mixed land use. A portion of 19.73 sq. km (Table 2.8) of mixed land use has been transformed during this period. Around 8 sq. km. of mixed land use was converted to vegetation, 3.87 sq. km. to fallow land, and 2.77 sq. km. to fallow land. Another

major transformation happened in cropland, which accounts for 18.51 sq. km. and maximally it converted to vegetation with 9.85 sq. km., followed by fallow land, with 5.56 sq. km. proportion and to built-up with 2.28 sq. km. of cropland area. The third class that has undergone maximum change is vegetation. Its transformed area is 11.42 sq. km., which primarily converted to cropland (8.55 sq. km.), then built up (1.47 sq. km.) and to fallow land (1.02 sq. km.).

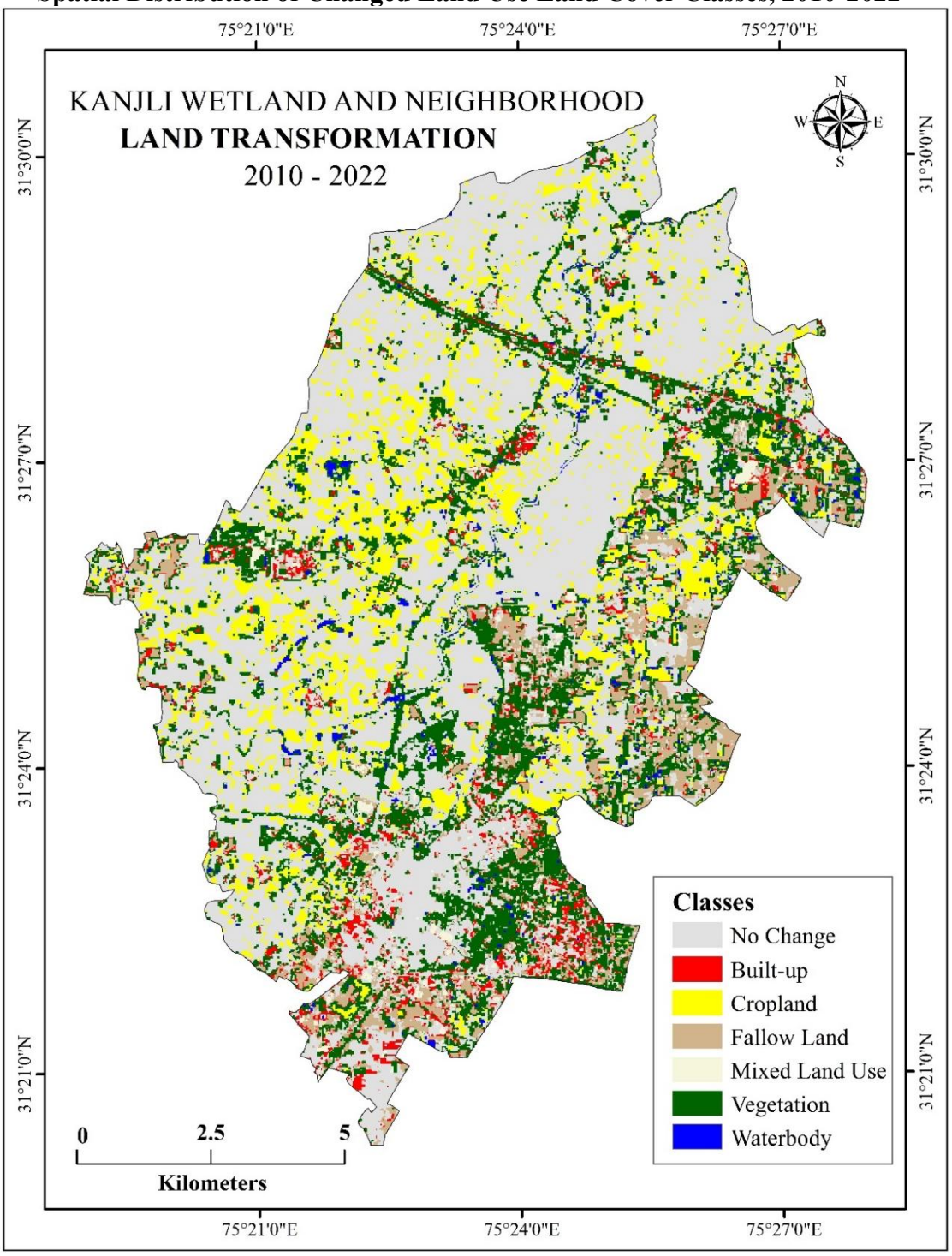
Table 2.8
Land Use Land Cover Change Matrix, 2010-2022

	2022 (Area in sq. km.)								
2010 (Area in sq. km.)	**CLASSES**	Built-up	Cropland	Fallow Land	Mixed Land Use	Vegetation	Waterbody	Loss	**Total**
	Built-up	7.84	0.42	0.01	0.03	0.37	0.06	0.89	**8.73**
	Cropland	2.28	59.23	5.56	0.33	9.84	0.5	18.51	**77.74**
	Fallow Land	1.18	1.05	3.83	0.62	1.59	0.05	4.48	**8.32**
	Mixed Land Use	2.77	4.59	3.87	0.94	8.31	0.19	19.73	**20.66**
	Vegetation	1.47	8.55	1.02	0.22	4.25	0.15	11.42	**15.66**
	Waterbody	1.12	0.34	0.06	0.13	0.35	0.43	2.01	**2.44**
	Gain	8.82	14.96	10.52	1.33	20.46	0.94	57.03	
	Total	**16.66**	**74.19**	**14.36**	**2.27**	**24.71**	**1.38**		**133.56**

The maximum gain in the vegetation class can be seen in Map 2.7; the proportion of fallow land has also increased under this decade. Proportionally, the maximum gain is experienced by built-up, which has increased manifold between 2010 and 2022. Its patches (red) can be seen around Kapurthala city, referring to the sprawl of the city.

Overall, this decade has seen an upward trend of increasing built-up, fallow land, and vegetation classes. These are coming up with the cost of decreasing cropland, mixed land use, and water bodies.

Map 2.7
Spatial Distribution of Changed Land Use Land Cover Classes, 2010-2022



2.10 Land Use Land Cover Change of Kanjli Wetland (1990-2022)

The last and ultimate transformational changes are analysed between the study's start and end years, i.e., 1990-2022. It gives a complete view of the transformations that occurred in the 32 years. Table 2.9 explicitly highlights that the maximum transformation happened in the cropland class. Its 21.97 sq. km. area is converted

majorly to vegetation, with 11.66 sq. km., followed by fallow land, with 5.78 sq. km., and to built-up, with 3.71 sq. km. of area. The second major transformation in the study area (Map 2.7) took place in the fallow land class, accounting for 19.2 sq. km. of its area. Fallow land primarily converted to vegetation, with 7.4 sq. km of area, followed by cropland, with 6.25 sq. km., and built-up, with 4.74 sq. km. of area. The third class that underwent maximum transformation is mixed land use, whose 9.76 sq. km. of area has changed to other classes like vegetation (3.46 sq. km.), cropland (2.3 sq. km.), built-up (2.05 sq. km.) and fallow land (1.08 sq. km.).

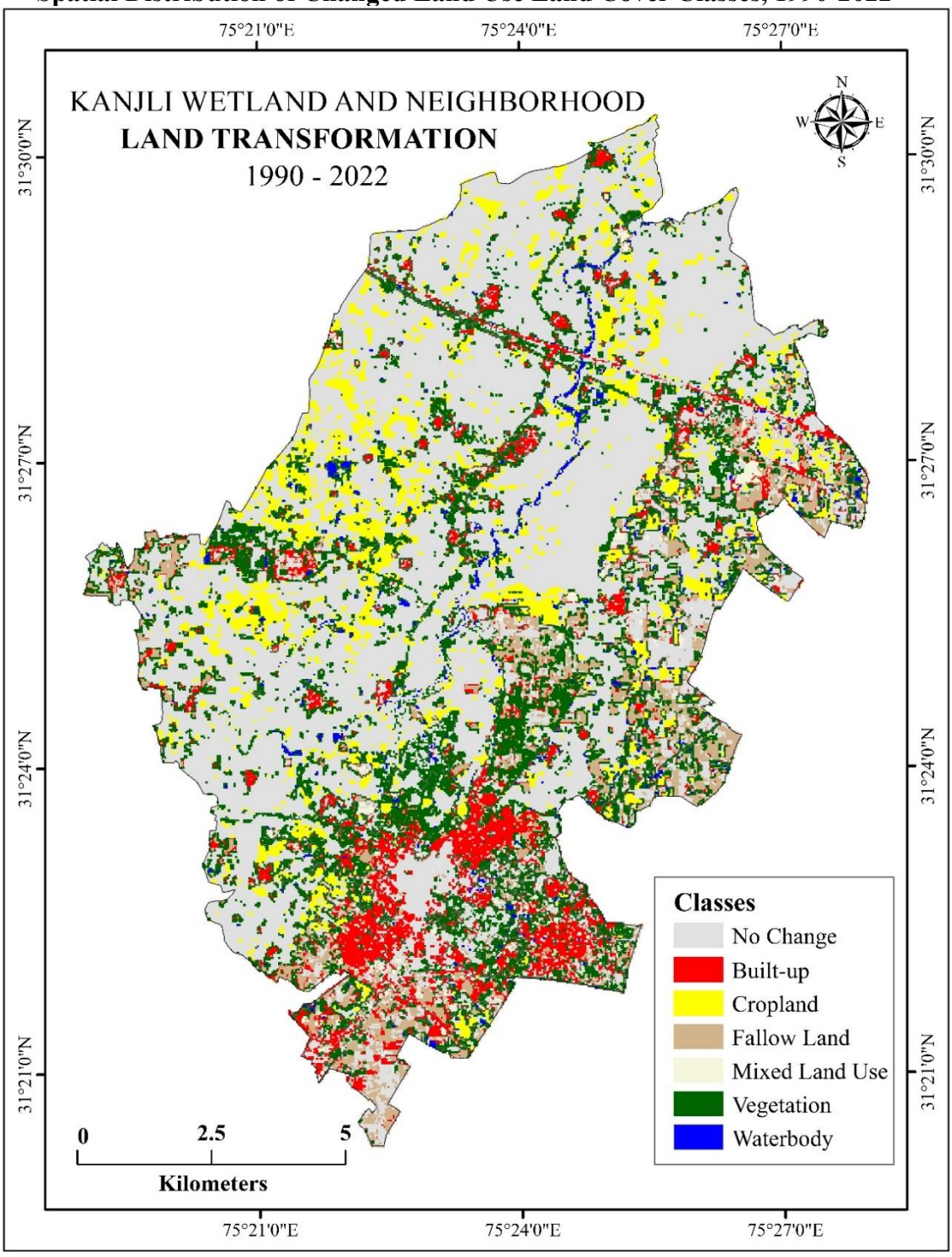
Table 2.9
Land use Land Cover Change Matrix, 1990-2022

	2022 (Area in sq. km.)								
1990 (Area in sq. km.)	**CLASSES**	Built-up	Cropland	Fallow Land	Mixed Land Use	Vegetation	Waterbody	Loss	**Total**
	Built-up	2.83	0.19	0.02	0.09	0.15	0.02	0.48	**3.31**
	Cropland	3.71	65.12	5.78	0.41	11.66	0.42	21.97	**87.09**
	Fallow Land	4.74	6.25	5.05	0.59	7.4	0.22	19.2	**24.26**
	Mixed Land Use	2.05	2.3	1.88	1.08	3.46	0.07	9.76	**10.84**
	Vegetation	0.66	1.83	0.75	0.06	2.8	0.41	3.7	**6.49**
	Waterbody	0.1	0.47	0.09	0.14	0.49	0.29	1.28	**1.57**
	Gain	11.27	11.04	8.51	1.28	23.16	1.13	56.39	
	Total	**14.1**	**76.16**	**13.57**	**2.36**	**25.95**	**1.42**		**133.56**

There are two classes that have prominently outclassed other classes in terms of gaining their overall proportions. These are vegetation and built-up, which have gained 23.16 sq. km. and 11.27 sq. km. in 32 years, respectively. On the contrary, the classes that have lost their maximum proportion during this period are cropland, fallow land, and mixed land use. There is a considerable conversion of cropland and fallow land, whose 10.93 sq. km. and 10.63 sq. km. of areas, respectively, converted to other classes. It is followed by mixed land use, whose 8.44 sq. km. of area converted into other classes.

The interpretation needs connecting cords that discuss the reason behind such transformation in the study area. The final section of the chapter highlights the significant factors that underplay such transformations in and around the Kanjli wetland area.

Map 2.8
Spatial Distribution of Changed Land Use Land Cover Classes, 1990-2022



SECTION – 3
FACTORS RESPONSIBLE FOR CHANGING LAND USE AND LAND COVER IN KANJLI WETLAND

Kanjli Wetland, a significant ecosystem located in the Indian state of Punjab, has undergone notable changes in land use and land cover over the studied decades. These changes are attributed to a combination of natural and anthropogenic factors, each contributing to the area's evolving landscape and ecological balance. Gaining insight into these factors is essential for devising effective management and conservation approaches. The enactment of Kanjli Wetland under the Ramsar Convention in 2002 also played a crucial role in highlighting the area's significance. This further influences the trends in agricultural productivity, vegetation cover, and built-up area. However, it's likely not the sole explanation and a combination of factors underplayed the situation. As it is basically a man-manmade wetland, the natural factors are few and few, driving the changes in the study area. The following mentioned factors have been summarised after many field visits, interactions with the locals, different stakeholders and officials, and an extensive literature review. The factors have been divided into two sub-heads, i.e., natural and anthropogenic.

2.11 Natural Factors

There are very few natural factors that result in the changing land use and land cover in the study area. These are as follows:

2.11.1 Climate Change

a. Altered Rainfall Patterns: There have been variations in monsoon patterns and overall precipitation, which affect water levels and impact the wetland's hydrology. The onset of monsoon the occurrences of repeated El-Nina events, accelerates the concerns related to the Kanjli wetland (Athira, 2023).

b. Temperature Fluctuations: Seasonal variations in terms of extended summers in the region cause rising temperatures that lead to increased evaporation rates, affecting water availability in the Kanjli's pond.

2.11.2 Natural Disasters

Although not frequent in the area, events like floods or droughts cause dramatic alteration of the wetland's characteristics in a short time.

a. Sedimentation

The recent floods of 2023 in the area, following extreme monsoonal rainfall in the higher reaches of Himachal Pradesh and the opening of dam gates to discharge surplus water, causes excessive sedimentation in and around the wetlands of Punjab. The river nourishing brought excessive sedimentation that can lead to the filling of wetland areas, gradually changing the land cover.

2.12 Anthropogenic Factors

2.12.1 Agricultural Expansion

Following the green revolution, the Punjab has seen the expansion of cropland, driven by the growing population's need for food production. The study area also witnessed the same drive, esp. engulfing the waterbodies, as these are easy to convert (Plate 2.1). On many fronts, the margins of wetlands are replaced by croplands. There are not even a few inches of unused land left in between.

Plate 2.1: Wheat crop grown up to the edges of the wetland. Installed electric transformer can also be seen. This clearly refers to the encroachment of the wetland area and also restricting the wetland area's growth in the future.
Source: Field Photo, 2023.

a. Impact on water health

The use of fertilizers and pesticides in nearby agricultural fields leads to nutrient runoff, affecting the water quality of the waterbodies of the Punjab (Tiwana et al., 2009). The same phenomenon is playing at the Kanjli wetland, where the same mismanagement cannot be ignored. In the vicinity of the cropland and upslope from

the wetland to protect their fields from the water overflow from the wetland, the agricultural runoff can be easily gauged at the study area. The field visits' observation also highlights the same where all the nearby croplands are at an elevation from the wetland.

b. Improved Irrigation Practices: Ramsar designation has spurred investments in sustainable water management practices like drip irrigation or micro-irrigation, leading to more efficient water use and potentially higher yields surrounding the Kanjli wetland. The land use land cover analysis clearly highlights the proportional change of cropland in 32 years, where changes in the cropland are minute compared to the other class in the study area.

c. Focus on Sustainable Agriculture: The conservation focus brought by Ramsar status has also encouraged farmers to adopt organic farming or other sustainable practices, leading to improved soil health and potentially higher quality crops in the area. During field visits to the study area, it has been observed that some farmers are progressively acting on sustainable agricultural methods and selling their organic produce, which fetch them higher returns.

d. Market Access and Incentives: Designation has attracted government support programs like Parampragat Krishi Vikas Yojana (PKVY) (MoA& FW, 2022), offering improved market access or financial incentives for farmers practising sustainable agriculture, leading to increased productivity and profits. It inclined many others to invest in the agricultural sector in the region.

2.12.2 Increase in Vegetation Cover:

One of the striking aspects of the analysis is the increase in the vegetation cover in the study area (Plate 2.2, 2.3). The trend complements the designation of Kanjli wetland under the Ramsar convention, which helps to initiate various acts in and around the wetlands.

a. Conservation Efforts: Post-Ramsar designation, increased focus on conservation have led to afforestation drives, restoration of degraded lands, and stricter regulations against deforestation, leading to an overall increase in green cover.

b. Habitat Protection: The protection of the wetland ecosystem under Ramsar has benefited surrounding vegetation indirectly by regulating water flow, preventing soil

erosion, and providing habitat for pollinators, all contributing to improved vegetation growth.

c. Awareness and Community Engagement: The Ramsar designation has increased public awareness about environmental conservation, leading to community initiatives like tree planting or habitat restoration projects and increasing vegetation cover.

Year 2002 **Year 2022**

Plate 2.2: Increased vegetation on the banks of the wetland at Village Kanjli

Image Source: Google Earth Pro.Location Coordinates: 31.416622031876695, 75.3857511182148

Year 2002 **Year 2023**

Plate 2.3: Conversion of open space (2002) to vegetation and built-up (2023) at Village Bishanpur, Kapurthala.

Image Source: Google Earth Pro.Location Coordinates: 31.418213000659886, 75.4019757926706

2.12.3 Urbanization and Infrastructure Development

One of the significant causes of the encroachment in and around the wetland is the uncontrolled urbanization of the nearby urban and rural centres. The construction of buildings, roads, and other infrastructure encroaches upon the area's surroundings, the wetland, leading to landscape fragmentation (Plate 2.3). Further encroachment from these sides could also lead to habitat loss in the wetland. As such, there's no prominent infrastructural development at Kanjli wetland, except the wetland's compound beautification promotes beautification, which could severely threaten the

studied wetland. However, there are indirect ways in which growing urbanization is threatening the wetland. The urban encroachment of croplands forced the farmers to convert waterbodies to farmlands for agricultural activities to cater growing population needs. Secondly, urban runoff can also introduce pollutants into the wetland. Though several stringent measures have been taken to keep the wetland's water intact, a few places can be spotted where the contaminants from the nearby land enter the waterbody that fills the Kanjli wetland (Plate 2.4).

Plate 2.4: A drain at Kapurthala city located 2 kilometres from the Kanjli wetland falls downstream to the Kali Bein River at Bhagwanpur village. Though the drain does not impact the wetland directly, the empathy of the site can be visualized where another waterbody in the vicinity of the studied wetland needs immediate attention. When it falls into the same stream that feeds the Kanjli wetland, even though downstream, it is a question mark on the status of the overall management of water bodies in the state.
Source: Field Photo, 2023

a. Increase in Built-up Area:

Economic Development: Improved agricultural productivity and potential eco-tourism opportunities around the wetland have attracted investments and infrastructure development, leading to increased construction and expansion of settlements (Plate 2.5).

Poorly Regulated Land Use: While Ramsar focuses on wetland conservation, it might not directly regulate development beyond its boundaries. Uncontrolled urban sprawl in Kapurthala has encroached on surrounding areas, including agricultural land near the wetland (Plate 2.6).

Lack of Sustainable Planning: Insufficient integration of environmental considerations into development plans has led to unsustainable construction practices and encroachment on valuable natural areas despite the Ramsar designation (Plate 2.7).

Year 2002 **Year 2023**

Plate 2.5: The expanding built-up on cropland at Village Boot, near Kali Bein River.
Image Source: Google Earth Pro. Location Coordinates: 31.451025268209726, 75.4001313638206

Year 2002 **Year 2022**

Plate 2.6: Conversion of cropland (2002) to built-up (2022) at Village Kanjli. A newly built Cambridge International School Kapurthala.
Image Source: Google Earth Pro. Location coordinates: 31.426112879762616, 75.3726899167741

Year 2002 **Year 2022**

Plate 2.7: Conversion of mixed land use, waterbody, vegetation, and cropland (2002) to built-up (2022) at Village Thikriwala. A new ITC Food factory and Kapurthala Central Jail have got their setup at the village.

Image Source: Google Earth Pro. Location Coordinates:31.434982310318155, 75.35175581259114b.

Industrialization

Discharge of industrial effluents leads to water pollution, affecting the wetland's aquatic life and overall ecosystem health. As the vicinity of the wetland is surrounded by agricultural land, so there's no major industrialization around it. But a few industries have been coming near the wetland—a tile factory industry built on a stream connecting the wetland pond (Plate 2.8).

Ground View **Aerial View**

Plate 2.8: A tile factory, ground view & aerial view - yellow encircled, in the Kapurthala MC, just 200 meters from the Kanjli wetland.

Source: Field Photo, 2023. Location coordinates:31.409425971641184, 75.3778480383877

2.12.4 Water Regulation Practices

Though the alteration of natural water flow due to dam construction, canal diversions, or other hydrological interventions leads to the degradation of aquatic life, the Kanjli wetland, a man-made ecosystem, thrives due to the modification of its water flow. The water management initiatives at the Kanjli wetland have been implemented since the start (Plate 2.9). The water level has been thoroughly checked daily using water management gates. It helps to maintain and regulate the aquatic environment of the wetland properly.

Plate 2.9: Installation of water management gates to regulate the water flow at Kanjli Wetland

Source: Field Photo, 2023. Location coordinates: 31.411300878509156, 75.37653123219539

a. Water usage concerns

However, some malpractices impact the aquatic life of the wetland. As the wetland is surrounded mainly by croplands, there is an illegal means of extracting water from the wetland's pond to irrigate the fields.

Plate 2.10: Use of illegal pump to extract water from the wetland pond and to irrigate the surrounding field.

Source: Field Photo, 2023. Location coordinates: 31.41255222399188, 75.38023013558433

It severely affects the wetland's biodiversity as over-extraction of water for irrigation or domestic use leads to reduced inflow into the wetland. Illegal water extraction pumps have been installed on the wetland's embankments to feed crops and can be

spotted easily during the day (Plate 2.10). Such activities clarify the law and order at the Kanjli wetland.

b. Fishing and Hunting

In the absence of effective governance and law enforcement measures at the Kanjli wetland, instances of illegal fishing (Plate 2.11) and, maybe, hunting of migratory birds have become prevalent. These unauthorized activities directly contribute to the decline in faunal diversity within the wetland ecosystem. The apparent lack of oversight and regulation portrays Kanjli Wetland as poorly administered, raising questions about its eligibility as a designated state wetland, let alone its prestigious international Ramsar designation. Urgent interventions and enhanced enforcement mechanisms are imperative to address these unlawful practices and safeguard the ecological integrity of the wetland.

Plate 2.11: Illegal fishing at the Kanjli wetland compound

Source: Field Photo, 2023. Location coordinates: 31.41129260058961, 75.37785935605764

It's crucial to emphasize that these insights are derived from a combination of field visits and published literature, and they clearly highlight the actual reasons being more complex and nuanced, leading to the changes in the land use and land cover of the study area. Exclusive research and data analysis on agricultural practices, land-use policies, and conservation efforts in the future would be necessary to control the mismanaged class conversion. Furthermore, attributing all changes solely to the Ramsar designation would be oversimplified. Factors like changing government

policies, technological advancements, and regional socio-economic trends would also contribute to the cause.

These changes in the study area led to the consequences of the Kanjli wetland. The further explanation highlights these consequences.

2.13 Consequences of Land Use and Land Cover Change

The following consequences will occur at the Kanjli wetland in light of the abovementioned changes. These concerns are uncovered while discussing with various stakeholders of the wetland.

2.13.1 Biodiversity Loss

One of the significant concerns related to any human intervention and consequent changes in the surroundings of the wetland or even within the wetland is habitat destruction and pollution. It has already led to the loss of flora and fauna species and may continue further, some of which might be endemic or endangered. The experts shared the decrease in the migratory bird population at the site due to the reduction of their prey in the wetland pond.

2.13.2 Water Quality Degradation

The loss of biodiversity is significantly connected with water quality degradation in wetlands. Pollution from various sources leads to eutrophication, affecting aquatic life and making the water unfit for even human consumption. As agricultural fields surround the Kanjli wetland, the runoff from the fields, which are sprayed with various insecticides, pesticides, and numerous fertilizers, critically impacts the wetland waters. The oversized proportions of phosphorus and nitrogen from the fertilizers pollute the wetland waters, leading to increased algal growth and subsequent ecological imbalances.

2.13.3 Invasive Species

The incursion of non-native plant or animal species, whether intentional or accidental, disrupts the ecological equilibrium of the wetland. The problem of water hyacinth is quite prevalent at the Kanjli wetland (Plate 2.12). It has been tackled a few times over the years, but its return again and again takes a toll on the authorities.

Every time, there's a need for a particular drive to tackle such problems as there's hardly any Suo moto from the government or authorities. (Plate 2.13).

Year 2012

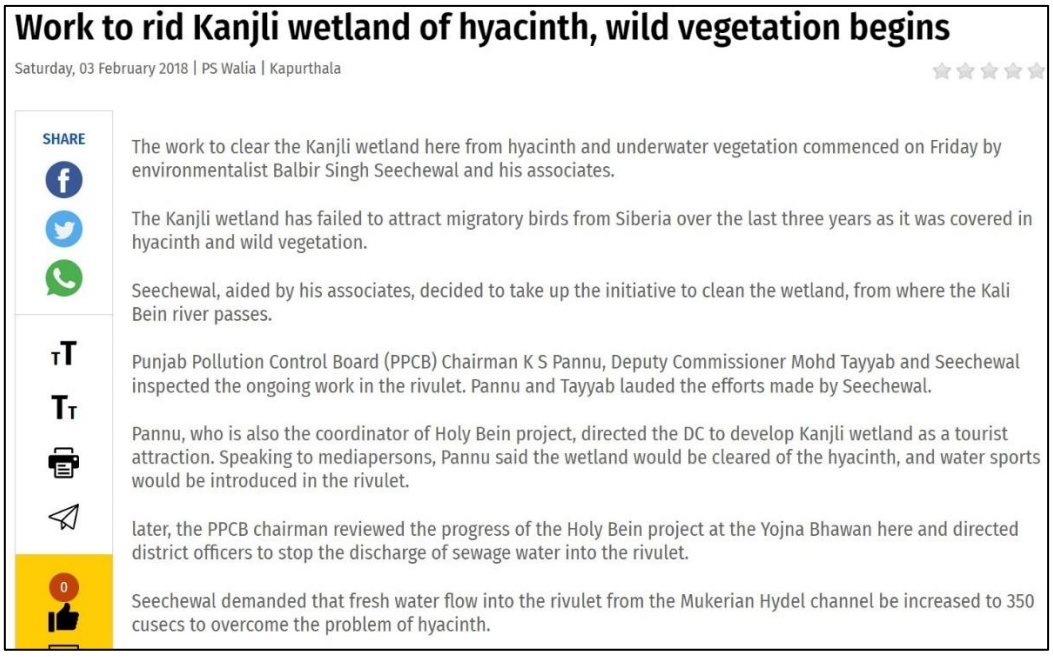
Year 2016

Year 2022

Year 2023

Plate 2.12: The repeated water hyacinth problem at Kanjli wetland, Village Kanjli. The cycle shows the arrival of water hyacinth after its removal in 2016. The problem persists.

Image Source: Google Earth Pro.Location Coordinates: 31.411516790851838, 75.37700712419506



Work to rid Kanjli wetland of hyacinth, wild vegetation begins

Saturday, 03 February 2018 | PS Walia | Kapurthala

SHARE

The work to clear the Kanjli wetland here from hyacinth and underwater vegetation commenced on Friday by environmentalist Balbir Singh Seechewal and his associates.

The Kanjli wetland has failed to attract migratory birds from Siberia over the last three years as it was covered in hyacinth and wild vegetation.

Seechewal, aided by his associates, decided to take up the initiative to clean the wetland, from where the Kali Bein river passes.

Punjab Pollution Control Board (PPCB) Chairman K S Pannu, Deputy Commissioner Mohd Tayyab and Seechewal inspected the ongoing work in the rivulet. Pannu and Tayyab lauded the efforts made by Seechewal.

Pannu, who is also the coordinator of Holy Bein project, directed the DC to develop Kanjli wetland as a tourist attraction. Speaking to mediapersons, Pannu said the wetland would be cleared of the hyacinth, and water sports would be introduced in the rivulet.

later, the PPCB chairman reviewed the progress of the Holy Bein project at the Yojna Bhawan here and directed district officers to stop the discharge of sewage water into the rivulet.

Seechewal demanded that fresh water flow into the rivulet from the Mukerian Hydel channel be increased to 350 cusecs to overcome the problem of hyacinth.

Plate 2.13: A snapshot of the news excerpt showing the state of affairs at the Kanjli wetland, where such cleanliness of the wetland becomes news as there are hardly any routine follow-ups of such practices at the Kanjli wetland. *Source: (Walia, 2018)*

Wetlands provide crucial services like groundwater recharge, flood control, and carbon sequestration. Untimely mismanagement causes heavily on the degradation of the wetland and can lead to the loss of these benefits.

2.13.4 Soil Erosion

The depletion of vegetation cover due to agricultural expansion or construction activities exacerbates soil erosion, thereby diminishing land fertility within the study area. Consequently, farmers rely on the extensive use of fertilizers to mitigate fertility losses, inadvertently contributing to soil and water pollution. The unimpeded flow of runoff from agricultural fields into the Kali Bein stream intensifies erosion along its banks, particularly in areas lacking tree plantation. While substantial tree plantation efforts are evident near the main compound along the stream's banks, vast stretches upstream remain devoid of such protective measures. This asymmetrical distribution of tree cover underscores the urgent need for comprehensive erosion control strategies and enhanced vegetation restoration initiatives along the entire length of the Kali bein stream to mitigate erosion and preserve water quality.

2.13.5 Microclimate Alteration

The issue of eutrophication, coupled with soil erosion along the wetland banks, the proliferation of water hyacinth, and the influx of insecticides, pesticides, and fertilizers from adjacent croplands into the wetland pond, collectively contribute to significant microclimate alterations within the aquatic ecosystem of the Kanjli wetland. These alterations perturb the local temperature regime and nutrient composition, consequently influencing the behaviour of marine microorganisms. Such disruptions pose a severe threat to the biodiversity of the wetland pond, both presently and in the foreseeable future unless proactive measures are implemented to address these environmental stressors. Immediate action and comprehensive management approaches are essential to alleviate the negative effects of these disturbances and safeguard the ecological health of the Kanjli wetland ecosystem.

2.13.6 Impact on Local Communities

The degradation of the Kanjli wetland poses significant challenges to the livelihoods of local communities reliant on its resources, including fishing and agriculture. As a crucial component of the local ecosystem, the wetland plays a pivotal role in

recharging the groundwater table, thereby facilitating irrigation for agricultural activities that underpin the region's prosperity. Moreover, preserving the wetland not only fosters the growth of its natural ecosystem but also holds the potential to boost tourism in the area, generating vital revenue streams for residents and the government. However, any form of degradation within the wetland ecosystem directly and indirectly impacts the surrounding communities. Therefore, safeguarding the environmental integrity of Kanjli wetland is imperative for ensuring the well-being of both the natural environment and the economic sustainability of the study area.

2.14 Mitigation and ManagementStrategies

The above-discussed causes and consequences of the land use and land cover change in the Kanjli wetland and its surroundings indicate that immediate attention is needed to address its mitigation and proper management strategies. Here are some of the utmost required measures that should be implemented in the study area:

The mitigation and management of the Kanjli Wetland necessitate implementing rigorous pollution control measures. It involves establishing stringent regulations and monitoring mechanisms to minimize the inflow of pollutants into the wetland. Effective implementation of pollution control technologies and best management practices requires collaboration with industries, agricultural stakeholders, and local authorities.

Furthermore, promoting sustainable agriculture and water use practices is integral to preserving the Kanjli Wetland. Encouraging the adoption of sustainable agricultural practices, such as organic farming, reduced chemical inputs, and efficient water management techniques, holds significant importance. Providing training and incentives to farmers for implementing eco-friendly farming methods and promoting water conservation practices can substantially contribute to mitigating environmental degradation in the wetland area.

Enforcing regulations to control urban expansion and industrial discharges is imperative to maintain the ecological balance of the Kanjli Wetland. It entails enforcing land use zoning regulations to prevent encroachment and uncontrolled urban expansion into wetland areas. Additionally, monitoring and regulating

industrial discharges to prevent the release of harmful pollutants into water bodies is crucial for safeguarding the integrity of the wetland ecosystem.

Initiating habitat restoration and conservation programs is essential for preserving and rejuvenating the Kanjli Wetland. Critical steps are rehabilitating degraded wetland areas and enhancing biodiversity through habitat restoration projects. Establishing protected areas and buffer zones around the wetland to safeguard critical habitats and wildlife populations is indispensable for promoting ecosystem resilience and sustainability.

Lastly, raising awareness and involving local communities are pivotal to wetland conservation efforts. Conducting outreach and educational campaigns to raise awareness about the importance of wetland conservation and sustainable resource management is necessary. Promoting community involvement in conservation efforts through citizen science initiatives, volunteer programs, and stakeholder consultations can instill a sense of ownership and responsibility towards wetland preservation. This approach ensures the long-term health and vitality of the Kanjli Wetland ecosystem.

2.15 Conclusion

The analysis of land use and land cover change in the Kanjli wetland area spans over four decades, delineated using satellite imagery from four different years, a decade apart. The study scrutinizes various land use and land cover classes, including Built-up, Cropland, Fallow land, Mixed Land use, Vegetation, and Waterbody. Over the years, significant transformations have been observed, reflecting both natural and anthropogenic influences.

In 1991, cropland emerged as the dominant land use, followed by fallow land, mixed land use, and built-up areas. However, over the decades, notable shifts occurred, with Vegetation gradually replacing fallow land as the second most dominant class by 2010. Built-up areas witnessed a four-fold increase attributed to urbanization and infrastructural development by 2022. The transformation analysis between consecutive decades revealed substantial conversions, primarily affecting cropland and fallow land. The transformations underscored the aftermath of the local farming drives and economic development initiatives.

The underlying causes of land use and land cover change encompass a spectrum of natural and anthropogenic factors. Altered rainfall patterns, temperature fluctuations, floods, and sedimentation represent natural influences, while agricultural expansion, urbanization, industrialization, and poorly regulated land use symbolize anthropogenic drivers. Consequently, these changes have led to biodiversity loss, water quality degradation, soil erosion, microclimate alteration, and adverse impacts on local communities.

Mitigation and management strategies are imperative to address the escalating challenges of land use and land cover change. Rigorous pollution control measures, sustainable agricultural practices, and regulations to curb urban expansion and industrial discharges are crucial. Additionally, habitat restoration and conservation programs, community involvement, and awareness initiatives are indispensable for ensuring the sustainable management of the Kanjli wetland ecosystem.

The findings highlight the pressing necessity for collaborative efforts and unified action among a diverse array of stakeholders, including governmental bodies, local communities, and conservation associations. By prioritizing ecosystem health and adopting holistic approaches to wetland management, it is possible to mitigate the adverse impacts of land use and land cover change and pave the way for a more sustainable future for the Kanjli wetland and its surrounding landscapes.

CHAPTER- 3

IMPACT OF DEVELOPMENT ACTIVITIES ON KANJLI WETLAND

Wetlands are a crucial part of India's environment because they offer a variety of ecological services like carbon sequestration, flood control and water filtration. However, anthropogenic activities like urbanization, agricultural intensification and industrialization have put wetlands in India in danger. In India, the degradation of wetlands significantly impacts the livelihoods of 74 percent of the rural population, who depend on wetlands for various necessities such as sustenance, irrigation, drinking water, and conveyance. Ladhar (2002) notes that occupants of wetland areas are apprehensive about the decline of wetlands as it jeopardizes their reliance on activities like fish farming and the cultivation of wetland crops such as nelumbium and trapa for sustenance. The ongoing mono-crop agriculture has an impact on the natural system of wetlands. Because people are uninformed of wetland crops and their economic significance, the conversion of wetlands into dry areas is caused by the need for a living. Due to the absence of water access to the wetlands, modern agricultural practices used today might also be held responsible for the decline of wetlands. In their research, Rana et al. (2009) examined the interplay between population growth and its related developmental activities, highlighting the corresponding decrease in the number of trees and shrubs in the tropical wetland regions of Bangladesh. This dynamic ultimately resulted in habitat loss for wildlife, the extinction of various species, and a decline in animal populations.

The wetland's socioeconomic functions are consequently connected to its ecological and biological properties. Sand mining and timber harvesting are among the various economic activities that wetlands support, providing income for local people. Tulu and Desta (2015) examined the ecological impact of human activities on wetlands, noting the transition from subsistence to commercial exploitation over time. The degradation or loss of wetland regions is primarily the result of government policies related to the expansion of industry and agriculture, such as the irrigation canalization of wetland water. Focus must be placed on "down to top" strategies for the preservation and organisation of wetlands, which necessitates the start of local level planning at the initial stage. Degradation of wetlands is linked to damage to

archaeological spots in-and-around them and to the disappearance of organic artifacts. (Nicholas, 1992).

The Kanjli wetland in Punjab, for example, has special devotional significance because of its connection to Shri Guru Nanak Dev Ji. Wetlands have significant economic relevance in addition to its religious significance, as demonstrated by the Naganon district of Assam, where the majority of the population depends on wetlands for fishing, farming, sericulture and the breeding of ducks, goats and livestock (Sarma & Saikia, 2010). According to a study done by Verma et al. (1998), the high fertility of the soil utilized for paddy production means that human meddling has a significant adverse impact on the Ropar wetland in Punjab. It is obvious that wetlands around the world have been significantly impacted by development activities. Flood control, water filtration and habitat for a wide variety of plant and animal species are all critical ecosystem services provided by wetlands. These ecological services are lost when wetlands are damaged or destroyed, which has a number of adverse impacts on both people and the environment.

Kanjli Wetland, as previously stated, is a significant wetland in the Indian state of Punjab. It is well-known for its diverse flora and fauna. However, recent development activities are having an influence on the wetland. The loss of habitat has been the main effect of development activities on Kanjli Wetland. Buildings, roads and other infrastructure have been built in and around the marsh, which is why this has happened. The number of species present in the wetland has decreased, and the region's biodiversity as a whole has decreased as a result of habitat loss. Pollution has also been a result of development activities in the Kanjli Wetland. A natural water filter, the wetland can filter out toxins from the water that passes through it. The ability of the wetland to serve this purpose has been negatively impacted by contamination from industrial waste and agricultural runoff. As a result, the wetland's water quality has deteriorated, which has had an impact on the wellbeing of the plants and animals that call it home.

Development activities have also contributed to an uptick in human presence and engagement within the area. Both the wetland's natural ecosystem and the cultural history of the nearby villages that rely on it have been adversely affected by this. The wetland is a popular location for ecotourism and bird watching, however as a result

of increased human activity; the natural habitats of the local fauna have been disturbed. As a result of construction activities, Kanjli wetland has suffered greatly, including habitat loss, pollution and an increase in human activity.

Therefore, in this chapter an attempt has been made to analyse the impact of developmental activities on Kanjli wetland. Both primary and secondary data sources have been used to accomplish this chapter. Primary data has been collected through extensive field work in 411 households of eleven villages in the study area (Table 3.1).

Table: 3.1
Kanjli Wetland: Village wise Number of Sampled Households

Sr. No.	Village	Households	Sample size (10 %)
1	Badshahpur (6)	145	14.5
2	Beja (8)	25	2.5
3	Boot (3)	623	62.3
4	Chuharwal (137)	176	17.6
5	Dham (7)	110	11.0
6	Hamira (229)	1652	165.2
7	Kanjli (10)	235	23.5
8	Lakhan Kalan (139)	667	66.7
9	Lakhan Khurd ()	224	22.4
10	Paharipur (2)	129	12.9
11	Subhanpur (1)	123	12.3
	Total	**4109**	**410.9**

Source: Census of India, District Census Handbook, Kapurthala, 2011.

There are total 38 administrative units i.e. Kapurthala and 37 villages comes under the buffer of 3 kilometres from study area out of which all eleven villages adjoining Kali Bein river have been considered for the field work. These eleven villages are Badshahpur, Beja, Boot, Chuharwal, Dham, Hamira, Kanjli, Lakhan Kalan, Lakhan Khurd, Paharipur and Subhanpur. Total 4109 households reside in these villages and 10 percent sample size of these households has been taken for further field work. Proportionate random sampling technique has been adopted for the collection of samples from the selected villages. Thus, 10 percent households (411 households) from each village have been surveyed out of which maximum surveyed in the village Hamira and minimum 3 were surveyed in the village Beja. After collecting data further steps like data coding, editing and tabulation and analysis has been done through Microsoft Excel.The Chi-Square test has been carried out in this chapter to

identify if there is a notable connection between various categorical variables, specifically gender and education in respect to Kanjli Wetland's development perceptions. This test has become commonplace in the social sciences and geography in determining whether the differences in category frequencies adduced are a product of random sampling or chance, or are the results of a set condition. Considering the purpose of the study which was to gauge public perception on the effects of development, the Chi-Square test was proficiently able to check whether factors like education and gender were of influence to these perceptions.

The application of the Chi Square test in this chapter also aims to support the assumption that gender and development education, perception and even opinion or attitude does not exist, which is another example of a uniform tendency in different demographic groups. This supports the claim on the need for incorporating spatial and environmental factors in the study of development issues rather than being confined to the demographic factors only. The study strives for a more scientific evaluation of the relationship of the population with categorical variables through this statistical method, particularly in relation to the activities of development in the Kanjli Wetland region.

The results of the study have been presented through appropriate bar, pie charts and maps. In the following sections the detailed description of the impacts of development activities on Kanjli wetland has been done under various sub-themes:

3.1 General Information of the Households
3.2 Development Activities in the Wetland
3.3 Positive Impact of Development Activities in the Wetland
3.4 Negative Impact of Development Activities in the Wetland
3.5 Perception of Respondents Regarding Status of Developmental Activities in Environment Aspect

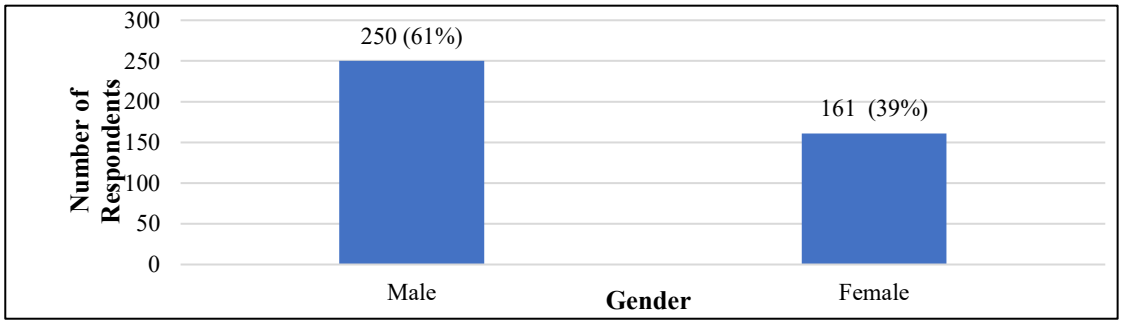
3.1 General Information of the Households

During fieldwork or primary survey, general information about household is crucial for a number of reasons. It provides essential demographic information about households; including their size, make up and location, which is crucial for the study. Researchers can better comprehend the context of a survey by learning general household information. This contains details about households' economic status, traditions and living arrangements, all of which might affect survey results. It enables researchers to contextualize survey results and make necessary correctios to data analysis and interpretation. It is possible for researchers to verify the precision and

caliber of the data gathered during the survey using general household information. It aids in confirming the consistency and dependability of the household responses.

During fieldwork for the present study, 411 households were surveyed. The gender distribution, age range, educational level, residential status, the relationship between respondents and heads of households, size of the household, length of stay in the study area, the primary source of income, ownership of agricultural land, the status of the livestock, house structure, etc. have all been discussed in this section. It is evident from the study that, of the total respondents to the survey, about 61 percent (250 respondents) were male and 39 percent (161 respondents) were female (figure 3.1).

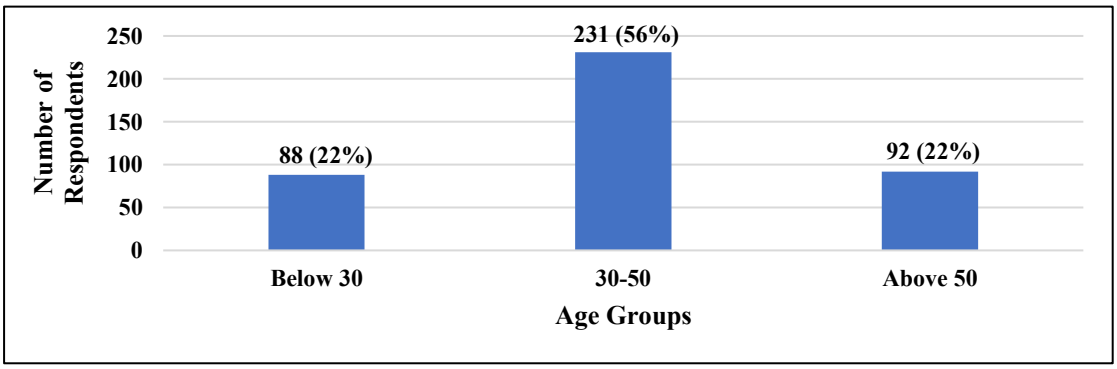
Figure: 3.1
Kanjli Wetland: Gender Composition of Respondents



Source: Field Work, 2023.

During fieldwork, respondents from a variety of age groups were covered. About 56 percent of the respondents (out of all respondents) reported being between the ages of 30 and 50, while 22 percent recorded having older than 50 and 22 percent of respondents recorded under the age of thirty (figure 3.2).

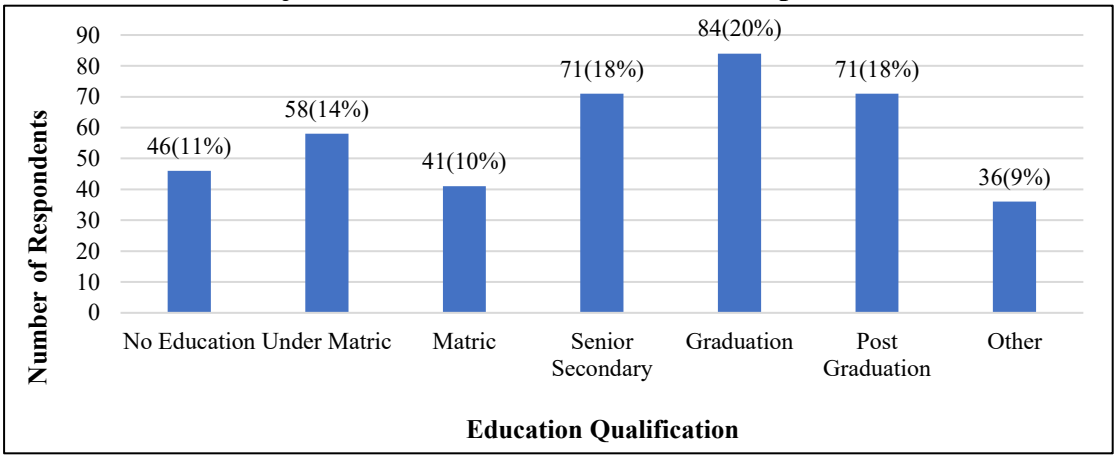
Figure: 3.2
Kanjli Wetland: Age Group of Respondents



Source: Field Work, 2023.

When the respondents' educational status is examined, it becomes obvious that 20% of the respondents had graduated, 18% had completed their post-graduate studies, 18% had passed their 12th grade, 14% had not completed matric, 10% had completed matric and 11% had no formal education (figure 3.3).

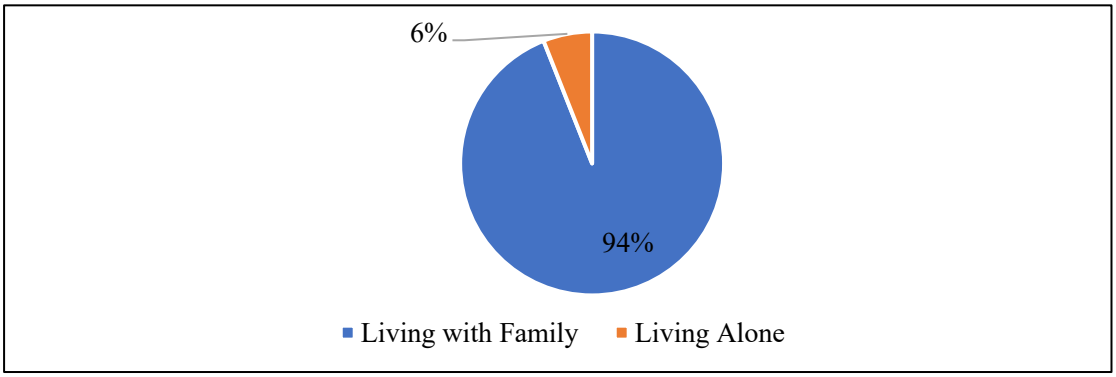
Figure: 3.3
Kanjli Wetland: Education Status of Respondents



Source: Field Work, 2023.

According to the figure 3.4, 94% of individuals have a residential status of living with their family, indicating that they share a living space with their relatives. Conversely, only 6% of individuals have a residential status of living alone, signifying that they reside independently without any family members or roommates.

Figure: 3.4
Kanjli Wetland: Residential Status of Respondents

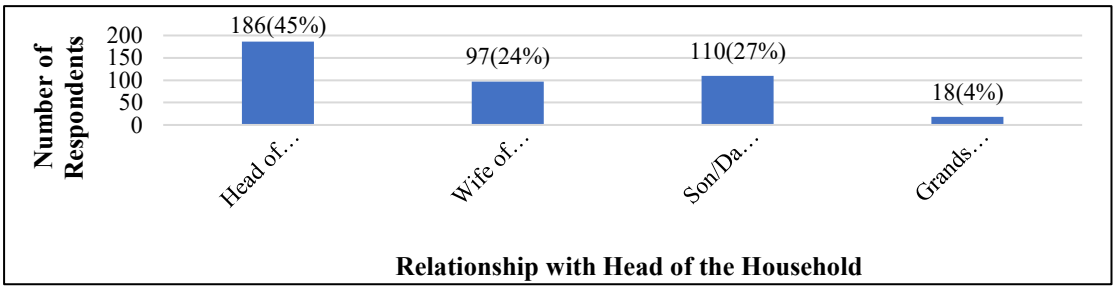


Source: Field Work, 2023.

The figure 3.5 displays the number of respondents and their relationship with the head of the household. The results show that 186 respondents are themselves the head of the household, while 97 respondents are wives of the head. Additionally, 110 respondents are the son or daughter of the head of the household, and 18 respondents

are the grandchild of the head. These results suggest that a significant number of individuals live in multi-generational households where the head of the household is often a parent, with spouses, children and grandchildren also residing in the same household.

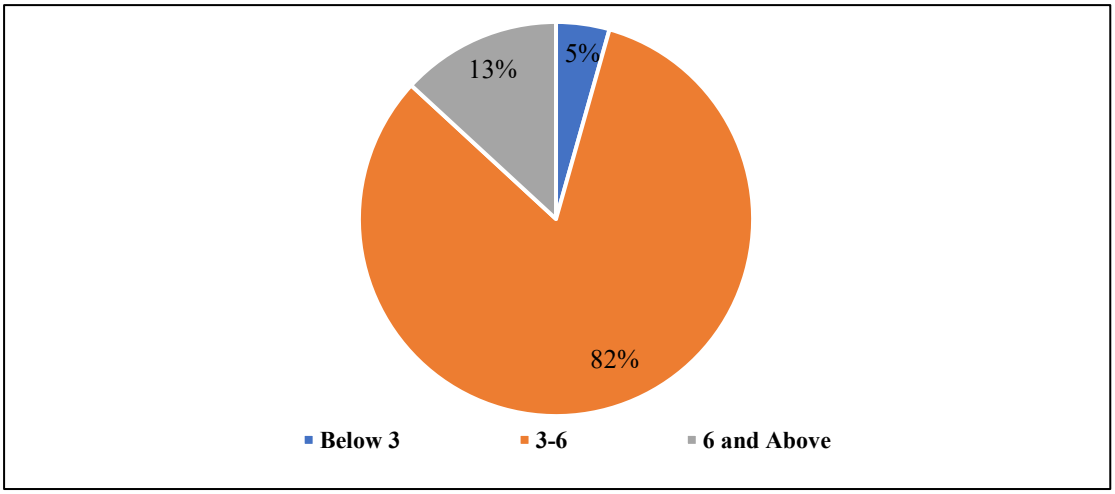
Figure: 3.5
Kanjli Wetland: Relationship of Respondents with Head of the Household



Source: Field Work, 2023.

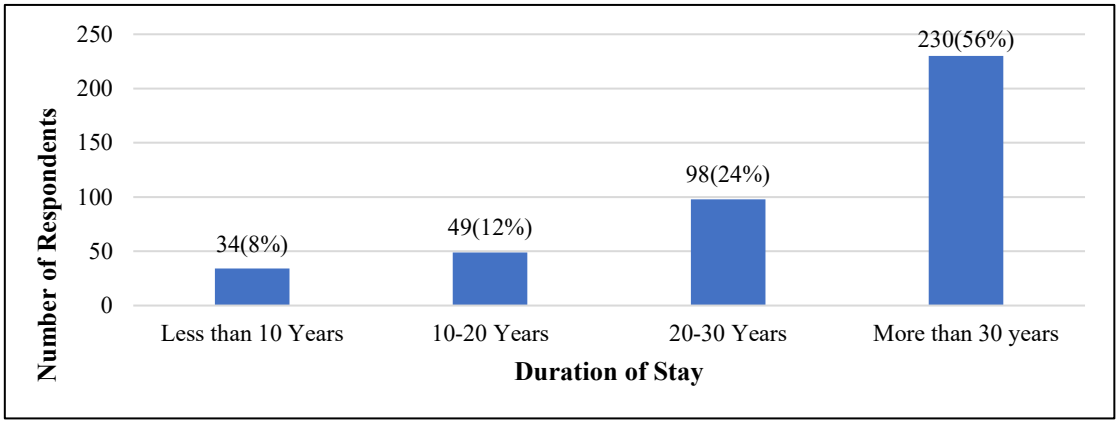
The figure 3.6 shows the number of households and their size based on the number of members. The results show that 18 households (5%) have less than three members, while 339 (82%) households have between 3 to 6 members. Additionally, 54 households (13%) have six or more members. These results suggest that the majority of households have a moderate size, with three to six members. However, a significant number of households have more than six members, indicating larger families or potentially multi-generational households. There is a smaller proportion of households with less than three members, which may indicate single-person households, couples without children or smaller families.

Figure: 3.6
Kanjli Wetland: Size of Household (According to the Number of Members)



Source: Field Work, 2023.

The number of respondents and the duration of their stay at the current location has also been studied during the field work. The results of the study indicate that 34 respondents have lived in their current location for less than 10 years, while 49 respondents have lived there for 10-20 years. Moreover, 98 respondents have lived in their current location for 20-30 years and the majority of respondents, 230, have

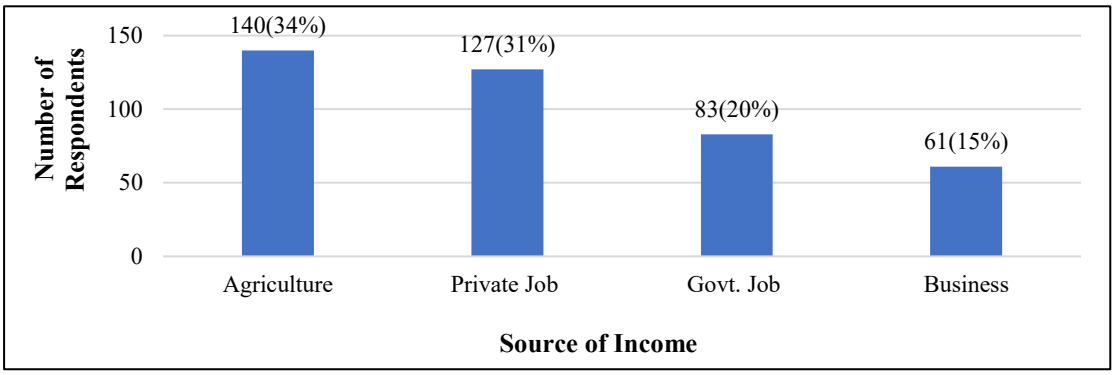


lived there for more than 30 years (Figure 3.7). These results suggest that a significant proportion of individuals have long-term residence at their current location, potentially indicating a sense of attachment or stability. However, a smaller proportion of individuals have recently relocated, which may indicate increased mobility or potentially economic or social factors.

Figure: 3.7
Kanjli Wetland: Duration of Household Stay in the Area
Source: Field Work, 2023.

Figure 3.8 presents the number of respondents and their primary source of income. The results indicate that 140 respondents have agriculture as their primary source of income, followed closely by 127 respondents who rely on private jobs. Additionally, 83 respondents have a government job as their primary income source, while 61 respondents engage in business activities. These findings suggest a diverse range of income sources among the respondents, with agriculture being a significant contributor. Private jobs and government employment are also prominent, indicating a mix of formal employment opportunities. The presence of individuals engaged in business activities highlights entrepreneurship as another important source of income within the surveyed population.

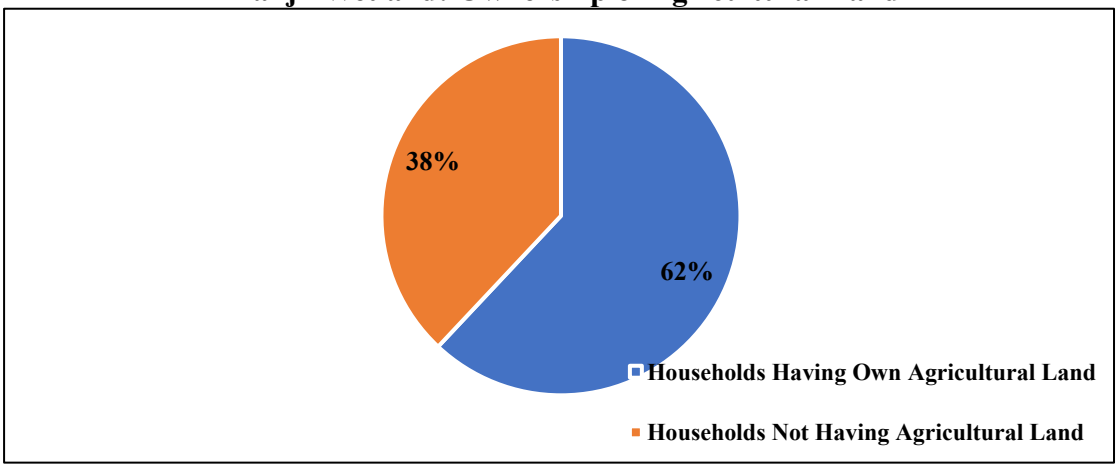
Figure: 3.8
Kanjli Wetland: Household's Primary Source of Income



Source: Field Work, 2023.

The ownership status of agricultural land among the households is shown in the figure below (figure 3.9). The findings indicate that 62% of the surveyed households have agricultural land, while the remaining 38% do not. This shows that the majority of households have access to land for agricultural purposes, indicating a potentially sizeable agricultural industry within the community. The existence of households without agricultural land, on the other hand, implies that not all households are involved in farming, which could point to a more diversified economy with additional sources of income. Overall, these findings shed light on the community's land ownership patterns, which may have consequences for both economic growth and agricultural practices.

Figure: 3.9
Kanjli Wetland: Ownership of Agricultural Land

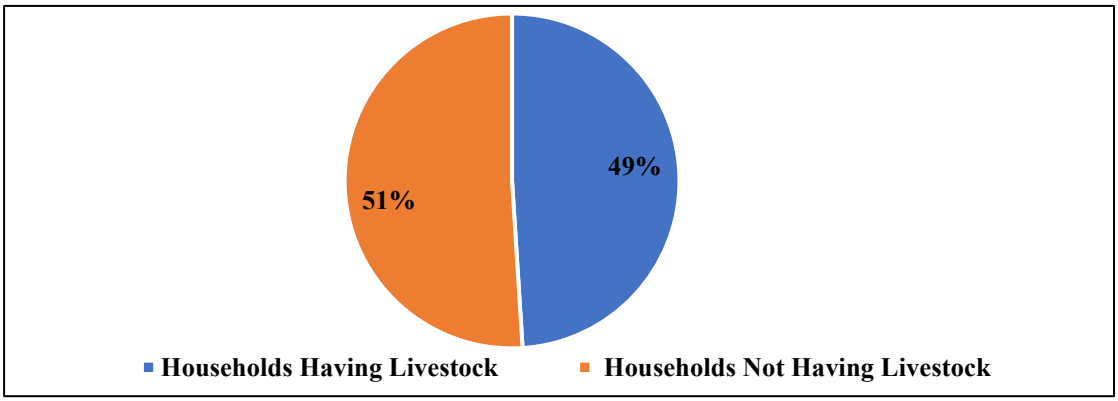


Source: Field Work, 2023.

The ownership of cattle by households is shown in the figure 3.10. The results show that 51% of households surveyed during fieldwork do not have any cattle, compared to the 49% who have cattle. This implies that a significant number of households raise animals, which can benefit the agricultural sector and serve as a source of

revenue through the sale of dairy and meat. The fact that slightly more than half of the families do not possess livestock, however, suggests that not all households raise cattle, or that some households depend on other types of agriculture or non-agricultural revenue sources. These results emphasize the variety of livelihood activities and give information on the community's livestock ownership patterns.

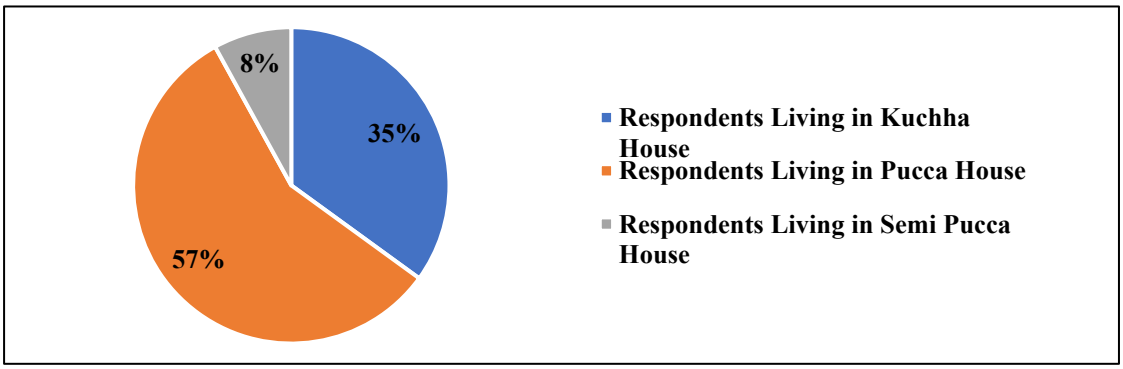
Figure: 3.10
Kanjli Wetland: Household Status of Livestock



Source: Field Work, 2023.

Figure 3.11 illustrates the type of houses among the households. The results of the study reveals that 35% of the respondents live in kutcha houses, which are typically made of temporary or less permanent materials such as mud, thatch or bamboo. Furthermore, the majority, 57%, reside in pucca houses, which are constructed with durable materials like bricks, concrete or stone. A smaller proportion of respondents, 8%, live in semi pucca houses, which may have a combination of permanent and temporary construction elements. These findings provide insights into the housing conditions within the surveyed population, indicating a significant presence of pucca houses and a notable number of kutcha houses, which may require attention in terms of infrastructure and housing development initiatives.

Figure: 3.11
Kanjli Wetland: House Structure of Households



Source: Field Work, 2023.

In conclusion, the provided data offers insights into various aspects of the surveyed population's living conditions and economic activities. The majority of individuals, 94%, live with their families, while a small proportion, 6%, live alone. Regarding the relationship with the head of the household, there is a significant representation of wives, sons/daughters, and grandchildren. When examining the household size, a considerable number of households have 3-6 members, but there are also households with less than three members or six and more members. In terms of income sources, agriculture emerges as the primary income source for a substantial portion of respondents, followed by private jobs, government jobs and business activities. This suggests a diverse economic landscape within the surveyed population. Furthermore, a majority of households, 62%, own agricultural land, while 38% do not have any agricultural land.

When it comes to housing, pucca houses are the most common, with 57% of respondents residing in such structures. Kutcha houses represent 35% of the respondents' dwellings, while 8% live in semi pucca houses. These findings provide valuable information for policymakers, researchers and organizations involved in urban planning, rural development and socioeconomic initiatives. They highlight the need to address housing conditions, support agricultural practices and diversify income opportunities to enhance the overall well-being and economic development of the study area.

3.2 Development Activities in the Wetland

Wetlands are vital ecosystems that provide a wide range of ecological services, including flood control, water filtration and habitat for diverse plant and animal species. However, developmental activities often encroach upon wetland areas, leading to potential positive and negative impacts on these delicate ecosystems. Constructing infrastructure such as roads, bridges and drainage systems in or around wetlands can improve transportation and connectivity, enhancing regional development and accessibility for local communities. Developmental activities in wetland areas can create employment opportunities, promote tourism and attract investment, thus contributing to economic growth and livelihood improvement for nearby communities. Certain developmental activities, such as wetland restoration projects, recreational activities can have positive impacts by rejuvenating degraded

wetlands, enhancing biodiversity and improving overall ecological health (Plate 3.1 and 3.2). These activities include invasive species management, habitat restoration and water quality improvement measures.

.Plate: 3.1

Kanjli Wetland: Recreational Activities (i)

Main Entrance of the Kanjli Wetland

Close View of the Entrance

Photgraphic View at Kanjli Wetland

Birds View at Kanjli Wetland

Residential Birds at Kanjli Wetland

Migraatory Birds at Kanjli Wetland

Pictures of Researcher during Field Work at Kanjli Wetland

Source: Fieldwork, 2023.

Plate: 3.2
Kanjli Wetland: Recreational Activities and Educational setups (ii)

Reccreation Park at Kanjli Wetland

Open Air Gym at Kanjli Wetland

Boating Facility at Kanjli Wetland

Sri Guru Nanak Dev Biodiversity Bagicha at Kanjli Wetland

Library at Kanjli Wetland

Source: Fieldwork, 2023.

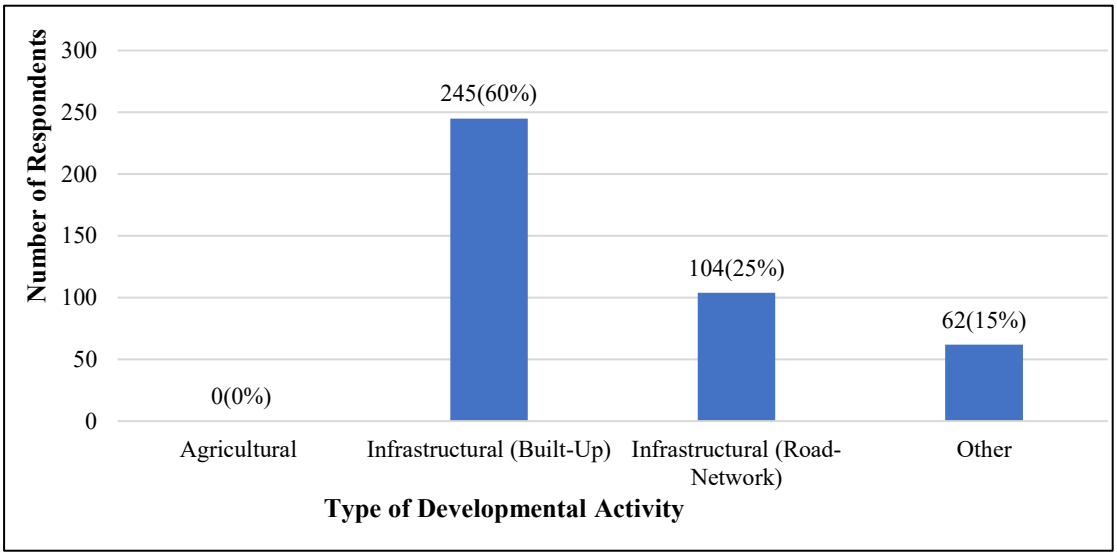
Village	Recreational Use of Kanjli Wetland						Total
	Hiking	Fishing	Bird watching	Boating	Nature photography	Other	
Badshahpur	0%	14%	29%	36%	7%	14%	100 %
Beja	0%	0%	67%	0%	33%	0%	100 %
Boot	0%	18%	32%	19%	16%	15%	100 %
Chuharwal	0%	11%	33%	33%	17%	6%	100 %
Dham	0%	0%	64%	0%	0%	36%	100 %
Hamira	0%	13%	30%	18%	23%	16%	100 %
Kanjli	0%	0%	33%	42%	17%	8%	100 %
Lakhan Kalan	1%	12%	39%	25%	15%	7%	100 %
Lakhan Khurd	0%	0%	41%	27%	9%	23%	100 %
Paharipur	0%	0%	54%	23%	15%	8%	100 %
Subhanpur	17%	8%	33%	8%	17%	17%	100 %
Total	1%	11%	35%	22%	18%	14%	100 %

Development activities frequently lead to the transformation of wetlands into agricultural land, industrial zones, or urban developments. This conversion results in habitat loss and fragmentation, which can displace or threaten numerous native plant and animal species that depend on wetlands for their survival. Altering the natural water flow patterns through drainage, dredging, or diversion channels can disrupt the hydrological balance of wetlands. This can cause changes in water levels, leading to the degradation of wetland habitats and negatively impacting the organisms dependent on these ecosystems. Developmental activities often introduce pollutants into wetlands through industrial runoff, agricultural runoff, or improper waste disposal practices. These pollutants can contaminate the water, soil and sediments, harming the wetland's biodiversity and compromising its ability to perform vital ecosystem functions

In this section, an attempt has been made to examine the development activities in the Kanjli Wetland in accordance with the viewpoints of local communities. There are various developmental activities taking place in the Kanjli wetland. These

activities include infrastructure development, agricultural practices, aquaculture, tourism development, flood control measures and restoration projects. According to the data, infrastructure development—both in terms of built-up infrastructure and road networks—is principally responsible for the encroachment of developmental activities on other land uses. According to the data, 104 respondents reported encroachment linked to road networks, while 245 respondents reported encroachment related to built-up infrastructure. Additionally, 62 respondents also mentioned additional types of encroachment (Figure 3.12).

Figure: 3.12
Kanjli Wetland: Household Perception on Encroachment by Various Development Activities



Source: Field Work, 2023.

The data depicted in the table 3.2 portrays each row with surveyed villages, and the columns displaying the proportion of different types of development activities (agriculture, infrastructure (Built-up), infrastructure (Road Network) and other) which led encroachment in the study area. Table 3.2 illustrates the distribution of causative activities in various villages within the Kanjli wetland area. The data indicate that agricultural activities have not encroached on any other area in any of the villages, whereas infrastructure development has encroached on a considerable percentage of the land, with an average of 60% of the area being built-up. This indicates that the region has experienced urbanization and development. The development of the road network is clearly visible, with around 25% of the land distributed for this purpose. Furthermore, other infrastructure activities account for 15% of land use, highlighting the area's growing development projects. These

findings indicate that the Kanjli wetland area has seen significant urban growth and infrastructural expansion, which could have an influence on the wetland ecosystem and requires cautious environmental planning and management.

Table:3.2
Kanjli Wetland: Percentage Share of Various Development Activities Causing Encroachment in Surveyed Villages

Village	Causal Activities				Total
	Agriculture	Infrastructural (Built-up)	Infrastructural (Road Network)	Other	
Badshahpur	0%	71%	21%	7%	100 %
Beja	0%	100%	0%	0%	100 %
Boot	0%	56%	24%	19%	100 %
Chuharwal	0%	56%	33%	11%	100 %
Dham	0%	100%	0%	0%	100 %
Hamira	0%	66%	19%	15%	100 %
Kanjli	0%	63%	25%	13%	100 %
Lakhan Kalan	0%	37%	40%	22%	100 %
Lakhan Khurd	0%	91%	0%	9%	100 %
Paharipur	0%	46%	31%	23%	100 %
Subhanpur	0%	8%	92%	0%	100 %
Total	0%	60%	25%	15%	100 %

Source: Fieldwork, 2023.

The research question being investigated is whether there is a significant relationship between the type of development activities and the encroachments that villages experience in the Kanjli wetland.

This section of present chapter incorporates the hypothesis testing to consider the research findings. Herein, the null hypothesis (H0) states that villages are independent of the development activity that has encroached upon them, implying

that there is no relationship between the type of development activity and the encroachments that the villages experience. The alternative hypothesis (H1) states that villages are dependent on the development activity that has encroached on them, meaning that the type of development activity is related to the encroachments that the villages confront.

H_0: Villages are independent of the development activity encroached
H_1: Villages are dependent of the development activity encroached

The Chi-Square tests are applied to test these hypotheses. The Chi-Square statistic measures the difference between the observed and expected frequencies, and determines if this difference is significant. The output of the Chi-Square tests is shown in the table 3.3.

Table: 3.3

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	68.367	20	.000
Likelihood Ratio	74.711	20	.000
N of Valid Cases	411		
df= degree of freedom, Asymp. Sig.= Asymptotic Significance or P-value			

Source: Statistical Package for Social Sciences, Version 21.

The p-values for both the Chi-Square tests (Pearson Chi-Square, Likelihood Ratio and Linear-by-Linear Association) are extremely small (*note: less than 0.001, denoted as .000*), showing that the relationship between the type of development activity and encroachments is statistically significant (Table 3.3). Therefore, the tests reject the null hypothesis (H0) and comes to the conclusion that villages are dependent on the development activity encroached upon. In other words, there is a significant relationship between the type of development activity and the encroachments on villages.

According to the analysis, there is a substantial association between the type of development activities and the encroachments experienced by villages in the Kanjli wetland. The Chi-Square tests indicate that the null hypothesis, which states that villages are independent of development activities, is rejected. This means that the type of development activity is related to the encroachments that villages confront. The data highlight the impact of agriculture, infrastructure (built-up and road

network) and other infrastructure activities on the wetland ecosystem, underlining the importance of careful environmental planning and management to deal with the area's urban growth and infrastructure expansion.

3.3 Positive Outcomes of Developmental Activities in Kanjli Wetland

There can be positive outcomes of development in wetland areas. While wetlands are delicate ecosystems that need to be protected, sustainable development in certain cases can bring about positive changes. Some potential positive outcomes of development in the Kanjli wetland are:

A. Economic Growth: Development activities in the Kanjli wetland can stimulate local economies and create employment opportunities. For example, tourism infrastructure development can attract visitors and generate revenue for local communities, contributing to economic growth and poverty alleviation (Plate 3.3).

Village	Economic Activities				Total
	Tourism	Fisheries	Agriculture	Other	
Badshahpur	57%	0%	29%	14%	100%
Beja	0%	33%	33%	33%	100%
Boot	60%	5%	26%	10%	100%
Chuharwal	33%	17%	33%	17%	100%
Dham	9%	36%	45%	9%	100%
Hamira	35%	22%	33%	10%	100%
Kanjli	25%	21%	38%	17%	100%
Lakhan Kalan	28%	27%	39%	6%	100%
Lakhan Khurd	64%	18%	18%	0%	100%
Paharipur	46%	31%	23%	0%	100%
Subhanpur	67%	17%	17%	0%	100%
Total	40%	20%	32%	9%	100%

B. Improved Infrastructure: Development in wetland area can lead to the construction of necessary infrastructure such as roads, bridges and water management systems. These infrastructure improvements can enhance connectivity,

accessibility and water resource management, benefiting local communities and industries.

C. Sustainable Resource Use: Development activities can incorporate sustainable practices that promote the responsible use of wetland resources. For instance, aquaculture projects can provide a controlled environment for fish production while minimizing negative environmental impacts.

D. Conservation and Restoration: Development in the Kanjli wetland can also facilitate conservation and restoration efforts. By implementing appropriate management strategies, it becomes possible to restore degraded wetland, enhance biodiversity and protect endangered species. This can contribute to the long-term health and sustainability of wetland ecosystems.

E. Research and Education: Development projects in Kanjli wetland can provide opportunities for research and educational activities. Scientists and students can study wetland ecosystems, monitor environmental changes and develop innovative solutions for sustainable development. This can lead to increased knowledge and awareness about wetland, ultimately promoting their conservation.

Village	Educational Importance					Total
	Learning Experience to the Individuals	Learning Experience to the community	Researcher	Flora and Fauna Studies	Studies on Water Pollution	
Badshahpur	29%	29%	7%	14%	21%	100%
Beja	33%	33%	0%	33%	0%	100%
Boot	23%	21%	27%	13%	16%	100%
Chuharwal	28%	28%	11%	22%	11%	100%
Dham	0%	82%	0%	18%	0%	100%
Hamira	16%	27%	34%	15%	8%	100%
Kanjli	17%	21%	29%	21%	13%	100%
Lakhan Kalan	15%	7%	22%	33%	22%	100%
Lakhan Khurd	0%	41%	23%	27%	9%	100%
Paharipur	15%	46%	8%	15%	15%	100%
Subhanpur	25%	42%	25%	8%	0%	100%

Total	17%	26%	26%	19%	12%	100%

It is crucial, however, that development in Kanjli wetland is undertaken with careful planning, adherence to environmental regulations and consideration of the long-term impacts. Balancing development with conservation is essential to ensure the protection of wetland ecosystems and the services they provide for both present and future generations.

According to the figure 3.13, positive outcomes of development in Kanjli wetland include increased prosperity (82 responses), job creation (100 responses), improved transportation (141 responses), enhanced financial security (84 responses) and other benefits (4 responses). These outcomes can contribute to economic growth, employment opportunities, better connectivity and improved livelihoods for communities in and around wetland areas and are discussed in detail in following paragraphs:

Plate: 3.3
Kanjli Wetland: Socio-Economic and Cultural Significance

Economic Significance of Kanjli Wetland


Cultural and Religious Significance of Kanjli Wetland

Agricultural Significance of Kanjli Wetland

Interaction with Farmers at Village Kokalpur

Source: Fieldwork, 2023.

i) Prosperity: Development in Kanjli wetland can contribute to overall prosperity by stimulating economic growth and generating income opportunities. For instance, the establishment of industries, commercial complexes and tourism infrastructure in wetland area can attract investments and foster local businesses. This can lead to increased economic activity, tax revenues and improved living standards for communities in and around the wetland areas.

ii) Job Creation: Development activities in wetland lead to the creation of employment opportunities. Infrastructure projects, such as the building of roads, bridges and structures, require a significant workforce. Additionally, sectors like tourism, agriculture, aquaculture and conservation efforts in wetlands can generate jobs across various skill levels (Plate 3.3). This can contribute to reducing unemployment rates and enhancing socio-economic well-being.

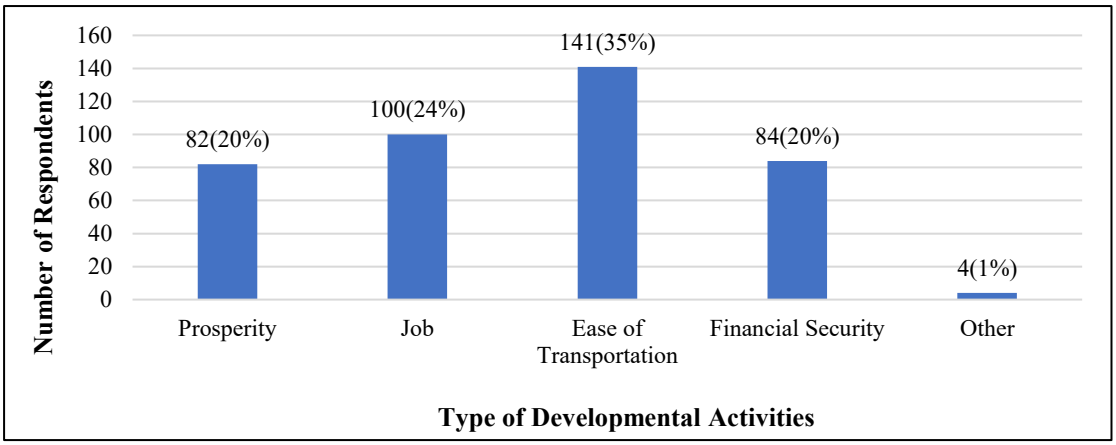
iii) Ease of Transportation: Development in wetland, such as the construction of roads and bridges, can improve transportation connectivity. This facilitates the movement of people, goods, and services, making it easier for communities to access markets, education, healthcare facilities, and other essential services. Improved

transportation infrastructure can also attract investment and promote regional development.

iv) Financial Security: Development in wetland can provide financial security through various means. For example, agricultural activities in wetlands can increase agricultural output, ensuring food security and income for farmers. Additionally, infrastructure projects can create revenue streams through toll collection, enhancing the financial stability of local governments. This financial security can be utilized for further development initiatives, public welfare programs and infrastructure maintenance.

v) Other Benefits: The category of "Other" positive outcomes could encompass a range of additional benefits. For instance, the development of wetlands can promote eco-tourism, providing recreational opportunities for visitors and boosting the local economy. It can also contribute to educational and research opportunities, allowing scientists, students and conservationists to study and understand wetland ecosystems better. Furthermore, development activities can support the restoration and conservation of Kanjli wetland, preserving its ecological value and providing habitats for diverse plant and animal species.

Figure: 3.13
Kanjli Wetland: Positive Outcomes of Developmental Activities



Source: Field Work, 2023.

It's worth noting that while these positive outcomes are possible, responsible and sustainable development practices are crucial to minimize negative impacts on wetland ecosystems. Environmental regulations, careful planning and monitoring are necessary to ensure the long-term health and preservation of wetlands.

Thus, development in Kanjli wetland area can bring about positive outcomes such as increased prosperity, job creation, improved transportation, financial security and various other benefits. By balancing development with conservation, it is possible to harness these positive outcomes while preserving the ecological integrity of wetland ecosystems.

Table: 3.4
Kanjli Wetland: Perception of People regarding Positive Impacts of Development Activities

Positive Outcomes of Development	Frequency	Percent
Prosperity	82	20%
Job	100	25%
Ease of Transportation	141	34%
Financial Security	84	20%
Other	4	1%
Total	411	100%

Source: Fieldwork, 2023.

The data in table 3.4 and 3.5 is showing the perception of people regarding positive impacts of developmental activities in Kanjli wetland. Table 3.5 presents the positive impacts of development activities on the Kanjli Wetland by gender. According to the data, development has resulted in overall positive outcomes for males and females in the study area. In terms of prosperity, job possibilities and ease of transportation, both genders have seen major advances, with males benefiting significantly more. Financial security has also benefited both genders, although females seem to have benefited more from these activities. However, it is crucial to highlight that the gender difference in these positive outcomes is minor. The findings also indicate that development activities in Kanjli Wetland have contributed to improved living conditions and opportunities for both males and females, with a relatively even distribution of profits across the genders.

Table: 3.5
Kanjli Wetland: Positive Impacts of Development Activities (Percentage of Respondents)

Gender	Positive Outcomes of Development					Total
	Prosperity	Job	Ease of Transportation	Financial Security	Other	
Male	22%	25%	31%	22%	1%	100%
Female	17%	24%	40%	18%	1%	100%
Total	20%	24%	34%	20%	1%	100%

Source: Fieldwork, 2023.

Furthermore, the relationship between gender and development opinions has been investigated using two hypotheses: The first alternative hypothesis (H1) asserts that there is a relationship between gender and opinions about the positive outcomes of development activities. The null hypothesis (H0) assumes that gender and opinions are not related to each other means that there is no relationship between them. A chi-square test is used to test these hypotheses (Table 3.6). The chi-square test statistic is 4.173 with 4 degrees of freedom. This test statistic's corresponding p-value is 0.383. The likelihood ratio is also presented, along with their p-values.

H_0: Gender is independent of believes for the positive outcomes of Development

H_1: Gender is dependent on believes for positive outcomes of Development

Table: 3.6

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	4.173	4	.383
Likelihood Ratio	4.160	4	.385
N of Valid Cases	411		
df= degree of freedom, Asymp. Sig.= Asymptotic Significance or P-value			

Source: Statistical Package for Social Sciences, Version 21.

As the p-value (0.383) is larger than the accepted significance level of 0.05, we cannot reject the null hypothesis. In other words, there is not enough evidence to support the claim that gender and opinions about positive developmental outcomes are interconnected. Based on this analysis, it is possible to conclude that there is no statistically significant association between gender and perceptions regarding the positive impacts of development initiatives. According to the findings, both male and female respondents had the same perceptions of the positive outcomes of development initiatives, and gender plays no role in shaping these opinions.

Ultimately, the data presented in Tables 3.4 and 3.5 reveal that development activities in Kanjli Wetland resulted in overall positive outcomes for both males and females, with considerable gains in prosperity, job opportunities, ease of transportation, and financial stability. Although males appeared to gain more in several areas, the gender gap in these favourable effects was minor. Furthermore, the chi-square test results (p-value = 0.383) show no statistically significant relationship between gender and perceptions of the beneficial effects of development projects. Both male and female respondents had similar perceptions. As a result, the data

indicate that development measures have had an equal influence on the lives of both genders in the study area.

Table: 3.7
Kanjli Wetland: Education Level of Respondents and Positive Outcomes of Development

Education	Positive Outcomes of Development					Total
	Prosperity	Job	Ease of Transportation	Financial Security	Other	
No Education	6	14	14	12	0	46
Under Matric	13	10	21	15	0	59
Matric	7	10	15	11	0	43
Senior Secondary	15	19	18	19	0	71
Graduation	12	28	31	12	1	84
Post Graduation	19	12	31	7	3	72
Other	10	7	11	8	0	36
Total	82	100	141	84	4	411

Source: Fieldwork, 2023.

Table 3.7 presents the findings of fieldwork carried out at Kanjli Wetland, with an emphasis on the respondents' education level and the positive outcomes of development they associate with it. The respondents were classified according to their educational level, which ranged from "No Education" to "Post Graduation." Development's positive outcomes include "Prosperity," "Job," "Ease of Transportation," "Financial Security," and "Other." The key findings indicate that respondents with higher education levels, specifically "Senior Secondary," "Graduation" and "Post Graduation," have a higher number of positive outcomes across all categories than those with lower education levels. It indicates that education is critical to obtaining favourable development results in the study area, with higher education levels favourably influencing characteristics such as prosperity, job opportunities, transit ease and financial security. It is important to emphasize, however, that there is still potential for progress in several areas, as a large number of respondents continue to connect positive results with lower education levels. These findings highlight the importance of encouraging education

and its potential contribution to the Kanjli Wetland community's overall development and well-being.

The alternate hypothesis (H1) and the null hypothesis (H0) have been created to evaluate the independence of education and people's perceptions of positive development results. The null hypothesis (H0) assumes that there is no association between education and people's perception. On the other hand, the alternative hypothesis (H1) suggests that there is a dependency between education and people's beliefs regarding positive outcomes of development. The author used Chi-Square tests on the data to examine these hypotheses. The Chi-Square test is used to determine if there is a significant relationship between two category variables.

H_0: Education is independent of the peoples believes for positive outcomes of Development.

H_1: Education is dependent of the peoples believes for positive outcomes of Development.

Table: 3.8

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	35.546	24	.061
Likelihood Ratio	35.664	24	.059
N of Valid Cases	411		
df= degree of freedom, Asymp. Sig.= Asymptotic Significance or P-value			

Source: Statistical Package for Social Sciences, Version 21.

The Chi-Square test results (Table 3.8) show that the Pearson Chi-Square value is 35.546 with 24 degrees of freedom. The corresponding p-value is 0.061. With 24 degrees of freedom, the Likelihood Ratio Chi-Square value is 35.664. The corresponding p-value is 0.059. Both the tests produced p-values greater than the standard significance criterion of 0.05 (or 5%). As a result, the researcher is unable to reject the null hypothesis (H0). Based on these findings, there is insufficient evidence to draw the conclusion that education is dependent on people's perceptions regarding positive developmental outcomes. As a result, the Chi-Square tests suggest that education and people's perception of favourable development outcomes are likely to be independent.

In conclusion, the data from the fieldwork at Kanjli Wetland show that higher education levels, such as "Senior Secondary," "Graduation," and "Post Graduation,"

are connected with a greater number of positive development outcomes across multiple categories. However, a sizable proportion of respondents still associate positive outcomes with lesser education levels. According to the Chi-Square tests, education and opinions of favorable development outcomes are most likely independent. Nevertheless, the importance of encouraging education and its potential contribution to the Kanjli Wetland community's overall development and well-being cannot be underestimated. More studies and initiatives may be required to address the possibility of growth in places where lower levels of education are still associated with favorable development outcomes.

3.4 NegativeOutcomes of Developmental Activities in Kanjli Wetland

There are also some negative aspects of development in the Kanjli Wetland area. While development activities can bring certain benefits, they can also have detrimental impacts on wetland ecosystems. Here are some potential negative aspects of development in Kanjli Wetland:

A) Loss of Biodiversity: Development activities often involve habitat destruction and fragmentation, leading to the loss of biodiversity. Kanjli Wetland is likely home to diverse plant and animal species, some of which may be rare or endangered. When wetland areas are converted into built-up infrastructure or agricultural land, it disrupts the natural habitats and ecological balance, potentially leading to the decline or extinction of species.

B) Disruption of Ecosystem Services: Wetlands provide valuable ecosystem services such as water filtration, flood control and carbon sequestration. Development activities can disrupt these services, affecting the overall health and functioning of the ecosystem. For example, the conversion of wetlands for agriculture or urbanization can reduce their ability to filter pollutants, resulting in water pollution and a loss of water purification capacity.

C) Water Management Issues: Wetland play a crucial role in regulating water flow, especially during periods of heavy rainfall or flooding. Altering the natural hydrological processes through development activities can disrupt the water balance in the wetland and surrounding areas. This can lead to increased flood risks downstream and reduced availability of water during dry periods.

D) Soil Degradation: Wetland soils are typically rich in organic matter and have unique characteristics. Development activities, particularly intensive agriculture or improper land use practices, can lead to soil degradation, erosion and loss of fertile wetland soils. This can reduce soil productivity, impact agricultural yields and contribute to sedimentation and water pollution.

E) Impact on Indigenous Communities: The development of Kanjli wetland area can have social implications, particularly for indigenous communities that have traditional ties to these ecosystems. The loss of wetland resources and disruption of traditional livelihoods can lead to social and cultural disturbance within these communities.

F) Increased Pollution: Development activities resulted in increased pollution in the Kanjli Wetland area. Industrial and urban runoff, agricultural fertilizers and pesticides and other pollutants may enter the wetland ecosystem, negatively impacting water quality and the health of aquatic plants and animals. This pollution can have cascading effects throughout the food chain and ultimately harm human health if wetlands are used for drinking water or other purposes.

G) Loss of Cultural and Recreational Value: Wetlands often hold cultural and recreational significance, providing spaces for traditional activities, eco-tourism, and recreational pursuits. Development in Kanjli wetland can lead to the destruction or alteration of these cultural and recreational spaces, resulting in the loss of their value and potential negative impacts on local communities and tourism.

It is crucial to balance development activities with conservation measures to minimize these negative impacts. Sustainable development practices, proper land-use planning and environmental regulations can help mitigate the potential harm to Kanjli Wetland and preserve its ecological integrity and socio-cultural values.

3.5 Perception of Respondents Regarding Status of Developmental Activities in Environment Aspect

According to the responses of fieldwork, the majority of respondents (79%) perceive the developmental activities in Kanjli Wetland as not being environmentally friendly. This indicates that there are concerns about the negative environmental impacts

associated with these activities. Here are some potential reasons behind this perception:

A) Habitat Destruction: Development activities frequently entail land clearing, which can lead to the destruction of natural habitats within wetland areas. Wetlands are unique ecosystems that support diverse plant and animal species. Clearing land for infrastructure, agriculture, or other purposes can lead to the loss of critical habitats, disrupt ecological processes, and result in the decline or displacement of native species.

B) Water Pollution: Development can contribute to increased water pollution in the wetland area. Runoff from construction sites, agricultural fields and industrial activities can introduce pollutants such as sediment, fertilizers, pesticides and chemicals into the water bodies. This pollution can have detrimental effects on water quality, aquatic life and the overall health of the wetland ecosystem.

C) Disruption of Hydrological Balance: Wetlands play a vital role in regulating water flow, maintaining water tables and controlling flooding. Development activities, such as altering drainage patterns or constructing impervious surfaces, can disrupt the natural hydrological balance of the wetland. This can result in changes in water availability, increased flooding and the loss of important wetland functions.

D) Loss of Biodiversity: Development activities can cost biodiversity in the wetland area. Wetlands are known for their high species diversity and provide habitats for numerous plants, animals, and migratory birds. When wetlands are converted or fragmented, it can lead to the displacement or extinction of species, disrupting the delicate ecological balance and diminishing the overall biodiversity of the area.

E) Carbon Emissions and Climate Change: Development activities, particularly those involving infrastructure and transportation, can contribute to increased carbon emissions and exacerbate climate change. Construction machinery, transportation vehicles and energy-intensive operations release greenhouse gases into the atmosphere. Climate change can have significant implications for wetland ecosystems, including sea-level rise, altered precipitation patterns and changes in temperature, which can negatively impact wetland health and functionality.

It is essential to acknowledge that not all developmental activities in wetlands are inherently environmentally unfriendly. With proper planning, implementation of sustainable practices and adherence to environmental regulations, it is possible to mitigate and minimize the negative impacts. Implementing measures such as green infrastructure, conservation initiatives and sustainable land-use practices can help strike a balance between development and environmental protection.

Engaging in environmentally friendly practices, such as wetland restoration, conservation of critical habitats and sustainable resource management, can promote the long-term health and resilience of the wetland ecosystem. Embracing a holistic approach that considers the social, economic and ecological aspects is crucial to ensure that development in Kanjli Wetland is sustainable and preserves its environmental integrity.

In nutshell, it can be concluded that, the changes in the Kanjli wetland ecosystem have impacted the biodiversity of the region, affecting the presence and abundance of various species. Pollution and human activities have resulted in a decline in water quality, potentially affecting the wetland's ability to support aquatic life. Expanding agriculture or industrial practices have led to land conversion, reducing the natural habitat and altering the landscape. An increase in the population of the nearby villages have influenced the social dynamics, infrastructure needs and resource distribution. Improved access to education, healthcare and other social services have positively affected the well-being of the communities. The cultural practices and traditions of the local communities have undergone changes due to urbanization and external influences. Shifts in agricultural practices, such as the adoption of new technologies or changes in crop patterns have impacted the income and livelihoods of farmers in the area. The wetland has gained popularity as a tourist destination, it may have led to the development of tourism-related businesses, contributing to the local economy. Changes in industries and economic activities can influence employment opportunities, with potential shifts from traditional sectors to more modern ones.

In addition to the above, the land use and land cover (LULC) analysis of Kanjli Wetland over four decades provides insights into the waxing and waning of the wetland’s ecosystem along with the livelihoods dependent on it in relation to the

surrounding infrastructure expansion, agricultural intensification and conservation measures taken. The monitoring of development activities provided in this chapter can be aligned with LULC patterns to better understand the changing landscape over time which is attributed to developmental actions taken in the region.

Rapid urbanization and infrastructural expansion are clearly visible by the significant increase of built-up area in Kanjli Wetland from 4.14 km² in 1990 to 16.65 km² in 2022. This relates well with the economic growth and employment opportunities discussed in this chapter. For example, two decades ago, only 20% of respondents noted increased economic prosperity while 24% attributed the changes to creation of employment opportunities. The increase of economic activity is however counterbalanced with the loss of agricultural land, where cropland decreased from 86.25 km² to 74.19 km² and fallow land plummeted from 24.26 km² to 14.36 km². This suggests a delicate balance between economic growth and agricultural productivity in the region.

The mention of ease of transport by 35% of respondents, coincide with the infrastructural development in the region. At the same time, there has been a decline of 80 percent in mixed land uses. This could indicate specialization in land use, but may also impact the economic diversity in the region. Moreover, although the area of vegetation cover has increased from 6.49 km² in 1990 to 24.71 km² in 2022, the area covered by water bodies has decreased from 1.57 km² to 1.38 km², which suggests possible encroachment as well as hydrological disequilibrium, despite the conservation measures undertaken.

The examination of land use and land cover changes (LULC) for Kanjli Wetland during the period between 1990 and 2022 reveals vital information regarding how development activities have altered the landscape. The observed changes during the period under analysis directly result from urban growth, agricultural practices and the depletion of wetland resources.

Conclusion

There is complete consensus that development activities are taking place in Kanjli wetland. The impacts of development reported by respondents include small landholdings being affected (57 respondents), dependence on migrant laborers (116 respondents), and unwillingness to practice agriculture (191 respondents).

Additionally, there were 47 respondents who mentioned other impacts, which were not specified. In terms of the environmental friendliness of the developmental activities, 79% of respondents perceive them as not being environmentally friendly, while 21% consider them to be environmentally friendly.

All respondents (100%) acknowledged the presence of positive outcomes resulting from development. These positive outcomes include prosperity (82 respondents), job creation (100 respondents), ease of transportation (141 respondents), financial security (84 respondents) and other unspecified positive outcomes (4 respondents). All respondents (100%) also recognized the presence of negative aspects of development, indicating that there are concerns or drawbacks associated with the developmental activities taking place. The specific nature of these negative aspects was not elaborated upon in the provided information.

It is important to note that these responses reflect the opinions of the respondents and may not capture the full range of positive and negative impacts or the overall complexity of the developmental activities in Kanjli Wetland. Further information and analysis would be required to gain a comprehensive understanding of the developmental activities and their impacts on the environment, society and the wetland ecosystem as a whole.

CHAPTER-4

IMPACT OF WETLAND DEGRADATION ON PEOPLE'S LIVELIHOOD

Wetlands are crucial ecosystems globally, often referred to as the earth's "kidneys" for their role in purifying water and supporting essential ecological functions. However, rapid population growth has led to widespread degradation and loss of wetlands due to factors such as pollution, land reclamation, changes in land use, and urbanization. This degradation poses threats to human health, biodiversity, regional climate, and ecological security. As a result, repairing these degraded wetlands is critical. The Wetlands and Water Synthesis report from the Millennium Ecosystem Assessment (2005) provides an in-depth examination of the function of wetlands in sustaining human well-being. The focus is on highlighting the vital ecosystem services offered by wetlands, including water purification, flood regulation, and support for agriculture and fisheries, alongside the factors driving wetland degradation like land use and climate change, and their repercussions on human health and sustenance. Wetlands stand as some of the most productive ecosystems globally, furnishing various ecological, economic, and societal advantages to nearby communities. Nevertheless, human actions like land use alterations, pollution, and excessive exploitation have precipitated wetland deterioration worldwide. This decline significantly impacts people's means of living, particularly those dependent on wetland resources for their sustenance. The decline in wetlands can lead to the loss of crucial ecosystem services such as water purification, flood regulation, and carbon sequestration. The study entitled "Biodiversity and its Conservation in the Sundarban Mangrove Ecosystem" by Gopal and Chauhan (2006) investigates the ecological relevance of the Sundarban mangrove ecosystem and the issues involved in protecting its biodiversity. They also emphasize the importance of mangroves in sustaining local populations' livelihoods and the need for coordinated management techniques to maintain this unique environment. This loss can have significant negative impacts on local communities, including reduced access to clean water, increased risk of flooding and reduced opportunities for income generation. Additionally, wetlands serve as vital habitats for a diverse array of plant and animal

species, including numerous commercially significant ones. The degradation of wetlands is a growing concern worldwide and it has significant implications for people's livelihoods, particularly those who depend on the ecosystem services provided by wetlands. The loss or degradation of wetlands can therefore have significant impacts on the availability and productivity of these resources, affecting the livelihoods of those who depend on them. Valbo-Jorgensen (2009) investigates the link between wetlands and people's livelihoods and examines the issues encountered by populations living in and around wetlands, such as wetland ecosystem deterioration caused by human activities such as drainage, damming and pollution. The study contends that the deterioration of wetlands can have serious consequences for local people, particularly those who rely on wetland resources for a living. Given the importance of wetlands for both ecological and human well-being, it is crucial to understand the impacts of wetland degradation on people's livelihoods. This chapter will therefore explore the different ways in which wetland degradation can affect people's livelihoods, including impacts on water resources, agriculture, fisheries and tourism. It is also an attempt to examine the different factors that contribute to wetland degradation and the negative impacts of wetland degradation on people's livelihoods.

The current chapter delves into the repercussions of wetland degradation on local livelihoods, with a particular emphasis on the Kanjli Wetland. This wetland faces imminent peril from a range of human-induced activities, including alterations in land use, urban expansion, industrial growth, and intensified agricultural practices. These actions have led to the deterioration of the wetland, diminishing its ecological vitality and operations. Consequently, the decline in the wetland's condition has impacted the livelihoods of nearby communities, which rely on it for their well-being. In "Wetland degradation and its impacts on livelihoods in Bangladesh," Kibria et al. (2013) investigate the effects of wetland degradation on the livelihoods of local populations in Bangladesh. The study emphasizes the value of wetland resources for livelihoods and investigates the numerous variables that contribute to wetland degradation in the region. The study highlights the need of long-term management practices that balance the demands of wetlands and local populations. The impact of

wetland degradation on livelihoods of the people can be seen through various dimensions such as food security, water availability, income generation and cultural identity. The local communities around Kanjli Wetland depend on wetland resources for their food and nutritional security. The UNDP (United Nations Development Programme) study "Wetlands and livelihoods: Integrating people and nature for sustainable development" (2016) gives a thorough examination of the relationship between wetlands and human well-being and underlines the vital role of wetlands in sustaining livelihoods, as well as the significance of protecting and maintaining these ecosystems in a way that balances people's and nature's demands. The wetland provides them with fish, wild vegetables and other aquatic resources, which have now become scarce due to the degradation of the wetland. The degradation of the wetland has also affected the availability of water for domestic and agricultural purposes. Abdi et al. (2017) investigated the effects of wetland degradation on people's livelihoods in Kenya's Lake Victoria region. The study revealed that wetland degradation has a detrimental impact on local residents, including decreased access to water, food and income-generating possibilities. The study stresses the need of long-term wetland management practices that prioritize conservation and livelihoods. Choudhury and Das (2018) investigated the impact of wetland degradation on people's livelihoods in West Bengal and discovered that wetland degradation had a significant negative impact on the local population's livelihoods, particularly those dependent on agriculture and fisheries. They highlight the importance of policy actions to reduce wetland degradation and safeguard people's livelihoods. The local communities rely on the wetland for irrigation and domestic water supply, which has been severely impacted due to the degradation of the wetland. The reduction in water availability has resulted in reduced agricultural productivity, affecting the income of the farmers who depend on the wetland for their livelihood.

Islam et al. (2019) investigated the influence of wetland degradation on rural people's livelihoods in Chalan Beel, Bangladesh. In this study it has been discovered that wetland degradation had a harmful influence on agriculture, fisheries and other activities in the region, leading to poverty and food insecurity. The study stressed on the requirement of sustainable wetland management in preserving natural resources and supporting community well-being. Singh et al. (2020) investigates the influence

of wetland degradation on livelihoods in India in their study. They discovered that wetland degradation has a substantial negative influence on the economy, society, and environment, and they suggested conservation approaches such as using ecosystem services and sustainable livelihood practices. Similarly, Jamshidi et al. (2021) investigated the effects of wetland degradation on rural livelihoods in Iran. Their findings revealed that wetland degradation has resulted in a drop in ecosystem services, which has a severe impact on local livelihoods, particularly for people who rely on wetland resources like agriculture and fishing. The study give emphasis to the need of conservation and restoration activities to preserve the long-term viability of wetland-dependent livelihoods. The degradation of the wetland has also resulted in the loss of cultural identity and traditional knowledge associated with the wetland. The local communities have a strong cultural connection with the wetland and it forms an integral part of their identity. However, the degradation of the wetland has led to the loss of traditional knowledge and practices associated with the wetland. The degradation of Kanjli Wetland has significant implications for people's livelihoods, particularly those who depend on the wetland for their sustenance. The impact of wetland degradation can be seen through various dimensions such as food security, water availability, income generation and cultural identity. Therefore, there is an urgent need for conservation and restoration of Kanjli Wetland to ensure the well-being and livelihoods of the local communities. in order to achieve the objective:

To assess the impact of Kanjli wetland degradation on people's livelihoods, data has been collected using field work. The lack of availability of secondary data at both the government and non-government level for various decades made it difficult to analyze the Kanjli Wetland in the context of the long-term impact of the developmental activities. To counter this gap, the Chapter 2 of the present study utilized satellite images from different periods in time to visually assess changes in land use and land cover (LULC). The chapter enabled detection of changes in the extent of the wetland, vegetation cover, waterbodies and built-up areas at different points in time, considering the developmental activities that were undertaken. This geospatial technique allowed to fill the gap in the data and provided a way of understanding the changes which occurred in the context of the wetland ecosystem in a scientifically justifiable manner. In an attempt to compliment the full information on this aspect, in the chapter 3 and 4, researcher undertook a field survey that focused on assessing the perceptions of the local communities about the impacts of the development activities on

Kanjli Wetland. This approach was important because it offered evidences from the local residents who directly experienced the changes and hence had valid concerns and opinions regarding them. This approach, combining satellite imagery-based analysis and perception-based research, was essential for a complete assessment of the development impacts on Kanjli Wetland from different angles which include social and spatial aspects of environmental change.

During the fieldwork, 411 households were surveyed in 11 villages and their opinions on the impact of degradation of Kanjli Wetland on the livelihood of people were obtained; a detailed explanation of the results is provided below under the following sub themes:

4.1 Degradation in the Kanjli Wetland

4.2 Causes of Degradation in the Kanjli Wetland

4.3 People's Reliance on Wetlands in Terms of Socio-Economic and Cultural Values

4.4 Impact of the Degradation Activities on People’s Livelihood

4.1 Degradation in the Kanjli Wetland

Wetlands are one of the most productive ecosystems on the planet, offering a variety of ecosystem services like as water purification, flood control and biodiversity support. However, wetlands are increasingly threatened by human activities such as land use changes, pollution and overexploitation of natural resources and the Kanjli Wetland is one such wetland that is deteriorating. The Kanjli Wetland is an important bird refuge as well as a source of water for agriculture and drinking in the region. However, the wetland is under threat from encroachment, pollution and unsustainable resource usage. Human activities including encroachment, agricultural development and sewage water are the primary causes of the deterioration of the Kanjli Wetland (Plate 4.1).

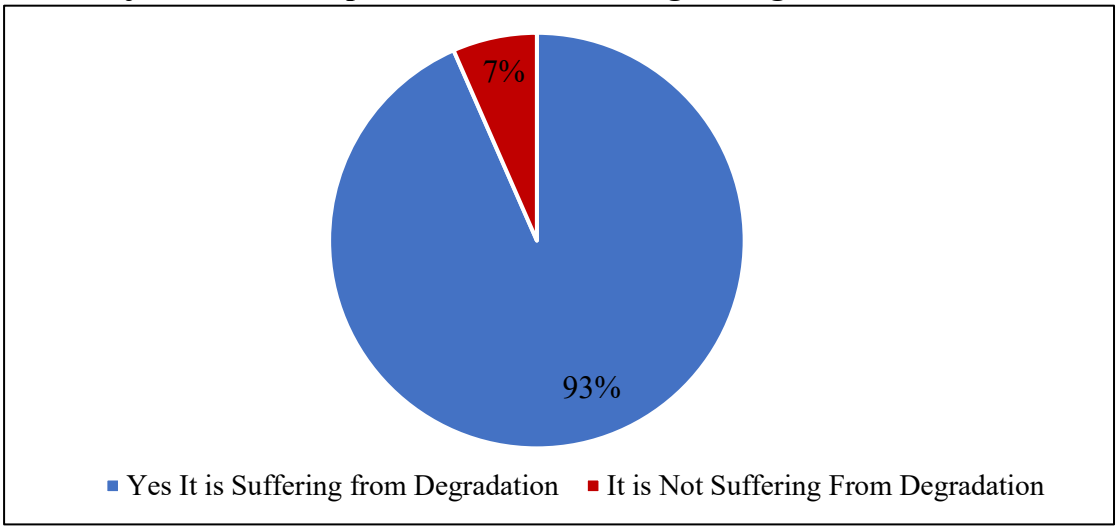
Plate: 4.1
Kanjli Wetland: Illustration of Kanjli Wetland Degradation

	
Degradation of Water, Soil and Natural Habitat at Village Seenpur	Release of Sewage Water into the Kanjli Wetland at Village Chuharwal
	
Degradation of Water Quality through Waste Material at Village Kanjli	Loss of Natural Vegetation at Village Beja
	
Decrease in the Amount of Water near Village Kokalpur	Depleted Quality of Water at Village Paharipur

Source: Fieldwork, 2023.

The deterioration endangers not just the wetland's biodiversity but also the livelihoods of the local inhabitants that rely on it. For the fulfilment of this objective a total of 411 households were surveyed and the detailed description of each one is discussed below:

Figure: 4.1
Kanjli Wetland: Respondents Understanding on Degradation of Wetland



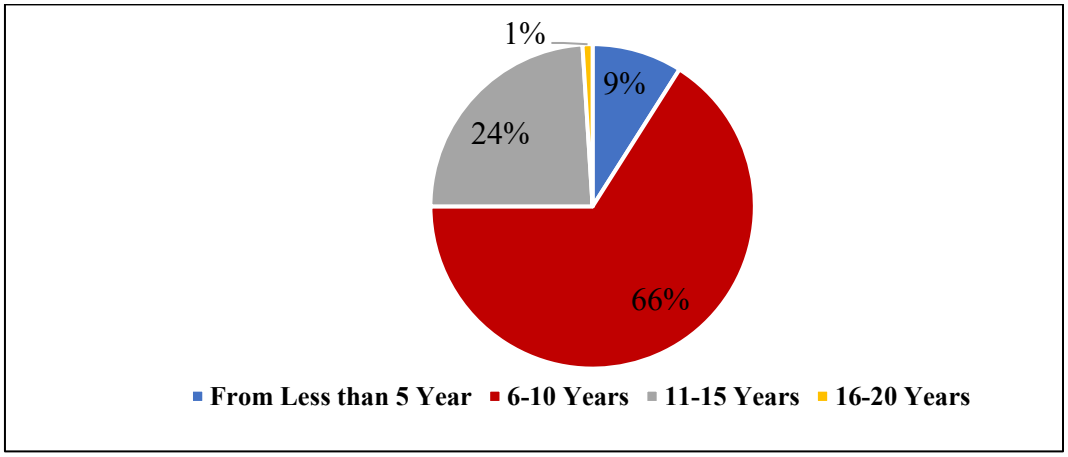
Source: Field Work, 2023.

The figure 4.1, shows the responses of a survey question asking whether there are any signs of degradation in the Kanjli wetland. Out of the total 411 respondents, 384 (93.43%) answered "Yes", indicating that they believe there are signs of degradation in the wetland. Meanwhile, 27 (6.57%) respondents answered "No", indicating that they do not believe there are signs of degradation in the wetland. Overall, the majority of respondents believe that the Kanjli wetland is showing signs of degradation, which highlights the urgent need for conservation and management efforts to address the issue.

The data presented in Figure 4.2 indicates that a significant number of respondents have witnessed degradation in the Kanjli Wetland for a considerable period. The majority of participants (66%) reported observing signs of degradation in the wetland over the span of 6-10 years. Furthermore, 24% of respondents stated that they have witnessed degradation for 11-15 years, highlighting a more prolonged trend. A smaller portion, comprising 9% of the respondents, reported observing degradation for less than 5 years. Remarkably, only 1% of the participants indicated a longer duration of degradation, specifically 16-20 years. These findings collectively

emphasize the concerning persistence and gradual nature of the degradation process in the Kanjli Wetland.

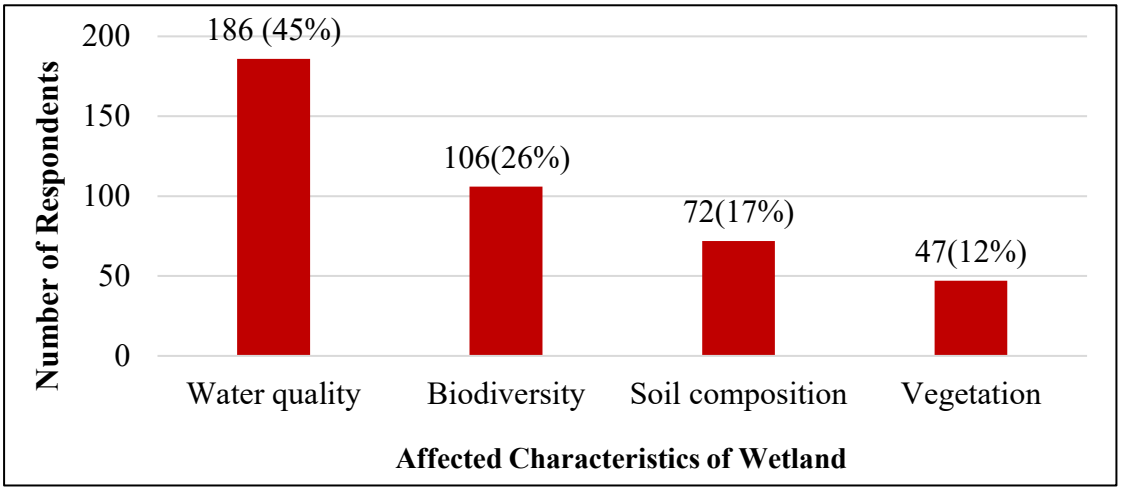
Figure: 4.2
Kanjli Wetland: Respondents Observation Regarding Duration of Degradation of Wetland



Source: Field Work, 2023.

This information is important as it indicates that the Kanjli Wetland is currently experiencing degradation, which is a cause for concern. The data also suggests that the degradation has been ongoing for a significant amount of time, highlighting the need for urgent conservation and management actions to reverse the negative impacts on the wetland's biodiversity and ecosystem services. It is also important to further investigate the causes of the degradation and the factors that have contributed to the observed trends, in order to develop effective conservation and management strategies for the Kanjli Wetland.

Figure: 4.3
Kanjli Wetland: Respondents' Perceptions on Various Characteristics of Wetland Affected by Degradation



Source: Field Work, 2023.

The figure: 4.3, shows that degradation of the Kanjli Wetland has a significant impact on the key characteristics of the wetland ecosystem. Water quality is the most impacted, with 45.25% of responses indicating its degradation as a key characteristic. This is likely due to the discharge of untreated sewage and industrial effluents into the wetland, as well as the excessive use of pesticides and fertilizers in surrounding agricultural fields that contribute to water contamination. Biodiversity is the second most impacted component, with 25.79% of responses indicating its degradation as a key characteristic. This is likely due to the destruction of natural habitats caused by encroachments on the wetland, which has had a significant impact on the diversity and abundance of species within the ecosystem. Soil composition and vegetation are also impacted, with 17.52% and 11.44% of responses indicating their degradation as key characteristics respectively. Soil degradation may be caused by erosion and nutrient depletion due to changes in land use, while the destruction of vegetation may be caused by overgrazing, deforestation, or changes in water levels. Overall, the degradation of these key characteristics of a wetland ecosystem can have significant negative impacts on the overall health and functioning of the ecosystem. It is important to address the underlying causes of degradation and take measures to restore and conserve wetlands to ensure their continued contribution to ecosystem services and biodiversity conservation.

4.1.1 Characteristics of Kanjli Wetland Affected by Degradation

Various characteristics of Kanjli wetland have been affected by degradation due to various anthropogenic factors. Degradation of the wetland has resulted in poor water quality due to pollution, fertilizer runoff, sedimentation and changes in water flow. In near future, it can destroy aquatic life and render the water unfit for human consumption. Wetland degradation has also resulted in biodiversity loss by destroying or altering the habitats of many plant and animal species. This leads to the decrease or extinction of native species. Soil composition has been affected by changes in wetland hydrology and land use. Wetland's soil quality has also been degraded by erosion, sedimentation and pollution. Wetland vegetation tends to adapt to certain hydrological conditions. Degradation of the wetland leads to changes in vegetation composition and structure, including the extinction of vital species and the spread of invasive species. Wetland hydrology alterations, such as changes in water flow, drainage or flooding patterns have upset the natural balance of the wetland ecosystem and create degradation.

Many species rely on wetlands for survival. Wetland habitats have become less functional as a result of degradation, making them less suited for breeding, feeding and shelter for a variety of wildlife. Wetlands' recreational and cultural values are also reduced by degradation, affecting their role as destinations for tourism, education and cultural relevance to local populations. Wetlands perform a variety of ecosystem services, such as flood control, water purification and carbon storage. Degradation of Kanjli wetland impairs these services, increasing flood risks, lowering water quality and having an impact on climate change.

Table: 4.1
Kanjli Wetland: Village wise Degradation Affected Key Characteristics

Village	Affected Characteristics				Total
	Water quality	Biodiversity	Soil composition	Vegetation	
Badshahpur	43%	50%	7%	0%	100%
Beja	33%	33%	33%	0%	100%
Boot	35%	37%	19%	8%	100%
Chuharwal	56%	33%	11%	0%	100%
Dham	55%	9%	27%	9%	100%
Hamira	45%	27%	9%	19%	100%
Kanjli	54%	8%	29%	8%	100%
Lakhan Kalan	54%	13%	22%	10%	100%
Lakhan Khurd	32%	32%	36%	0%	100%
Paharipur	46%	23%	31%	0%	100%
Subhanpur	42%	25%	33%	0%	100%
Total	**45%**	**26%**	**18%**	**11%**	**100 %**

Source: Fieldwork, 2023.

The table 4.1 shows the percentage distribution of the effects of degradation on various key characteristics of wetland ecosystems, such as water quality, biodiversity, soil composition and vegetation (related to the characteristics of wetland ecosystems and how they are affected by degradation in different villages). In all of the listed villages, 45% of the respondents had noticed an average decline in water quality. Chuharwal village's households suffer the most deterioration (56%), followed by Dham village (55%). A considerable proportion of respondents in these villages believe that the water quality in the wetlands has deteriorated, based on the high percentages. This can result from pollution, contamination or changes in water flow and levels.

In all of the villages listed in table 4.1, approximately 26% of households have noticed a decline in biodiversity. The highest degradation is observed by 50% households in Badshahpur village, followed by Boot (37% households). Kanjli and

Dham have relatively lower degradation percentages at nearly 8% households each. Many respondents report a decline in the variety and abundance of wildlife and plant species within the Kanjli wetland, which is commonly connected to habitat loss and environmental changes.

The average soil composition degradation across all the listed villages is observed by 18% of the households. The highest degradation is observed in Lakhan Khurd village (by 36%), followed by Beja and Subhanpur (by 33% households). In some villages, a big proportion of respondents detect changes in the soil composition of the wetlands, which may include issues such as erosion, sedimentation or soil contamination. The average vegetation degradation across all the listed villages is observed by 11% respondents. The highest degradation is observed by 19 Percent households in Hamira village, followed by Lakhan Kalan (10% households). None of the households in Badshahpur, Beja, Chuharwal, Kanjli and Subhanpur village have reported any degradation in vegetation. Vegetation degradation may signify the loss or alteration of plant species within the wetland. High percentages may indicate changes in plant communities or invasive species encroachment.

Overall, the findings indicate that different villages are suffering varying degrees of wetland degradation. Wetland degradation can have serious biological and environmental effects, affecting both the quality of life in local populations and the overall health of the ecosystem. Conservation activities may be required to address these challenges and save these unique natural resources. Two hypotheses are formulated and the chi-square test is used to statistically analyze the results and explained in the following paragraphs:

H0 (Null Hypothesis): Villages are not associated with the key characteristics of the wetlands affected by degradation.

H1 (Alternative Hypothesis): Villages are associated with the key characteristics of the wetlands affected by degradation.

In simplest terms, H0 implies that there is no relationship between the villages and the characteristics of degraded wetlands, whereas H1 implies that there is a relationship. The chi-square test is performed to examine whether there is a significant relationship between the villages and the key characteristics of wetlands affected by degradation. Here are the outcomes (Table 4.2):

Table: 4.2

Chi-Square Tests			
	Value	Degree of Freedom	Asymptotic Significance (2-sided)
Pearson Chi-Square	58.369	30	.001
Likelihood Ratio	67.008	30	.000
N of Valid Cases	411		

Source: Statistical Package for Social Sciences, Version 21.

The Pearson Chi-Square statistic is 58.369 with 30 degrees of freedom and the p-value is 0.001 (Table 4.2). This p-value is less than the typical significance level of 0.05, indicating that there is a significant association between villages and the key wetland characteristics affected by degradation. The Likelihood Ratio statistic is 67.008 with 30 degrees of freedom, and the p-value is 0.000. Similar to the Pearson Chi-Square test, the p-value here is very low, indicating a significant association. Which means that there is a significant association between the villages and the key characteristics of Kanjli wetland affected by degradation based on the Pearson Chi-Square and Likelihood Ratio tests.

Table: 4.3

Symmetric Measures			
		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.353	.001
N of Valid Cases		411	

Source: Statistical Package for Social Sciences, Version 21.

The Contingency Coefficient, a symmetric measure, is used to quantify the strength of association between the two variables. In this case, the Contingency Coefficient is 0.353 with an approximate significance of 0.001, indicating a moderate association (35.3%) between the villages and the key characteristics of wetlands affected by degradation (Table 4.3).

Therefore, the analysis suggests that while there is a significant overall association between villages and the key characteristics of wetlands affected by degradation, the linear relationship may not be significant. However, the moderate Contingency Coefficient indicates some level of association between the two variables.

4.1.2 Current Status of Degradation of Kanjli Wetland

Table 4.4 highlights the current state of degradation in various villages as indicated by surveyed households on the categories of degradation observed in their villages. Three types of degradation have been observed in the wetland area i.e., changes in water quality, loss of habitat for certain species and other types of degradation.

Table: 4.4
Kanjli Wetland: People's Perception on the Current Status of Wetland Degradation

Village	Current Status of Degradation			Total
	Changes in water quality	Loss of habitat for certain species	Any other	
Badshahpur	57%	43%	0%	100%
Beja	67%	33%	0%	100%
Boot	48%	34%	18%	100%
Chuharwal	72%	28%	0%	100%
Dham	64%	18%	18%	100%
Hamira	45%	35%	19%	100%
Kanjli	54%	25%	21%	100%
Lakhan Kalan	64%	6%	30%	100%
Lakhan Khurd	77%	5%	18%	100%
Paharipur	69%	8%	23%	100%
Subhanpur	42%	17%	42%	100%
Total	54%	26%	20%	100%

Source: Fieldwork, 2023.

The "Changes in water quality" category shows the percentage of respondents in each village who have noticed and agreed on a decline in the quality of their local water sources. On average, 54% of responders in all villages observed changes in water quality. This indicates that slightly more than half of the population is concerned about the state of local water sources. Chuharwal had the highest consensus rate of 72% among the individual villages, showing a significant consensus among the residents that water quality has decreased. Subhanpur, on the other hand, has the lowest agreement at 42%, which is still a significant percentage.

The category "Loss of habitat for certain species" indicates the proportion of respondents in each village who have witnessed and recognized a reduction in habitat suited for specific wildlife species. In its entirety, 26% of respondents have observed such losses in their areas. This indicates that one-quarter of inhabitants are concerned

about the impact of human activity on local wildlife and habitats. Lakhan Kalan stands out in this category with only 6% agreement, indicating that locals there are less concerned about habitat loss for some species. Badshahpur and Hamira, on the other hand, have comparatively high agreement rates of 43% and 35%, respectively.

The "Any other" category includes various kinds of other forms of degradation or problems that are not particularly classified as changes in water quality or habitat loss. On average, 20% of respondents in all villages reported different kinds of deterioration or concerns in their communities. This implies that one-fifth of the respondents have concerns or have observed degradation that is not addressed by the predefined categories.

In a nutshell, table 4.4 shows the level of agreement among residents in various communities about various categories of degradation. It emphasizes that changes in water quality is a major concern throughout villages, although loss of habitat for some species and other issues vary in importance. These findings have the potential to be useful in environmental management and community engagement activities aimed at addressing and mitigating the observed degradation in Kanjli wetland. Now, the objective is to look at the relationship between the variable "Villages" (representing different villages) and the current situation of wetland degradation, which is classified into above discussed three categories: "Changes in water quality," "Loss of habitat for certain species," and "Any other." Two hypotheses have been formulated to achieve this objective, which are as follows:

H0 (Null Hypothesis): Villages are not associated with the status of wetlands degradation.

H1 (Alternative Hypothesis): Villages are associated with the status of wetlands degradation.

The null hypothesis (H0) in hypothesis testing often reflects a declaration of no effect or no association, whereas the alternative hypothesis (H1) represents the statement for which the author is looking for evidence. In this situation, H0 implies that there is no relationship between different villages and the status of wetland degradation,

whereas H1 implies that there is an association. Chi-square tests are used to determine whether there is a statistically significant relationship between these variables. Two chi-square statistics have been calculated in this analysis:

Table: 4.5

Chi-Square Tests			
	Value	Degree of Freedom	Asymptotic Significance (2-sided)
Pearson Chi-Square	46.755	20	.001
Likelihood Ratio	58.923	20	.000
N of Valid Cases	411		

Source: Statistical Package for Social Sciences, Version 21.

The Pearson Chi-Square value is 46.755 with 20 degrees of freedom and the p-value is less than 0.001 (as indicated by ".001"). This p-value indicates that the Villages and the Status of wetlands degradation variables have a significant relationship. The second test is the Likelihood Ratio Chi-Square test, which has a value of 58.923 with 20 degrees of freedom and a p-value less than 0.001 (Table 4.5). This p-value, like the Pearson Chi-Square test, indicates a significant relationship between the variables, supporting the rejection of the null hypothesis.

Table: 4.6

Symmetric Measures			
		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.320	.001
N of Valid Cases		411	

Source: Statistical Package for Social Sciences, Version 21.

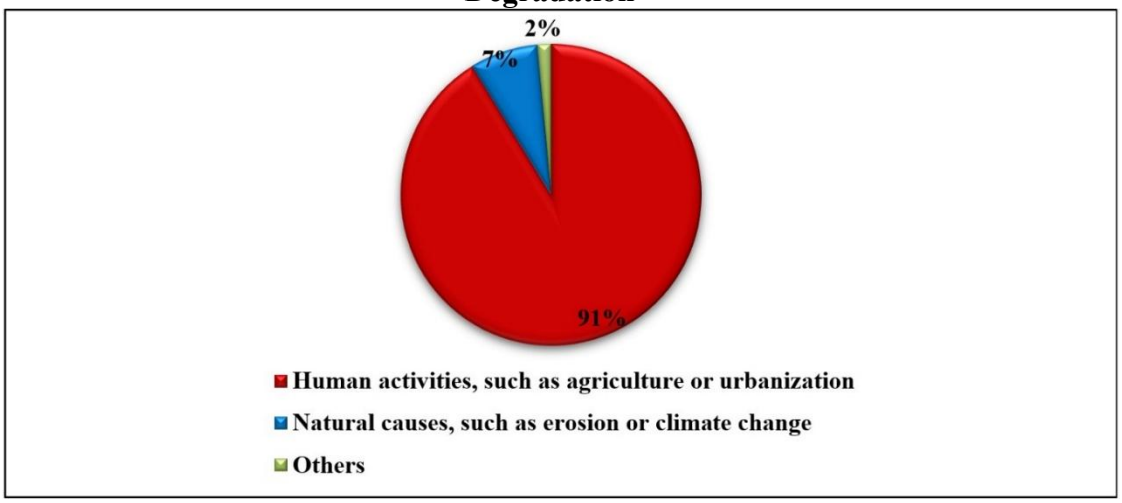
Furthermore, the Contingency Coefficient, with a value of 0.320 and a p-value of 0.001, reveals a 32% association between the two variables, supporting the conclusion that villages are related to the state of wetlands degradation (Table 4.6).

As a result of the above discussion, it is possible to conclude that both the Pearson Chi-Square and Likelihood Ratio Chi-Square tests produce very low p-values, showing a significant association between the villages and the status of wetlands degradation. As a result, the null hypothesis (H0) is rejected and it is concluded that villages are connected with the deterioration condition of wetlands.

4.2 Causes of Degradation in the Kanjli Wetland

Based on the responses of the sampled households, the main causes of wetland degradation are presented in Figure 4.4. The results indicate that the majority of the respondents (91 %) identified human activities as the primary cause of wetland degradation. This is not surprising, as wetlands are often threatened by human activities such as agriculture, urbanization and industrialization. Agricultural practices such as irrigation and drainage can alter the hydrology of wetlands, leading to reduced water levels, increased sedimentation and changes in water quality. Urbanization, on the other hand, can lead to increased runoff and pollution from roads, parking lots and other impervious surfaces, which can have negative impacts on the ecology of wetlands.

Figure: 4.4
Kanjli Wetland: People Perceptions on Significant Cause of Wetland Degradation



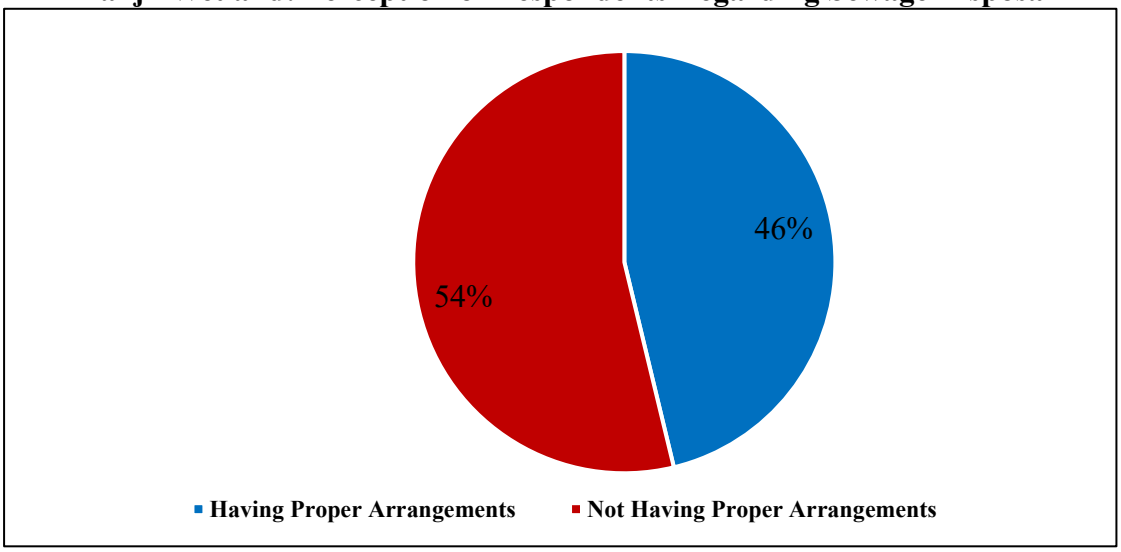
Source: Field Work, 2023.

In addition to these human activities, natural causes such as erosion and climate change were identified by 7 % of the respondents. Wetlands are particularly vulnerable to erosion due to their location in low-lying areas and their unique hydrological characteristics. Climate change can also have significant impacts on wetlands, including changes in precipitation patterns, increased temperatures and sea level rise, which can alter the hydrology and ecology of wetlands. A small fraction of respondents (2 %) identified other causes of wetland degradation. These may include factors such as invasive species, overfishing, or other human activities not captured in the survey. Overall, the results suggest that human activities are the primary cause

of wetland degradation and efforts to protect and restore wetlands must focus on addressing these impacts. This may involve implementing sustainable agricultural practices, reducing urban runoff and pollution, and addressing the root causes of industrial and urban expansion. It may also involve promoting public awareness and education about the importance of wetlands and the role they play in supporting biodiversity, mitigating climate change and providing important ecosystem services.

Figure 4.5, shows the responses of individuals in a particular area regarding the presence or absence of proper sewage disposal arrangements. The data indicates that 46% of respondents reported having proper sewage disposal arrangements, while 54% reported not having proper arrangements. This information is relevant in the context of wetland degradation because improper sewage disposal can lead to water pollution, which can have a detrimental effect on

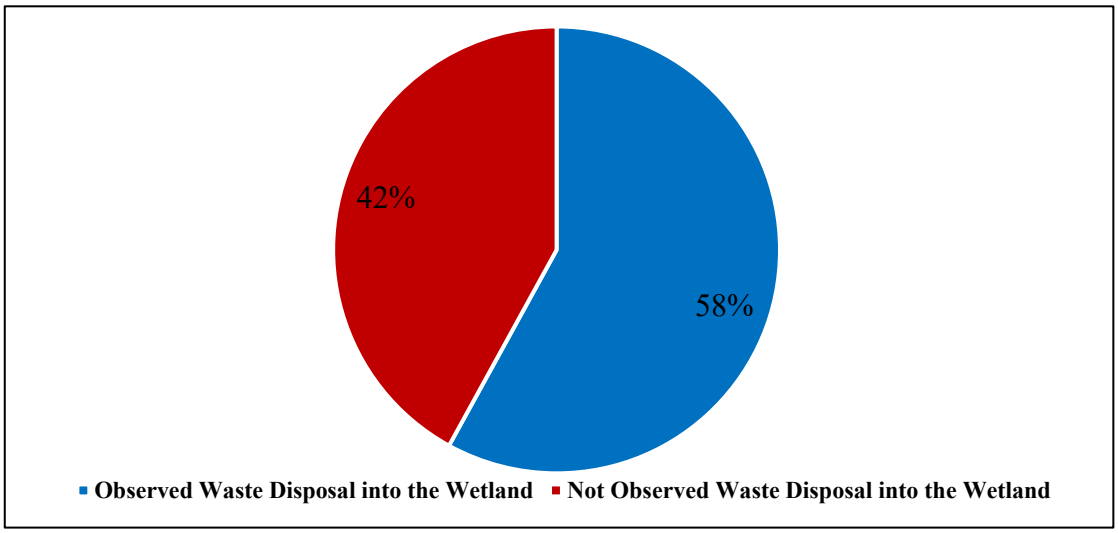
Figure: 4.5
Kanjli Wetland: Perception of Respondents Regarding Sewage Disposal



Source: Field Work, 2023.

wetland ecosystems.Polluted water reduces the quality of wetland habitats, harm aquatic and terrestrial wildlife and negatively impact the ecosystem services that wetlands provide. Therefore, the data in this figure highlights the need for improved sewage disposal arrangements to prevent water pollution and protect wetland ecosystems.

Figure: 4.6
Kanjli Wetland: Perception of People Regarding Waste Disposal into the Wetland



Source: Field Work, 2023.

The figure given above (Figure 4.6) represents the results of a primary survey conducted to assess the presence of waste disposal into the wetland. The survey respondents were asked whether they had observed any waste drain flowing into the wetland. Out of the total 411 respondents, 238 (58%) reported that they had observed waste disposal into the wetland, while the remaining 173 (42%) reported that they had not observed any waste disposal into the wetland.

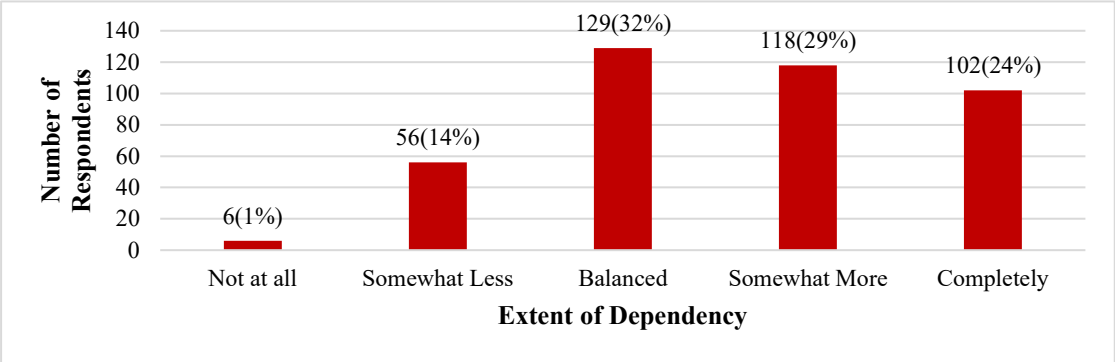
This suggests that a considerable number of respondents have observed waste being disposed of in the wetland, raising concerns about potential degradation of the wetland and its ecosystem services. Effective waste management strategies and regulations are needed to prevent further degradation and ensure the sustainability of the wetland ecosystem.

4.3 People's Reliance on Wetlands in Terms of Socio-Economic and Cultural Values

Figure 4.7 presents data on the dependency of individuals on the wetland, in the context of a particular study or survey. The survey asked respondents about their level of dependency on the wetland, with five response options ranging from "not at all" to "completely." The figure 4.7 shows the number of respondents and the percentage of respondents who chose each response option. The results suggest that a majority of the respondents (85%) have some level of dependency on the wetland,

with 32% reporting a "balanced" dependency and another 29% reporting "somewhat more" dependency. Only a small minority (1%) reported having no dependency on the wetland. Interestingly, 24% of the respondents reported a complete dependency on the wetland indicating that their livelihoods and well-being are closely tied to the health and productivity of the wetland.

Figure: 4.7
Kanjli Wetland: Perception of Respondents Regarding Waste Dependency on Wetland

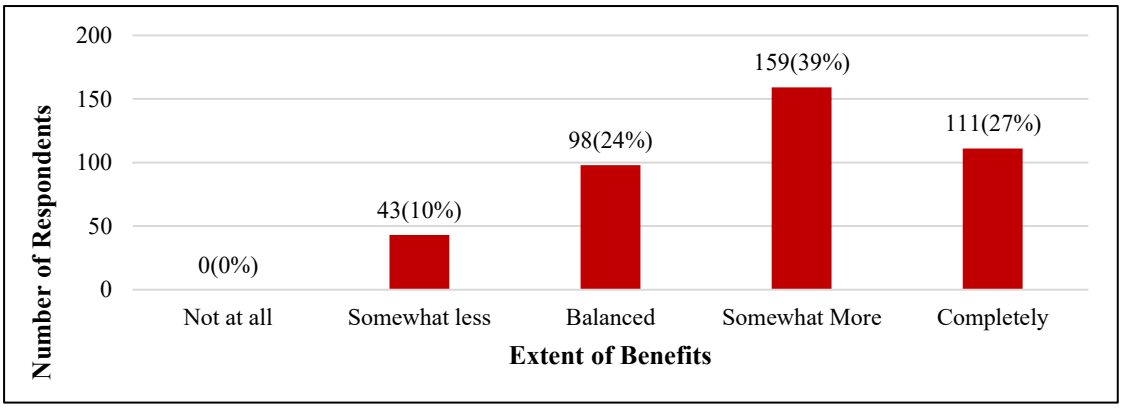


Source: Field Work, 2023.

These results underscore the crucial role of wetlands in sustaining the livelihoods of nearby communities and emphasize the necessity for robust conservation and management approaches to safeguard the long-term viability of wetland ecosystems. The insights garnered from this study could guide policymakers and stakeholders in making informed decisions and allocating resources to safeguard and rehabilitate wetlands, especially those vital for the welfare of local populations.

Similarly, the figure 4.8 given below shows the responses of individuals who were asked to rate how much the existence of wetlands benefits them. Out of the total 411 responses, the majority of respondents (159) indicated that wetlands benefit them somewhat more, followed by 111 respondents who indicated that wetlands benefit them completely. A significant number of respondents (98) felt that the benefits of wetlands were balanced, indicating that they recognized the importance of wetlands but did not perceive them as having a significant impact on their lives. However, there were also 43 respondents who felt that wetlands benefited them somewhat less, indicating a lack of awareness or appreciation for the services that wetlands provide. No respondents indicated that wetlands did not benefit them at all.

Figure: 4.8
Kanjli Wetland: Perception of Respondents Regarding Benefits of Wetland

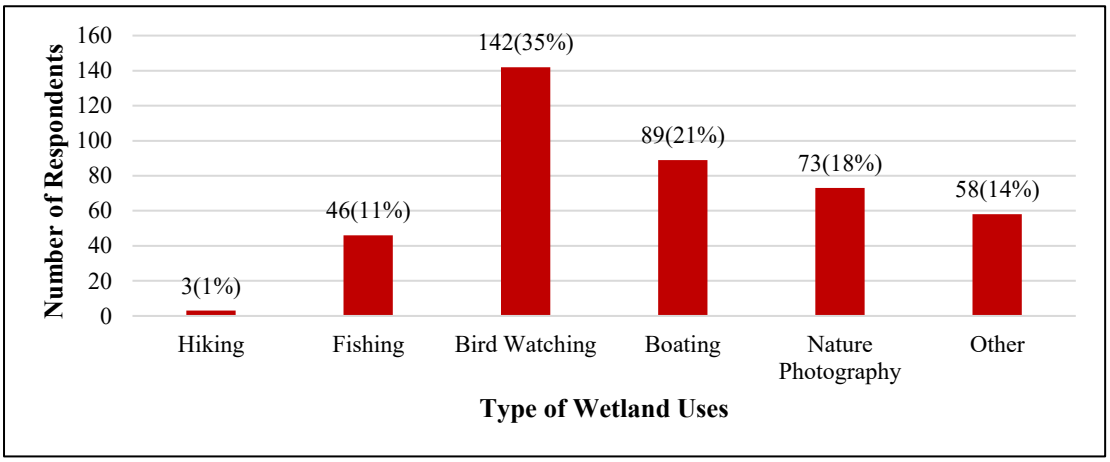


Source: Field Work, 2023.

Overall, the responses suggest that a majority of individuals recognize the benefits of wetlands, with many perceiving them as having a significant impact on their lives. However, there is also a need for increased awareness and education on the value of wetlands, particularly among those who do not perceive their benefits as significant.

From the figure 4.9, given below, data on the types of recreational activities observed in wetlands has been shown. Out of 411 total responses, the majority (35%) reported bird watching as the most common activity. This is likely due to the high biodiversity found in wetlands, which attract a variety of bird species. Fishing was also a popular activity, with 11% of respondents reporting it. This is not surprising given that wetlands are often home to a variety of fish species. Boating was also a popular activity with 21% of respondents reporting it. This may be due to the scenic beauty and calm waters of wetlands, which make them ideal for boating. Nature photography was another common activity, with 18% of respondents reporting it. Wetlands provide a unique opportunity to capture images of diverse wildlife and landscapes.

Figure: 4.9
Kanjli Wetland: Perception of People Regarding Recreational Utilization of Wetland



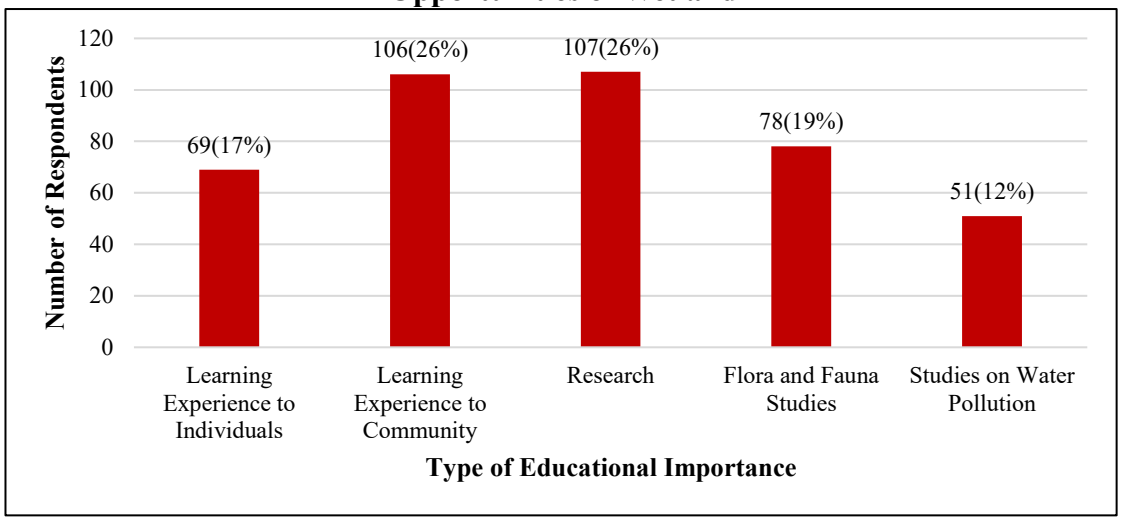
Source: Field Work, 2023.

Other recreational activities reported included camping, picnicking and hunting. Overall, the data highlights the importance of wetlands as recreational spaces and the need for their conservation and sustainable management to ensure continued access to these activities for future generations.

Figure 4.10 highlights the educational opportunities offered by a wetland, particularly the Kanjli Wetland, in terms of learning experiences and research possibilities. The above figure (Figure 4.10) shows that the majority of respondents (43%) identified learning experiences as the primary educational opportunity that the wetland possesses, with 17% indicating that it offers a learning experience to individuals and 26% indicating that it offers a learning experience to the community. This suggests that the wetland provides an opportunity for individuals and communities to learn about the importance of wetlands and the ecosystem services they provide, as well as the threats they face and the conservation efforts needed to protect them. In addition to learning experiences, the table also highlights the research opportunities that the wetland offers, with 26% of respondents indicating that it is an important site for research. This includes flora and fauna studies, which were identified by 19% of respondents, as well as studies on water pollution, which were identified by 12% of respondents. This suggests that the wetland is an important resource for scientists and researchers who are interested in studying wetland ecosystems, biodiversity and water quality. Overall, the study suggests that the Kanjli Wetland offers significant educational and research opportunities and

highlights the importance of protecting and conserving wetlands for future generations.

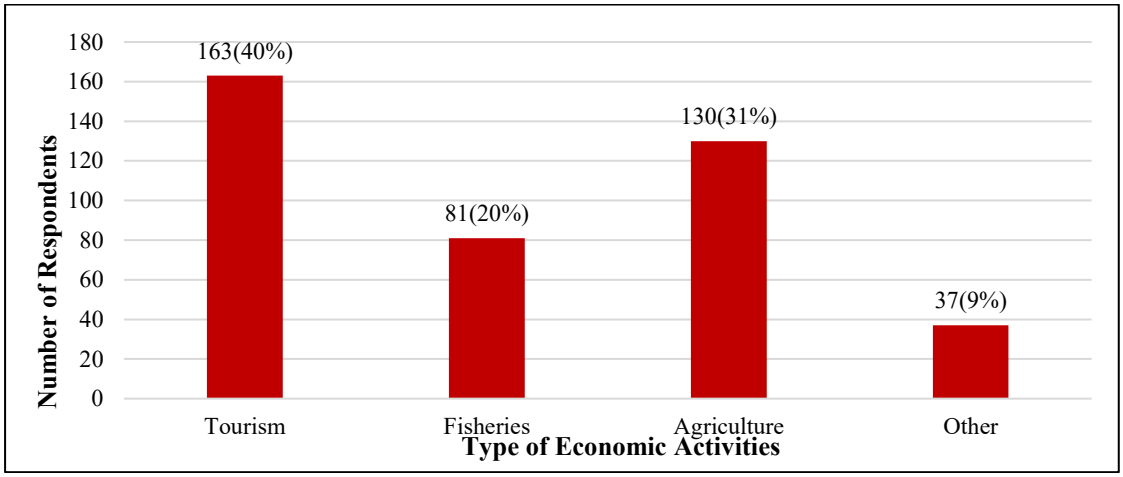
Figure: 4.10
Kanjli Wetland: Perception of Respondents Regarding Educational Opportunities of Wetland



Source: Field Work, 2023.

The data provided in the figure 4.11, given below suggests that the economic role of wetlands can be observed in various industries, with tourism being the most prominent economic role, accounting for 40% of the observed economic benefits of wetlands. Wetlands can provide opportunities for eco-tourism, bird watching and other recreational activities, which can attract visitors and generate revenue. The second most prominent economic role of wetlands is in fisheries, accounting for 20% of the observed economic benefits. Wetlands can serve as critical habitats for fish and other aquatic life, and they can support sustainable fishing practices, which can contribute to local economies. Agriculture also plays a significant economic role in wetlands, accounting for 31% of the observed economic benefits. Wetlands can provide valuable agricultural land for crops, such as rice, or grazing land for livestock. Additionally, wetlands can serve as natural water sources for irrigation and livestock watering, which can be beneficial for farmers. In conclusion, the data indicates that there are other economic roles of wetlands, accounting for 9% of the observed benefits. These other roles may include water purification, carbon sequestration, and flood control, which can have significant economic benefits but may be harder to quantify. Overall, the data highlights the diverse economic benefits that wetlands can provide, and the importance of their conservation and sustainable use for the benefit of local communities and the environment.

Figure: 4.11
Kanjli Wetland: Perception of People Regarding Economic significance of Wetland

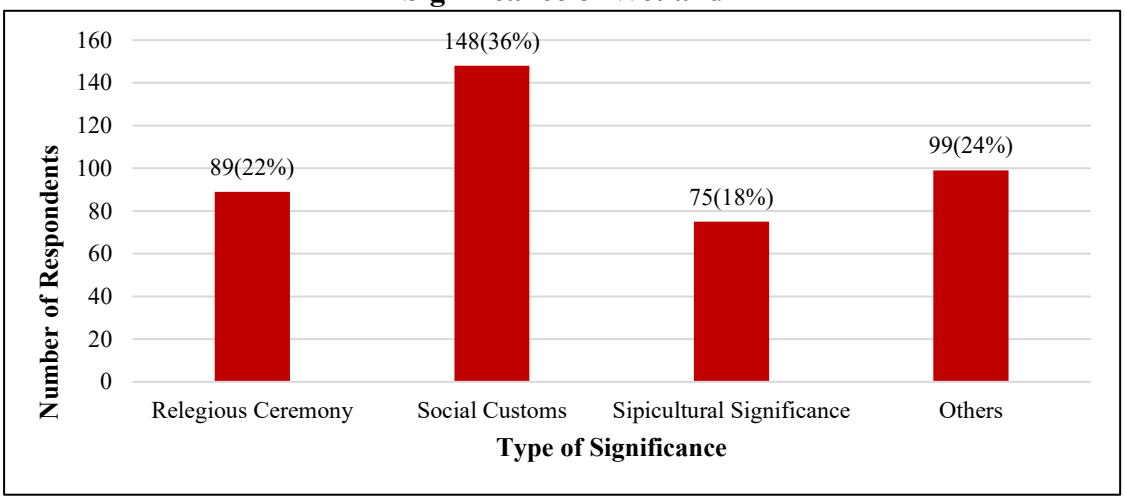


Source: Field Work, 2023.

Figure 4.12 shows the results of a survey that was conducted to determine the cultural significance of wetlands. The data suggests that respondents identified a variety of cultural values associated with wetlands, including religious ceremony, social customs, and significance for indigenous peoples or traditional knowledge. Out of 411 total responses, 89 respondents (22% respondents) identified religious ceremony as a cultural significance of wetlands. This suggests that wetlands may hold spiritual or sacred meaning for some cultures or religions and that they may be used as a location for rituals, prayers or other ceremonies. Additionally, 36% respondents identified social customs as a cultural significance of wetlands. This may refer to the role that wetlands play in supporting local livelihoods, such as through fishing or farming or to the ways in which wetlands provide opportunities for recreation or social gatherings. Seventy-five respondents or 18% identified wetlands as having a significance for indigenous peoples or traditional knowledge. This suggests that wetlands may hold special meaning for certain cultural groups, and that they may be important for preserving cultural practices or traditional knowledge.

In addition, 99 respondents (24% respondents) identified other cultural significance of wetlands. Overall, this suggests that wetlands are important for a variety of cultural reasons and that understanding these values is essential for ensuring that wetlands are protected and managed in a way that respects their cultural significance.

Figure: 4.12
Kanjli Wetland: Perception of Respondents Regarding Cultural and Religious Significance of Wetland



Source: Field Work, 2023.

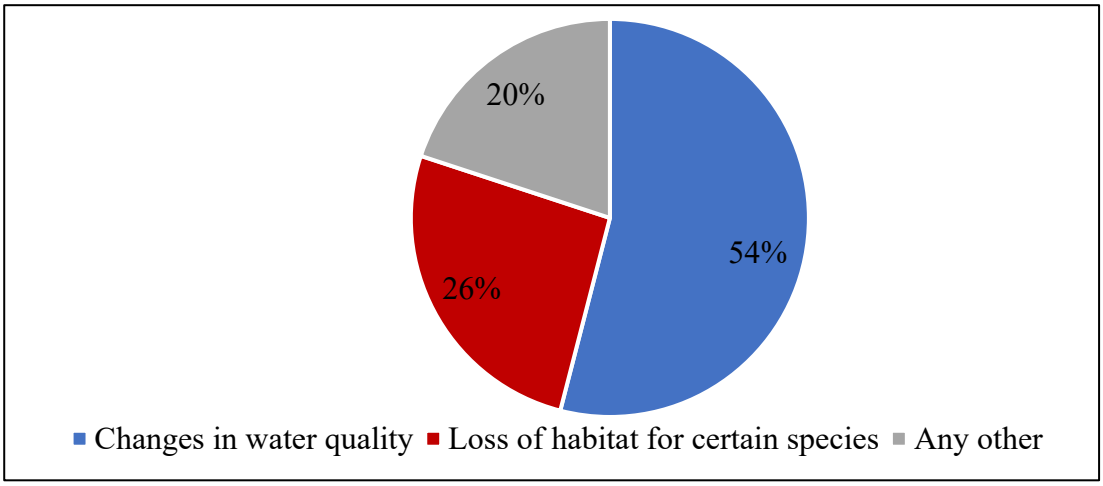
4.4 Impact of the Degradation Activities on People's Livelihood

The deterioration of Kanjli Wetland has profoundly affected the livelihoods of communities in the vicinity. This wetland plays a crucial role as a primary water source for irrigation, household needs, and fishing. Consequently, its degradation has led to a depletion of these essential resources. Additionally, the reduction in water levels has led to a decrease in agricultural productivity and impacted the availability of fodder for livestock. The degradation has also impacted the tourism industry, which depends on the wetland's biodiversity to attract visitors. As a result, the livelihoods of local communities who depend on these resources have been adversely affected. Addressing the degradation of Kanjli Wetland is essential for the sustainable management of natural resources and the livelihoods of local communities. To understand the people's perception about the impact of degradation activities on the people's livelihood, a total of 411 household survey were conducted and the detailed description is given below:

The figure given below (Figure 4.13) indicates that a majority of the respondents (54 % respondents) identified changes in water quality as the primary issue affecting the health and functioning of the wetland. This suggests that the wetland may be experiencing pollution or other forms of contamination that are negatively impacting the quality of water in the area. The loss of habitat for certain species was identified as the second most pressing issue with 26 % of respondents highlighting this as a concern. This suggests that the wetland may be experiencing habitat loss due to

factors such as human encroachment or changes in the natural landscape. This loss of habitat can have a significant impact on the biodiversity of the wetland ecosystem and the species that depend on it for their survival.

Figure: 4.13
Kanjli Wetland: Respondents Understanding Regarding Current Health Status of Wetland



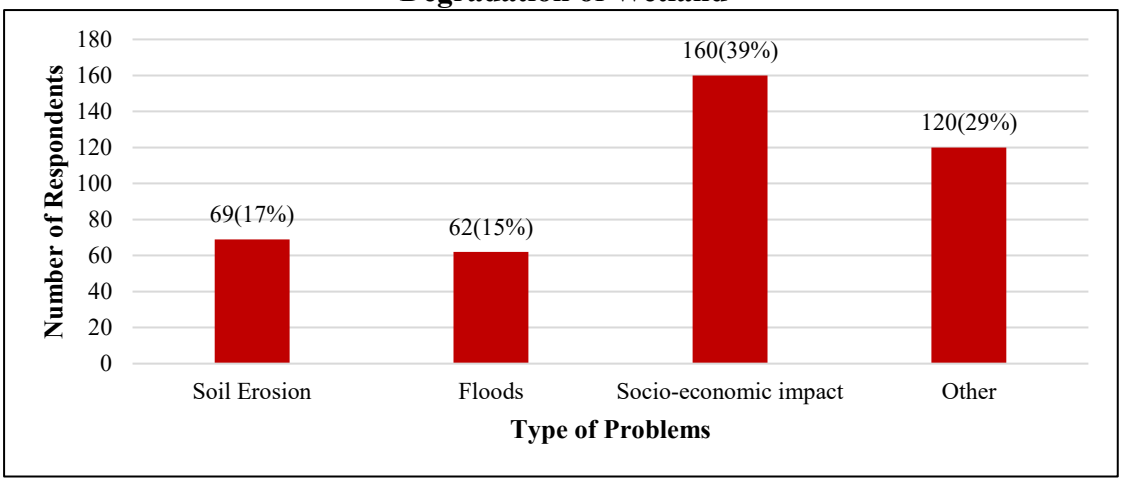
Source: Field Work, 2023.

The remaining respondents (20 % respondents) identified "any other" issues, which could include a range of concerns such as changes in weather patterns, invasive species, or the impact of human activities such as agriculture or development on the wetland. The impact of these issues on people's livelihoods depends on a number of factors, such as the degree to which people rely on the wetland for resources such as water, fish, or timber. For example, if the changes in water quality are making it difficult for people to fish or grow crops in the area, this could have a significant impact on their ability to make a living. Similarly, if habitat loss is leading to a decline in certain species that are important for local livelihoods, this could also have negative consequences. Overall, it is clear that the health and functioning of the wetland are closely tied to the well-being of the people who live in the surrounding area.

The figure 4.14 shows that the natural problems that arise due to the degradation of wetlands affect people's livelihoods. The results indicate that the respondents identified three main categories of natural problems associated with the degradation of wetlands, with varying degrees of impact on people's livelihoods.

Soil erosion was identified as a major problem by 69 respondents, which accounts for 17 % of the total responses. Wetlands play an important role in preventing soil erosion, as they act as a natural buffer zone between land and water. When wetlands are degraded, soil erosion can occur, which can lead to loss of fertility and productivity of land, resulting in reduced crop yields and food insecurity for the people relying on these lands for their livelihoods.

Figure: 4.14
Kanjli Wetland: Respondents Perception Regarding Problems Arises due to Degradation of Wetland



Source: Field Work, 2023.

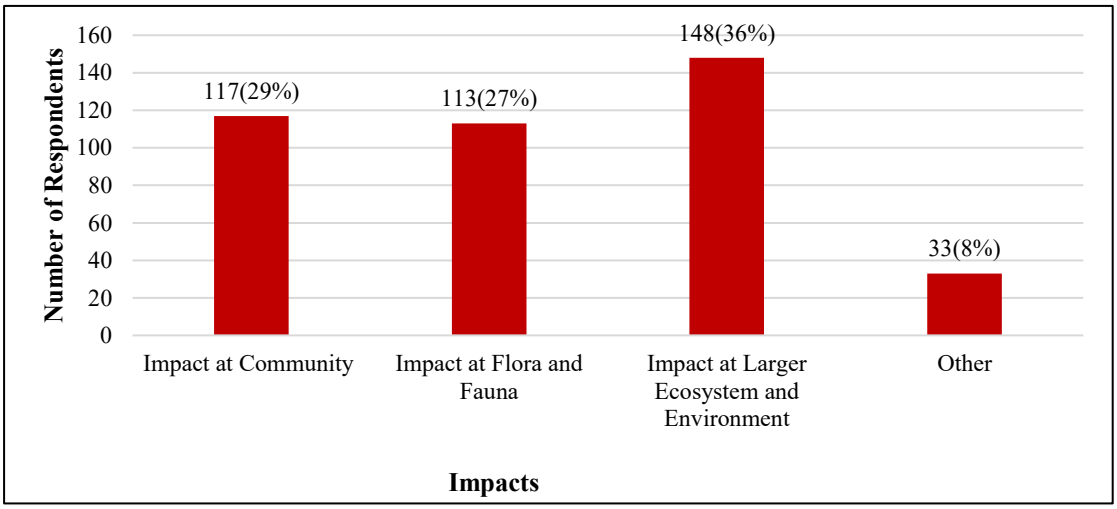
Floods were identified as the second most significant problem, with 62 respondents (15 % respondents) indicating this issue. Wetlands are natural flood buffers and when they are degraded, there is a higher likelihood of flooding during heavy rains or storms. This can result in significant damage to settlements, infrastructure and crops, leading to a loss of income and livelihoods for those who rely on these resources. As shown in the figure 4.14, Socio-economic impacts were identified as the most significant problem by the largest number of respondents (160, accounting for 39 % of the total responses). Degradation of wetlands can lead to a range of socio-economic impacts, including loss of income and jobs, reduced access to food and water and displacement of communities.

Wetlands are often critical resources for local communities, providing them with water, food and raw materials for construction and other purposes. When these resources are degraded or lost, people's livelihoods are severely impacted, leading to poverty and increased vulnerability. Additionally, 120 respondents (29 % respondents) identified "Other" problems associated with the degradation of

wetlands, which may include impacts on biodiversity, water quality, and other environmental factors that can impact people's livelihoods. Overall, the fieldwork results highlight the importance of wetlands for people's livelihoods and the significant impacts that degradation of wetlands can have on both natural systems and human well-being. Protecting and restoring wetlands is essential for sustaining local communities and the ecosystems they rely on for their livelihoods.

In the figure 4.15, the responses of individuals or groups to the possible consequences of wetland degradation has been shown. The survey respondents were asked to indicate the potential impacts of wetland degradation on people's livelihoods and the results are presented in four different components: community impact, flora and fauna impact, larger ecosystem and environment impact and other impacts.

Figure: 4.15
Kanjli Wetland: Perception of People about Potential Impact of Degradation of Wetland on Livelihood and Environment



Source: Field Work, 2023.

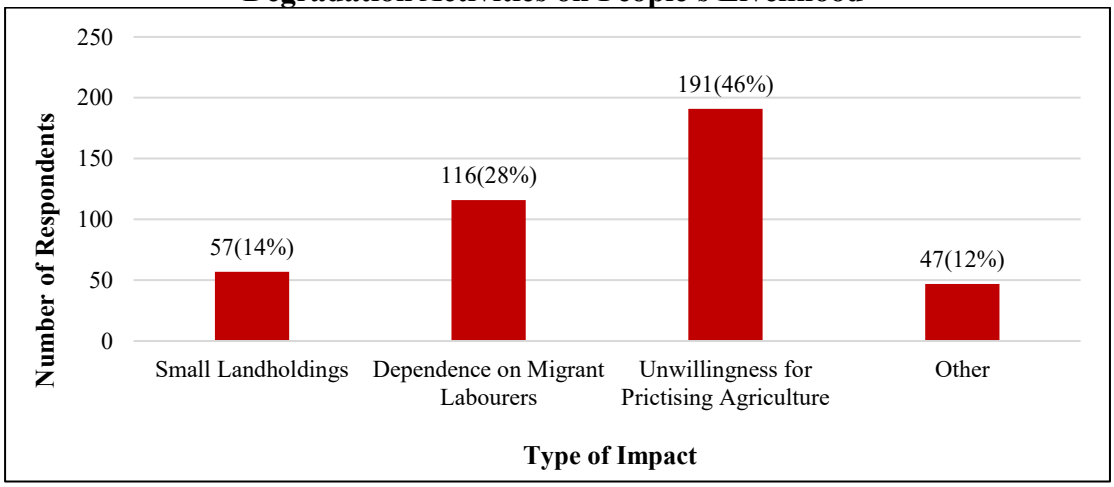
According to the figure 4.15, the majority of respondents (36% respondents) believe that wetland degradation will have the greatest impact on the larger ecosystem and environment. This suggests that the degradation of wetlands may cause significant harm to the ecological health of the surrounding environment, including water quality, biodiversity and natural resources. This impact can also have a cascading effect on the entire ecosystem and can potentially lead to the extinction of certain plant and animal species. The second-largest percentage of responses (29% respondents) suggests that the impact of wetland degradation will be felt at the community level. This means that the degradation of wetlands can have a direct

impact on the lives and livelihoods of local communities who rely on wetland resources for their subsistence, including fishing, agriculture and tourism. As wetlands are often used for recreational activities, the degradation of these areas can also lead to reduced tourism and economic opportunities for local communities. The third-largest percentage of responses (27% respondents) suggests that the impact of wetland degradation will be felt on flora and fauna (Figure 4.15). This means that the degradation of wetlands can have a severe impact on the plant and animal species that inhabit these areas. Wetlands are home to a variety of species, including migratory birds, amphibians and reptiles. The loss of wetlands can lead to habitat destruction, which can ultimately result in the extinction of certain species.Conclusively, the remaining percentage of responses (8% respondents) falls under the category of "other," which include responses related to cultural and spiritual values associated with wetlands or potential impacts on the health and wellbeing of communities living near wetlands. Overall, the figure highlights the potential consequences of wetland degradation, including impacts on the larger ecosystem and environment, community livelihoods and flora and fauna. It emphasizes the need for conservation efforts to protect these vital ecosystems and the importance of recognizing the significant role that wetlands play in sustaining our planet's biodiversity and ecosystem services.

Figure 4.16 indicates the impacts of degradation activities on people's livelihood as perceived by the respondents. Specifically, the figure 4.16 shows the percentage of respondents who identified various impacts of wetland degradation on their livelihood. According to this figure the most significant impact of wetland degradation on people's livelihood is their unwillingness to practice agriculture, as indicated by 46% of the respondents. This suggests that wetland degradation has had a substantial negative impact on the agricultural sector, which is likely to be a critical source of livelihood for the local population. The second most common impact of wetland degradation is the dependence on migrant laborers, identified by 28% of the respondents. This implies that wetland degradation has reduced the availability of local jobs, forcing people to seek work elsewhere and causing a loss of income for the local population. Small landholdings were identified as the third most common impact, with 14% of the respondents indicating that they have been adversely affected by wetland degradation. This suggests that wetland degradation has reduced

the availability of arable land for farming and other agricultural activities, leading to a decline in agricultural productivity and income for the local population. At last, 12% of the respondents identified other impacts of wetland degradation on their livelihood, which could include factors such as the loss of biodiversity and ecological services, reduced access to water resources and changes in traditional land use practices.

Figure: 4.16
Kanjli Wetland: Perception of Respondents Regarding Impacts of Wetland Degradation Activities on People's Livelihood



Source: Field Work, 2023.

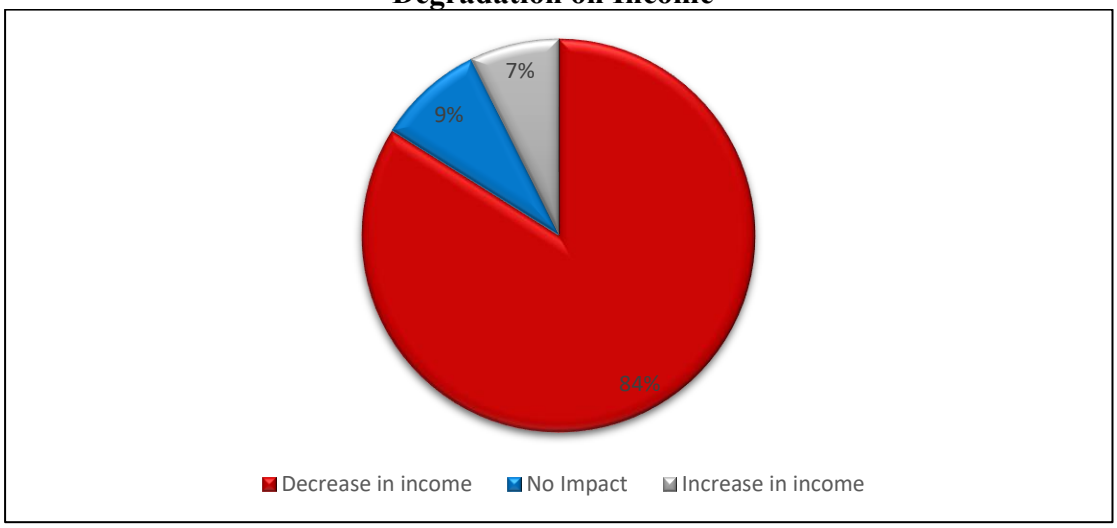
In summary, the figure 4.16 indicates that wetland degradation has had a significant negative impact on people's livelihood, particularly on their ability to practice agriculture, which is likely to be a critical source of income for the local population. The figure 4.16 also suggests that wetland degradation has led to a loss of local jobs, reduced agricultural productivity and other negative impacts on the local population.

Figure 4.17 shows the impact of degradation of Kanjli Wetland on people's livelihood in terms of household income. The responses of 411 households were taken into consideration and categorized into three categories - decrease in income, no impact and increase in income. The data indicates that out of the total 411 respondents, 345 (84%) reported a decrease in income due to the degradation of the wetland, while 36 (9%) reported no impact and 30 (7%) reported an increase in income. This figure (Figure 4.17) suggests that the degradation of the Kanjli Wetland has had a significant negative impact on the livelihoods of the local population with the majority experiencing a decrease in income. This could be due to a variety of factors, such as reduced agricultural productivity, loss of fishing opportunities or

decreased tourism revenue. The decrease in income reported by 84% of respondents is a cause for concern, as it can have serious implications for the well-being of households and their ability to meet basic needs such as food, shelter, and healthcare. The loss of income can also lead to augmented levels of poverty, debt and social exclusion.

The fact that 9% of respondents reported no impact on their household income suggests that some people may have been less reliant on the wetland for their livelihoods or have found alternative sources of income. However, it is important to note that even if households are not directly dependent on the wetland, they may still be indirectly affected by its degradation through factors such as reduced water availability or increased flooding.

Figure: 4.17
Kanjli Wetland: Perception of Respondents Regarding Impacts of Wetland Degradation on Income



Source: Field Work, 2023.

Approximately 7% of respondents reported an increase in income may have benefited from new economic opportunities arising from the degradation of the wetland including the development of new industries or infrastructure projects. However, it is important to ensure that these benefits are distributed fairly and do not come at the expense of the environment or the livelihoods of other local communities. Overall, the data highlights the importance of protecting and conserving wetlands like Kanjli, not only for their ecological value but also for the vital role they play in supporting the livelihoods of local communities.

4.4.1 Natural Problem Arises Due to the Degradation of Kanjli Wetland

Kanjli Wetland suffers from significant degradation and associated problems, such as biodiversity loss, water pollution from agricultural and industrial sources, invasive species encroachment, habitat loss due to urban development, altered hydrology, climate change impacts, siltation, over-exploitation of resources and legal and policy challenges. These challenges, taken together, pose a threat to the wetland's ecological health and sustainability, necessitating restoration initiatives, stronger laws, community involvement and more awareness to maintain this essential ecosystem and its wildlife. Table 4.7 depicts data on the perceptions of people in different villages in Kanjli wetland area regarding its degradation and related problems. These problems are classified into four categories: soil erosion, flooding, socioeconomic impact and other. The percentages in each category show the proportion of households in each village that agreed on the presence of these issues.

Table: 4.7
Kanjli Wetland: People's Perception on the Problems Arises due to Degradation

Village	Type of Problem				Total
	Soil Erosion	Floods	Socio-Economic Impact	Other	
Badshahpur	21%	7%	57%	14%	100%
Beja	0%	33%	33%	33%	100%
Boot	37%	16%	39%	8%	100%
Chuharwal	6%	11%	44%	39%	100%
Dham	0%	18%	36%	45%	100%
Hamira	17%	15%	36%	32%	100%
Kanjli	13%	17%	46%	25%	100%
Lakhan Kalan	7%	13%	43%	36%	100%
Lakhan Khurd	9%	9%	41%	41%	100%
Paharipur	8%	31%	31%	31%	100%
Subhanpur	25%	25%	17%	33%	100%
Total	17%	15%	39%	29%	100%

Source: Field Work, 2023.

Table 4.7 shows that the village Boot has the most reported soil erosion, with 37% of households admitting that it is an issue in their locality. Subhanpur stands in second with 25%, showing a serious risk for soil erosion. Other villages, including Kanjli, Badshahpur and Hamira, report varied degrees of soil erosion as well. According to the surveyed households, Dham and Beja have no soil erosion issues. Beja is the village with the worst flood problems, with 33% of households considering it as a major issue. Floods are also reported in Paharipur and Subhanpur, though to a lesser extent, with 31% and 25% of houses, respectively. Lakhan Khurd, Dham and Boot

have low percentages, indicating that floods are not a major threat in these areas. Badshahpur has the highest documented socioeconomic impact (57%), showing that wetland degradation is negatively impacting locals' livelihoods and well-being. Kanjli and Chuharwal both exhibit significant socioeconomic effects of 46% and 44%, respectively. Wetland degradation affects the local economy and social situations in villages such as Boot and Lakhan Khurd, demonstrating that wetland degradation has a modest influence. Paharipur and Beja have lower percentages, indicating that the socioeconomic impact is less severe in these areas.

The "Other" category most likely includes a variety of additional problems or concerns associated with wetland degradation that are not particularly classified as soil erosion, floods or socioeconomic effect. Dham and Lakhan Khurd have the highest percentages in this category, showing that these villages are concerned about other issues related to wetland degradation. Subhanpur also has a significant percentage in this category, implying that there may be a variety of concerns in that location in addition to the main categories. Kanjli, Boot and Chuharwal have lower percentages, indicating that there are less reported concerns in the "Other" category. In conclusion, table 4.7 shows how different villages observe and experience wetland degradation, with varying levels of concern in each village. This information is useful for analyzing the environmental and socioeconomic impact of Kanjli wetland degradation in these villages, as well as for prioritizing conservation and mitigation actions in the most affected areas.

From table 4.7, it is possible to analyze the relationship between the villages and the issues caused by wetland degradation. Two hypotheses have been designed to investigate this association. These hypotheses are as follows:

H0 (Null Hypothesis): Villages are not associated with the problem arising due to the degradation of wetlands.

H1(Alternative Hypothesis): Villages are associated with the problem arising due to the degradation of wetlands.

To find out this relationship, the Chi-Square Test have been used, and the results are as follows:

Table: 4.8

Chi-Square Tests			
	Value	Degree of Freedom	Asymptotic. Significance (2-sided)
Pearson Chi-Square	48.860	30	.016
Likelihood Ratio	52.352	30	.007
N of Valid Cases	411		

Source: Statistical Package for Social Sciences, Version 21.

The Pearson Chi-Square value is 48.860 with 30 degrees of freedom and a p-value of .016 (Table 4.8). This test analyzes whether there is a statistically significant relationship between the variables. We reject the null hypothesis since the p-value is less than 0.05 (assuming a 5% significance level). Similarly, the Chi-Square value of the Likelihood Ratio is 52.352 with 30 degrees of freedom and a p-value of .007. This test, like the Pearson Chi-Square test, investigates the relationship between the variables. A significant connection is indicated by a p-value less than 0.05. The p-value being less than 0.05 suggests that there is a linear association between villages and the type of natural problem. This indicates a statistically significant relationship between the villages and the type of natural problem caused by wetland degradation.

Table: 4.9

Symmetric Measures			
		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.326	.016
N of Valid Cases		411	
a. Not assuming the null hypothesis.			

Source: Statistical Package for Social Sciences, Version 21.

Also included is the Contingency Coefficient (Table 4.9), which measures the degree of association between nominal variables. In this situation, it indicates a 32.6% association between the villages and the types of natural concerns associated with wetland degradation. This validates the findings of the chi-square tests, demonstrating that there is a relationship between the two variables.

As a result of the chi-square test results, it is possible to conclude that there is a statistically significant relationship between the villages and the type of natural problem caused by wetland degradation. As a result, the null hypothesis (H0) can be rejected and the alternative hypothesis (H1) accepted, showing that the villages are associated with specific natural problems related to the degradation of Kanjli wetland.

Conclusion

Kanjli Wetland has been significantly impacted by human activities such as water extraction, agricultural expansion and the dumping of industrial and domestic waste. This degradation has had adverse effects on the local communities who depend on the wetland for their livelihoods. The wetland's degradation has led to a decline in fish populations, a significant source of income for local fishermen. The degradation has also resulted in reduced water availability for irrigation, affecting agricultural production and the livelihoods of farmers. The degradation of Kanjli Wetland has also led to water scarcity in the surrounding areas. This has a direct impact on agriculture which is the primary source of livelihood for many in the region. Farmers have to rely on groundwater for irrigation which has led to a decline in water quality and an increase in salinity and affecting crop yields. Additionally, the pollution in the wetland has contaminated the water supply, impacting the health of nearby communities that rely on it for drinking purpose for animals and other domestic use. Furthermore, the wetland's degradation has resulted in a loss of biodiversity, with the disappearance of some bird species that were once abundant in the area. This loss has negatively affected ecotourism, another source of income for the local communities.Many households have experienced financial hardship as a result of the deterioration of the Kanjli Wetland. In summary, the degradation of Kanjli Wetland has had a severe impact on the livelihoods of the local communities who depend on it for their income, food security and water supply. Urgent action is needed to protect and restore the wetland, not only for the benefit of the local communities but also for the conservation of the wetland's biodiversity and ecological functions.

CHAPTER – 5

CONSERVATION AND MANAGEMENT OF KANJLI WETLAND

Wetlands play an increasingly crucial role in global environmental health due to their multifaceted contributions. They act as reservoirs during dry spells, maintaining high and stable water tables. Additionally, wetlands help mitigate floods by retaining suspended particles and nutrients, resulting in streams entering lakes with reduced sediment and nutrient loads compared to direct streams. The degradation of wetlands, often caused by construction or other human activities, typically leads to a decline in lake water quality. Moreover, wetlands serve as vital habitat for wildlife, providing essential feeding and nesting grounds, as well as serving as rest stops and sanctuaries for birds. These diverse ecosystems are essential for maintaining species diversity and offer a wide range of ecological benefits (Prasad et al., 2002). India boasts a rich diversity of wetland ecosystems due to its varied topography, climate patterns, and an annual rainfall averaging around 130 cm. These wetlands include high-altitude Himalayan lakes, floodplain wetlands along major rivers, saline and seasonal wetlands in dry and semi-arid regions, coastal wetlands such as lagoons, backwaters, and estuaries, as well as mangrove forests, coral reefs, and marine wetlands.

India's diverse array of reservoirs, shallow ponds, and tanks significantly enhance wetland biodiversity, enriching the country's ecosystems. According to Deepa and Ramachandra (1999), freshwater wetlands alone harbor approximately 20% of India's biodiversity. However, despite their ecological significance, wetlands lack specific administrative oversight. The primary responsibility for managing these habitats falls under the purview of the Ministry of Environment and Forests. While some wetlands enjoy protection under the Wildlife Protection Act, many others remain under imminent threat of extinction. Preserving these invaluable ecosystems hinges on effective collaboration among various ministries responsible for energy, industry, revenue generation from fisheries, agriculture, transportation, and water resources.

Several governmental and legislative activities promote wetlands protection in India (Parikh & Parikh 1999). The Indian Fisheries Act was passed in 1857; the Indian Forest Act was passed in 1927; the Wildlife (Protection) Act of 1972; the Water (Prevention and Control of Pollution) Act of 1974; the Territorial Water, Continental

Shelf, Exclusive Economic Zone, and Other Marine Zones Act of 1976; and the Water (Prevention and Control of Pollution) Act of 1977; the 1976 Act on Territorial Water, Continental Shelf, Exclusive Economic Zone and Other Marine Zones; Indian Maritime Zone Act (Regulation of Fishing by Foreign Vessels) - 1980; Forest Act (Conservation Act) of 1980; Environmental (Protection) Act of 1986; Notification of Coastal Zone Regulations - 1991; Wildlife Protection Act Amendment Act of 1991. Some of the primary components of legislation concerning wetlands protection in India are the National Protection Strategy and Environment and Development Policy Statement (1992), the National Biodiversity Policy, and the Macro-level Action Strategy (1999), among others.

Apart from the Convention on Biological Diversity, India has also become a party to the Ramsar Convention on Wetlands. Alongside governmental oversight, enhanced surveillance methods are essential to enhance understanding of the physical and biological attributes of each wetland resource and to gain deeper insights into wetland dynamics and regulatory mechanisms. Given India's status as one of the world's most biodiverse nations, preserving the ecological integrity of these habitats, along with the diversity of associated flora and fauna, is imperative. Leveraging remote sensing data and Geographic Information Systems (GIS) can significantly contribute to wetland conservation and management efforts.

As per Jonna (1999), applications of remote sensing encompass a wide array of water resource evaluations, hydrological modelling, flood management, capacity estimation for reservoir surveys, ecological impact assessment of water resource projects, and water quality mapping and monitoring. Satellite imagery aids in identifying flood-inundated regions and flood-risk zones. Integration of satellite data with geographic information systems presents a cost-effective and time-efficient approach for delineating, mapping, inventorying, and monitoring cropping patterns, crop production and condition, irrigation status, and identifying inefficient irrigation practices. With advancements in spatial, spectral, and temporal resolution, remote sensing data offer economically viable means for inventorying, monitoring, and managing water bodies.

Wetlands in Punjab span approximately 23,000 acres, with many natural wetlands facing the threat of conversion for agricultural purposes. Additionally, man-made

wetlands, primarily established to fulfil drinking water needs in Punjab and neighbouring states, are at risk due to general ecological deterioration. Despite the state government's emphasis on wetland conservation and protection, community attitudes toward these ecosystems are predominantly negative, with efforts underway to repurpose wetlands in the near future. Consequently, wetlands continue to disappear, with this trend persisting. Notable wetlands like Bhupinder Sagar, Rahon de Chhamb, and ChhangaliChhamb have lost their original characteristics due to land reclamation. Lowland drainage, reduced water inflow into natural wetlands, sedimentation, and encroachment are the primary drivers of their decline. The ongoing depletion of natural wetland areas in the state is not only altering the local hydrological system but also diminishing ecological diversity (Ladhar, 2002). Urgent conservation measures are required to safeguard some of the state's most valuable wetlands.

Five wetlands—Dholbaha Reservoir Keshopur-Miani Jheel, Chhamb, Jastarwal Jheel, Mand Bharthala andChhawarian Bhangar—have been designated as wetlands of state significance by the Punjab State Council for Science and Technology. The aforementioned wetlands join the Harike, Kanjli and Ropar wetlands on the list of wetlands of national significance. According to Kumar and Kaur (2018), several major issues are brought about by the effects of industrialization, urbanization and agricultural practices on wetlands, including the contraction of wetlands and ecological imbalance. Several organizations, institutions, and governmental bodies at the national and international levels have proposed provisions for wetland protection to understand and assess the threat and severity of wetland regions. Punjab is renowned around the world for its agricultural leadership, greater contribution and enhanced production of food grains that feed a sizable section of the populace. Agriculture development, industrialization and urbanization all pose significant dangers to Punjab's wetlands. Wetlands face major threats unless state, national and international measures are taken to manage and maintain them.

The Kali Bein stands as one of Punjab's largest freshwater streams, coursing over 160 kilometers from Hoshiapur to Kapurthala, traversing Sultanpur Lodhi before converging into the Harike Wetland. Within the Kapurthala district lies the Kanjli Wetlands, an integral part of the Kali Bein Biosphere Reserve. Established in 1870 by the Maharaja of Kapurthala, a barrage was constructed on the Kali Bein near

Kanjli village. This barrage creates a water reservoir, eventually forming the Kanjli Wetland spanning 183 hectares, renowned for hosting a diverse array of migratory birds.

The Kanjli marsh lies approximately 20 kilometers northeast of Harike. Situated on the Kali Bein, historically a significant tributary of the River Beas, this rivulet played a vital role in creating fertile agricultural land by depositing large sediment loads downstream during floods. In 1870, the construction of a modest barrage led to the formation of Kanjli Lake, ensuring a steady flow of fresh water. The predominant soil types are alluvium, comprising clay, loam, and alluvial sand. Water depths range from 10 to 25 feet, contingent on seasonal variations and water influx. The catchment area is predominantly agricultural. After traveling approximately 20 kilometers, the Kali Bein merges with the Harike Wetland downstream.

An attempt has been made in this chapter to analyze various threats, challenges, conservation and management practices of Kanjli wetland. A number of threats i.e. reduced inflow of water, weed infestation, excessive grazing and deforestation and encroachments along the bank etc. have emerged in the wetland in past few years. However, a number of government actions have been taken by the state government for the protection and management of this wetland. To accomplish this chapter, various government reports, policy documents and research papers have been reviewed along with field work. This chapter has been discussed under the following headings:

5.1 Threats to Kanjli Wetland

5.2 Conservation and Management of Kanjli Wetland

5.2.1 Government Initiatives for the Conservation and Management of Kanjli Wetland

5.2.2 Community-Level Initiatives for the Management and Conservation of the Kanjli Wetland

5.3 Proposed Measures for the Conservation of Kanjli Wetland

5.1 Threats to Kanjli Wetland

The health of the wetland is threatened by a number of issues, including pollution, excessive freshwater extraction and diversion, and water-chemical intensive agriculture. Because of these problems, wetland protection and management become critical. Before describing the conservation and management efforts executed by the government and the communities in Kanjli Wetland, the major risks and challenges to Kanjli Wetland have been explained in this section. Anthropogenic pressure, weed infestation, eutrophication, fishing, and chemical contamination have all been cited as immediate and long-term threats to the wetland. The biggest threat to wetlands is human activity, specifically the unplanned destruction of wetlands for recreational, industrial, agricultural, and human habitation purposes. In recent years, there has been a rise in encroachment on the Kanjli wetland. According to Ladhar (1993) the district administration has abandoned about 7.34 acres of this encroached-upon wetland. The widespread evolution of aquatic hyacinth is threatening the ecological status of Kanjli Lake by detracting migrating avifauna and replacing indigenous water floral and faunal sections. Apart from the aquatic hyacinth, several underwater and deep-rootedwild plants have turn out to be a nuisance in thereservoir. Controlling these water weeds is challenging and possibly improper because it can disturb the food chain structure. Their in-situ degradation contributes to lake eutrophication. The rapid growth of aquatic hyacinth and the biochemical properties of reservoir water imply a pollution hazard to the habitat. The pollution is caused by the runoff of Micronutrients and pesticide from nearby farming areas. Illicit fishing, which occurs at all hours of the Both days and nights. through the year, trigger off significant disruption to flora and fauna and diminishes the number of fish in the lake.

Before addressing wetland Restoration and Maintenance, an in-depth overview of the various threats that have evolved in the Kanjli wetland needs to be discussed. The most significant threats and challenges to Kanjli Wetland are as follows:

5.1.1 Urbanization and industrialization: Rapid urbanization and industrialization in the Kanjli wetland result in its encroachment. Land reclamation for development, road construction and industrialization are altering the ecosystem of a wetland and decrease its water quality.

5.1.2 Pollution: The cumulative effects of untreated industrial discharge, solid waste, and agricultural runoff pollution are harmful to the water quality of the wetland. Pollutant levels in the water affect aquatic plants and animals, reducing the wetland's total biodiversity.

5.1.3 Habitat Loss: Wetland habitat destruction and degradation can occur as a result of practices such as farming, tourism andinfrastructural advancement. This damage of habitat has the potential to reduce species diversity and upset the natural equilibrium of the ecosystem.

5.1.4 Invasive Species: Non-native plant and animal species may dominate native species, disrupt food chains and change the ecological dynamics of a wetland. Invasive species can also alter the structure of a wetland, perhaps having long-term harmful implications.

5.1.5 Climate Change: Rising temperatures and changed precipitation patterns all have an influence on Kanjli wetland. Weather variations can disturb wildlife mating and migration patterns.Extreme weather events such as storms, flooding and droughts can directly harm ecosystem of wetland and can displace species.

5.1.6 Water Extraction & Diversions: Diverting water from Kanjli wetland to agricultural or industrial areas can affect the hydrology of the wetland, resulting in water level variations, reduced water availability and habitat destruction.

5.1.7 Overfishing and poaching: Unsustainable fishing methods and illegal wildlife hunting in the Kanjli wetland place a strain on wetland biodiversity, resulting in the extinction of critical species and the disruption of the food web.

5.1.8 Lack of Education and Conservation Efforts: One of the main issues in Kanjli Wetland is a lack of community education and awareness. Many people are likely unaware of the biological importance of wetlands, the advantages they give and the consequences of their degradation. The community is probably unfamiliar with sustainable practices that can help maintain the wetland due to a lack of education and awareness. For instance, they are unaware of the significance of preserving the wetland's natural vegetation, preventing pollution and conserving water resources in order to support the wetland's health.

To address these risks and challenges, comprehensive conservation and management initiatives that involve local communities, government agencies and environmental organizations are required. This could include creating protected areas, encouraging environment-friendly land use practices, conducting regular monitoring and studies, and raising knowledge about the value of wetlands for biodiversity, water purification and climate regulation. In this regard, the sections that follow discuss various government and community-level programs aimed at conserving and managing Kanjli wetlands.

5.2 Conservation and Management of Kanjli Wetland

Since 1987, multiple initiatives have been carried out to ensure the long-term protection and management of Kanjli Wetland. The Punjab State Council for Science and Technology has functioned as a hub aimed at the synchronization of a wide range of activities. The greatest threat to the Kanjli wetland has been the water hyacinth. The main issue is its persistent rapid development, as well as its in-situ death and degradation. It has been brought under control using an integrated approach that includes artificial and organic procedures however not biochemical treatments. At Kanjli, human eradicated weed is being used to produce biogas. The Punjab Irrigation Department built a "log boom" to restrict the spread of this weed onto greater portions of Kanjli Lake and to facilitate its clearance in one location. However, the log boom collapsed due to the immense pressure produced by rainwater during the 1993 monsoons. As a result, the Irrigation Department has removed it. Apart from water hyacinths, various submerged and rooted plants are also an issue in Kanjli Wetland. Many species of birds and fish rely on aquatic weeds for survival. If these are removed, the food chain structure may be disrupted. Trees contribute to the biological balance of the wetland by providing fuel, feed and fruit.

The Forest Department of Punjab has planted native trees on around 10 acres of Kanjli wetland. In the future, greater emphasis should be placed on vast plantation in places that are less prone to flooding. Planting some alien tree species may necessitate research into the preferences of migrating birds stayingin thewetlands. Fencing is required for addressing the issue of overgrazing and human encroachment. The Forest and Wildlife Department of Punjab has fenced off select

important regions to protect already threatened ecosystems. Soil conservation is also required both inside and outside the wetland region. To develop long-term conservation measures, research studies should be conducted to analyze biological elements, the food chain pattern, and possible risks. The need of the hour is integrated wetland management that benefits both humans and animals while maintaining ecological equilibrium. The enduring solution to the challenge of reservoir protection is education. Still there isa chanceof the survival of these geographicallyvalued and endangered habitats exceptpublic recognize the requirement to protect wetland ecologies and understand in what way they may help.

The conservation and management of the Kanjli Wetland require coordinated efforts from the government, corporate sector, and the community. The Kanjli Wetland is a significant ecosystem that supports a diverse range of plant and animal species while also providing ecological benefits such as water purification, flood control and recreational activities. All stakeholders must actively participate in a variety of initiatives to ensure its preservation and long-term use. Each of these stakeholders contributes significantly to the wetland's ecological integrity and long-term use. The following section discusses the specific efforts made by each stakeholder.

5.2.1 Government Efforts

Here are some common International, National and State level initiatives and actions that are typically undertaken for the conservation and management of wetlands in India:

A. Ramsar Convention on Wetlands of International Importance

B. World Wildlife Fund for Nature (WWF) India and Danone Fund for Nature (DFN) India

C. National Wetland Conservation Program (NWCP)

D. Punjab State Wetland Authority

A. Ramsar Convention on Wetlands of International Importance

Kanjli Wetland is declared as Ramsar Site in February 2002. The Ramsar Convention is an international treaty for the conservation and sustainable use of wetlands. The Ramsar Convention, also known as the Convention on Wetlands of International Importance, is an international convention that aims to conserve and sustainably use wetlands. It was enacted in the Iranian city of Ramsar in 1971 and came into effect in 1975. The convention establishes a framework for the responsible management and conservation of wetlands and their resources. The convention emphasizes the importance of maintaining the ecological integrity of wetlands while promoting their sustainable utilization. Countries identify and designate certain wetlands inside their borders as Ramsar Sites. These locations have international significance in terms of biodiversity, ecology and other characteristics. The Ramsar Convention is critical to wetland conservation because it raises awareness about the importance of wetlands, promotes sustainable management techniques and encourages international collaboration. Ramsar Site declaration provides a forum for governments to prioritize conservation and smart use of these critical ecosystems. The main objectives of the Ramsar Convention are to halt the global loss of wetlands and to conserve those that remain through effective utilization and management. The Ramsar Convention on Wetlands establishes a framework for the conservation and judicious use of all wetlands through local, national and international collaboration, as a contribution to achieve global sustainable development. Recognized for its diverse biodiversity encompassing aquatic, mesophytic, and terrestrial flora and fauna, the Kanjli wetland attained international recognition in 2002 It was designated as a wetland of global significance within the provisions of the Ramsar Convention. However, various challenges jeopardize the wetland's well-being, including excessive freshwater extraction and diversion, intensive chemical-dependent agriculture, and pollution. In a proactive measure, in 2019, the Punjab government recognized the 210-hectare Kali Bein River and Kanjli Wetland as the Kali Bein Conservation Reserve, with the goal of streamlining conservation initiatives.

B. World Wildlife Fund for Nature (WWF) India and Danone Fund for Nature (DFN) India

The World-Wide Fund for Nature (WWF) India is committed to developing and implementing practical solutions for the conservation of India's ecosystems and biodiversity. By leveraging science-based approaches, WWF India aims to tackle issues at the intersection of growth and management. As a component of the global WWF system, operating in more than 100 nations, WWF India operates in more than twenty states. Their initiatives span a wide range of zones, together with the protection of crucialflora and fauna species and their territories, sustainable conservation of streams, marshlands and ecological systems, adaptation to changing climate, promotion of resilient practices in commercial and farming, empowerment of nearby communities as management advocates, contendingillicit wildlife trade, and awakening environmental stewardship among scholars and inhabitants through outreach and education efforts.

Danone is a prominent multi-national food and beverage corporation focused on health-oriented and fast-growing categories across three divisions: Essential Dairy and plant-based Products, Waters and Specialized Nutrition. Danone seeks to promote healthier and more sustainable eating and drinking choices through its 'One Planet One Health' frame of action, which views people's and the planet's health as inextricably linked. Danone ventured into the nutrition sector in India in 2012 through the acquisition of the nutrition portfolio from Wockhardt Group. Operating under the umbrella of Danone India, the company offers a comprehensive variety of goods catering to expectingfemales, newborns, offspring, and children. Renowned brands such as Aptamil, Neocate, Farex, Protinex, Dexolac, and Nusobee are part of their product lineup. The Danone Fund for Nature (DFN), a joint initiative involving Danone Group, IUCN, and Ramsar, is dedicated to conserving and restoring wetland habitats crucial to the carbon cycle across various regions worldwide. Collaborating with WWF India, with an emphasis on the Kanjli wetland in the Kapurthala region of Punjab, Danone India is actively working to improve the biological stability of the Kali Bein reserve. Over the span of three years, this initiative aims to facilitate the formulation of a comprehensive management strategy to conserve the Kanjli

wetland. It will entail crafting a blueprint for reinstating natural freshwater flows and establishing a collaborative platform connectingnumerousparticipantsfor exampleGovernmental organizations, non-profit groups, experts, local communities, and industries, to ensure effective wetland preservation efforts.

This collaboration between WWF India and Danone India forges paths to address these concerns and increase ecological health through the use of an integrated basin approach, which contributes to the normalinterface and interconnection of Kanjli, Kali Bein and the Harike Wildlife Sanctuary. The initiative intends to reestablish the environmental and physiological interdependence of 3 vital river habitats in Punjab such as, Kanjli, Kali Bein and the Harike Wildlife Sanctuary. Itwill also benefit the continuingstrength of abundant wildlife that depends on these structures, predominantly the threatenedDolphins of Indus River, as well as community well-being. According to Danone India's Managing Director, Danone India collaborated through WWF India since river conservation stays critical to our earth.

The aim of this collaboration is to enhance WWF India's ongoing conservation endeavours within the maintenance of Kanjli Wetland and Kali Bein Reserve. Recognized as a Ramsar site, the Kanjli wetland in Punjab holds international significance, and this partnership seeks to bolster populations of aquatic species and their habitats within the Kali Bein ecosystem. Additionally, WWF India has initiated an educational campaign focused on capacity-building and awareness-raising to promote effective wetland management. As part of this effort, a system of Wetland Mitras (Friends of Wetlands) is being established to establish a perfect of multi-investorappointment in wetland preservation. Moreover, the project includes the launch of a Water School initiative in 30 local schools. To further involve local communities, the project is collaborating closely with residents to develop improved agricultural practices aimed at reducing water usage, as well as the use of chemical fertilizers and pesticides in crop cultivation.

C. National Wetland Conservation Program (NWCP)

As of February 2022, India has the greatest network of wetlands and Ramsar sites in South Asia, with 49 sites totalling 10,93,636 hectares. These wetlands must be

protected since they suffer numerous dangers such as variations in natural as well as hydrological systems, global climate change, invasive species and others. As a result, the government is focusing on wetlands conservation under the National Wetlands Conservation Programme (NWCP). The National Wetlands Conservation Programme (NWCP) is a Centrally Sponsored Scheme (CSS) of the Ministry of Environment, Forests and Climate Change that has been in place since 1986 with the goal of preventing further deterioration of the nation's wetlands. The NWCP follows the same criteria as the Ramsar Framework Convention guidelines on Wetlands to identify wetlands of national significance and the central government is in charge of general coordination of wetland protection activities. Since 1986, 115 wetlands have been designated for conservation and management in 24 states and two UTs. Annual grants to state and municipal governments provide 100% financial assistance for MAP (Management Action Plan) implementation. The program's central assistance is dependent on proposals made by state governments, compliance with requirements and budget availability. Treatment of catchment areas, de-siltation, pollution control, afforestation, fisheries, public participation and so on are all permissible components.

The National Wetlands Conservation Programme (NWCP) and the National Lake Conservation Plan (NLCP), both of which have been in place since 2001, were integrated as schemes into the National Plan for the Conservation of Aquatic Ecosystems (NPCA) in February 2013. The program intends to achieve the desired water quality upgrade through holistic protection and restoration of wetlands, as well as improvements in biodiversity and ecosystems. It seeks to encourage the inclusion of wetlands in development planning with states by assisting in the development and execution of integrated management plans, capacity development and research.

a. Kali Bein Conservation Reserve

A conservation and protection plan scheme has been instituted in the Punjab state to safeguard its wildlife resources. The State's Protected Areas Network includes 13 Wildlife Sanctuaries (WLS), 4 Community Reserves, and 5 Conservation Reserves. Six of these are located in Patiala, one in each of the districts of Sangrur, Hoshiarpur, Tarn Taran, Ferozepur, and Gurdaspur, and two in Ropar. Harike wetland is a Ramsar

Site in Tarn Taran area that represents a riverine/wetland habitat. Abohar Wildlife Sanctuary is predominantly a Protected Area on private land in Ferozepur district, and it is India's best example of a community participatory management system for wildlife conservation. Lalwan in Hoshiarpur, Keshopur-Miani in Gurdaspur, Panniwala-Gumjal in Fazilka, and Siswan in S.A.S. Nagar are the most recent Community Reserves to be proclaimed in the state. Conservation Reserves in the state include Rakh Sarai Amanat Khan in Amritsar, Ranjit Sagar Dam in Gurdaspur, Ropar Wetland in Ropar, Kali Bein in Kapurthala and the Beas River (185 km stretch from Talwara Head to Harike Barrage).

The Punjab government recognizes the ecological, botanical, and zoological importance of the area specified in the table below. Consequently, it has designated it as a conservation reserve for the protection, propagation, and enhancement of wildlife and its habitat. Therefore, under Section 36-A of the wildlife protection act, 1972 and after consultation with local communities, the governor of Punjab declares the area of following 29 villages of Kapurthala district totaling to 520.824 Acre as "Kali Bein Conservation Reserve" from 11 November 2019 (Table 5.1).

Table: 5.1
Villages Included in Kali Bein Conservation Reserve by Punjab Government in 2019

Sr. No.	Name of Village	Area included in Conservation Reserve (in Acre)
1	Aahli Khurd	56.281
2	Aaloowal	16.619
3	Awan Bhikheshah	13.263
4	Begowal	28.794
5	Bhadas	8.331
6	Bhagobudha	29.125
7	Bhulakh Garbi	14.162
8	BhulakhSharki	5.625
9	Biza	9.162
10	Busewal	59.656
11	Daulatpur	2.006
12	Dhodiawala	13.600
13	Husainabad	8.337
14	Husainpur	3.119
15	Jalal Bhulana	5.962
16	Kadhal Kallan	18.763
17	Kanjali	42.281
18	Khasan	27.181

19	Khera Dona	29.644
20	Mana Talwandi	33.244
21	Mubarakpur	3.781
22	Mustafabad	13.294
23	Ratta Nauabad	0.694
24	Sadali	12.206
25	Sedo Bhulana	16.125
26	Sherpur Sadha	13.869
27	Shikarpur	16.994
28	Sidhwa	10.706
29	Sroopwal	8.000
	Total	**520.824**

Source: Notification of Department of Forest and Wildlife Protection, Govt. of Punjab, 2019.

Table 5.01 provides a detailed overview of the villages included in the Kali Bein Conservation Reserve by the Punjab Government in 2019, along with the corresponding area designated for conservation in acres. The Kali Bein Conservation Reserve is a substantial effort to preserve and conserve the Kali Bein. The 29 villages including Aahli Khurd, Busewal and Kadhal Kallan etc. contribute a total area of 520.824 acres within the conservation reserve. Each village has been allotted a specified area, ranging from 0.694 acres in Ratta Nauabad to 59.656 acres in Busewal. This comprehensive strategy demonstrates the Punjab Government's commitment to biodiversity protection and sustainable environmental practices, with a particular focus on the Kali Bein region.

b. Conservation of Kanjli Wetland under National Wetland Conservation Program (NWCP)

Kanjli Wetlands and Harike Wetlands have been chosen for management and protection by the Government of India's Ministry of Environment and Forests (MoEF, GOI). A State Level Coordinating Committee was formed in 1987 to address the area's problems and implement corrective actions. The Environment Division of the Punjab State Council for Science and Technology was tasked by this Committee to organize and execute Wetland Projects. Various conservation and management initiatives have been undertaken at Kanjli Wetland under the National Wetland Conservation Programme:

i.Survey, Mapping and Notification

The Town & Country Planning Department conducted a detailed study of Kanjli Wetland and developed a draft map as well as a draft notification. A draft notice has been submitted to the MoEF, Government of India, to propose the designation of Kanjli Wetland as a protected area under the Environment Protection Act of 1986.

ii.Weed Regulator

Aquatic hyacinth poses the significant challenge on Kanjli Wetland, and efforts to eradicate this invasive weed must be prioritized. The excessive growth of water hyacinth covers the entire surface of the lake, depriving bird fauna of the crucial water availability that attracts them to these wetlands. Additionally, the high transpiration rate of the plant leads to increased water loss.Regardless of its potential to absorb toxic substances in lakes and streams, thereby acting as a natural water purifier, the decomposition of water hyacinth within the wetland can reintroduce these chemicals into the water, exacerbating eutrophication.

The overgrowth of aquatic hyacinth in the West Bein and nearby waterbodies poses anenormousenvironmental challenge. While biochemicalunwanted plantelimination is not preferred and weed management methods have been employed. However, manual removal efforts have revealed that the plants regenerate every 3 to 4 months, necessitating weed clearance up to three times per year. Attempts to block the weed upstream of the main lake area have proven ineffective. Similarly, efforts to utilize the weed for biogas generation have yielded unsatisfactory results.

The responsibility for weed management falls on the Irrigation Department and the district administration, with occasional assistance from the District Police in clearing the lake of vegetation. In the past, the Army cleared a portion of the lake during the years 2000-2001. Currently, there are plans to implement a conveyor belt system for mechanical weed removal.

iii.Afforestation

While Kanjli Wetland may not be considered an ideal avian habitat, it still draws a diverse array of bird species. The presence of trees, although limited, plays a crucial role in providing breeding and roosting spaces, as well as food sources for certain bird species. Moreover, a healthy forest ecosystem serves as the lungs of the

ecosystem, contributing to air purification and fostering understory vegetation growth. Additionally, trees aid in preventing siltation by stabilizing soil with their robust root systems. Therefore, it is imperative to plant trees not only around the pond but also on the small islands within the wetland. The Forest Department has afforested approximately 26 hectares. of Kanjli Wetland with mixed indigenous species to date. Plantation work in both wetland zones must be continued. To boost tree cover, work on plantation in both wetland zones and catchment areas must be continued.

iv.Fencing

Kanjli Wetland must be protected against overgrazing by cattle and public encroachment in order to preserve crucial pockets of habitat for wading birds. The District Administration must inspect encroachments and remove unlicensed occupations. The Department of Forests and Wildlife has erected a 10880 (Linear Feet) Ln.Ft. fence around the Kanjli Wetland region to date. It's important to recognize that the purpose of this fencing extends beyond the protection of young plants; it also serves to delineate the habitationused forstriding birds.

v.Monitoring of Pollution

Outdoor nutrient load is also a critical component in influencing lake water production. Nutrient overloading in lakes can cause eutrophication. Preventive and curative measures are required for the restoration of wetland quality. Hence, the monitoring of water quality is crucial due to the influx of contaminated water from certain municipalities and manufacturing into the Kali Bein. Additionally, various sources ofcontamination from agricultural substances in watershed zones poses additional challenge. The Punjab Pollution Control Board conducted quality assessments of stream water at Kanjli Wetland in 1991-1992, 1992-1993, and 1996-1997. The findings indicate that the water quality in this wetland typically meets the standards outlined for class "B," representing the recommended best usage. However, it deteriorated to Class 'D' in December.

The Punjab Pollution Control Board (PPCB) has suggested the following measures:

- To prevent seepage and runoffs from an adjacent field, intensive afforestation is required. A dense tree cover, which acts as the ecosystem's lungs, will also provide ample space for some bird species to nest.

- Manual or dredged weed removal is often necessary.

- Efforts should be made to deter individuals from using the lake as a dumping ground.

- Maintaining an appropriate water level in wetland is essential for preservingecology of the reservoir, especially during summerseasons.

- Desertificationmust be absolutely prevented (at the Kali Bein wetland area).

- Communities residing along Kali Bein, which feeds into Kanjli Lake, are prohibited from discharging sullage into the Kali Bein.

- Farmers should receive education on minimizing the use of fertilizers and pesticides, transitioning to bio-composts and bio-insecticides wherever feasible.

- Proliferation of aquatic hyacinth in the wetland suggests a worsening eutrophication problem over time, largely attributed to the use of pesticides in nearby farms.

- Following the recommendations of the Board, it is imperative to conduct a comprehensive analysis of the pollution sources and extent in the stream water supplying the reservoir, along with addressing the underlying issues contributing to water quality degradation.

vi.CommunityAttentiveness

The state council is actively engaging in communityconsciousness campaigns in partnership with NGOs and other relevant departments. They have produced and distributed posters, leaflets, and other informative materials, and have installed educational billboards onsite. In addition to this, seminars and meetings are also held on a regular basis.

vii. Fish Introduction

Introducing new fish species into the wetland has been an important method for maintaining ecological balance and mitigating the negative effects of invasive species. Invasive species have threatened native aquatic life and disrupted the local environment at the wetland, which is part of the Beas River system. Conservationists hope to promote biodiversity and create a more balanced aquatic environment by introducing new fish species, particularly native and beneficial ones. This strategy helps control invasive species populations through natural predation and competition, benefiting the health and sustainability of the Kanjli Wetland environment. The technique also supports fish population stability and benefits the local fishing community by making fisheries more diversified and sustainable.

viii. Biodiversity Park

The authorities in Kanjli Wetland have contributed commendably to biodiversity protection by establishing a biodiversity park in 2019. This park strives to raise awareness, conduct research and educate people about the need to sustain varied ecosystems. The biodiversity park is located within the rich habitat of the Kanjli Wetland, which is already a Ramsar site. It acts as a hub for studying native flora and fauna and supporting sustainable practices. It offers researchers, students and visitors a unique opportunity to interact with and comprehend the region's rich biological resources, emphasizing the need for conservation efforts in maintaining such valuable natural assets.

ix. Bird Watch Tower

A bird watch tower has been constructed near the Kanjli Wetland, increasing its appeal as a destination for birdwatchers and nature lovers. The Kanjli Wetland is part of the Beas River Conservation Reserve and is well-known for its diverse wildlife. The recently erected watch tower offers a high vantage point from which visitors can witness a diverse range of resident and migratory bird species that frequent the marsh, including egrets, herons and numerous waterfowl. This addition not only encourages eco-tourism, but it also increases awareness about the significance of wetland conservation. The tower acts as an educational center where visitors may learn more about the local ecosystem, helping to raise environmental awareness and support the region's sustainable development goals.

x.Boating

The Kanjli Wetland provides a variety of recreational opportunities including boating facilities, which enhance tourists' experiences. Boating here allows visitors to explore the tranquil surroundings and see the different plant and animal life up close, making it an enjoyable way to interact with nature. These facilities encourage ecotourism and raise awareness about the need of wetland conservation. Additionally, boating activities in Kanjli are regulated to have the least impact on the ecology, balancing the demand for recreational amenities with the preservation of the wetland's ecological integrity.

xi.Nature Based Huts

Nature-based huts have been created at Kanjli Wetland to give visitors a one-of-a-kind experience that mixes comfort with the beauty of the natural environment. These huts are designed to fit in with the surrounding habitat, allowing guests to experience the wetland's beautiful sceneries and diverse wildlife. Staying in these huts allows visitors to immerse themselves in nature, study the rich plants and animals and savor the tranquillity of the marsh. Furthermore, these nature cottages encourage eco-friendly tourism by reducing environmental impact and fostering a stronger connection with nature. This effort not only improves the visiting experience, but it also promotes awareness about the value of wetland conservation.

xii.Walking Pathways

Walking pathways have been meticulously created at Kanjli Wetland, improving visitor accessibility while improving eco-tourism. These trails allow nature lovers to get up close and personal with the wetland's diverse wildlife without disrupting the sensitive ecosystems that thrive there. These routes help to manage foot traffic, lessenanthropological influence on natural setting and ensure the protection of wetland flora and animals. They also provide a tranquil atmosphere for wandering, bird watching and admiring the natural beauty of this significant biological location.

xiii.Parking Facilities

The Kanjli Wetland, recognized for its ecological significance and scenic beauty, attracts numerous tourists throughout the year. To enhance the visitor experience, parking facilities have been developed to accommodate the influx of tourists,

ensuring convenient and accessible entry to the site. These parking places are intentionally positioned to reduce the environmental impact on the marsh, preserving its natural ecosystem while fostering sustainable tourism. By providing well-organized parking, the management aims to reduce congestion and manage visitor flow more effectively, thereby enhancing both the conservation efforts and the overall experience of the tourists who come to enjoy the serene beauty and biodiversity of the Kanjli Wetland.

xiv. Wooden Nests

Wooden nests have been deliberately placed in Kanjli Wetland to aid in bird species conservation and multiplication. This wetland, an important habitat for both resident and migratory birds, is suitable for nesting and breeding. The introduction of these wooden nests attempts to improve bird nesting possibilities by providing secure and adequate habitats away from predators and human disruptions. These initiatives, by providing improved nesting places, help to sustain and increase the region's bird population, support biodiversity and maintain the ecological balance of the Kanjli Wetland ecosystem.

xv. Wooden Hideouts

Wooden hideouts have been built in the Kanjli Wetland to reduce human disturbance of the area's rich wildlife. These buildings allow visitors, birdwatchers and researchers to examine the wetland's rich biodiversity without stressing or alarming the species that live there. The wooden hideouts, which blend into the natural surroundings, serve as unobtrusive observation stations, ensuring that birds and other animals' natural activities are not disrupted. This strategy contributes to the wetland's biological equilibrium while also promoting sustainable tourism and educating people about the need to preserve such essential ecosystems.

It is evident from the above discussion that the Kanjli Wetland has emerged as a conservation and eco-tourism hotspot thanks to a variety of efforts aimed at maintaining its rich biodiversity and supporting sustainable development. To combat the negative effects of invasive species and restore ecological balance, conservationists have imported native fish species that help control invasive populations and foster a healthier aquatic ecosystem. In addition to these efforts, the development of a biodiversity park in 2019 provides a dedicated space for study,

education and awareness about ecosystem diversity, developing a better understanding of local flora and fauna. Additionally, birdwatching amenities such as the bird watch tower and wooden nests provide secure habitats for bird species while attracting eco-tourists and nature enthusiasts, raising awareness about the importance of wetland conservation.

Walking pathways, nature-based shelters and wooden hideouts all contribute to responsible tourism by allowing visitors to immerse themselves in the Kanjli Wetland's natural beauty while causing minimal ecological harm. Regulated boats and well-organized parking facilities also help to manage tourism's environmental impact while improving the visitor experience. These joint initiatives help to conserve the biological integrity of the Kanjli Wetland, support local animals and biodiversity and align with larger sustainable development aims. The Kanjli Wetland is a paradigm for how to preserve and enjoy natural environments responsibly by combining conservation, education and eco-friendly tourism.

D. Punjab State Wetland Authority

The Punjab State Wetlands Authority was established by the Punjab Government to serve as an apex organization for the integrated management of wetlands in the province. This authority's primary role is to prepare a list of wetlands to be notified and to facilitate collaboration and cooperation among various departments for successful wetlands management at the district level. The authority is also in charge of forming district-level wetland management committees in all of the state's districts. The district-level wetland management committee is in charge of wetland management and conservation in the district and reports to the Punjab State Wetland Authority. The organizational chart of district is given in the table 5.2 with the name of post and designation in the committee.

Table: 5.2
Organizational Set-up of District Level Wetland Management Committee in Punjab

Sr. No.	Name of the Post	Designation in the Committee
1	Deputy Commissioner	Chairperson
2	Deputy Director, Fisheries	Member
3	District Development Panchayat Officer	Member
4	Executive Engineer, Irrigation (Drainage)	Member
5	Environmental Engineer, Punjab Pollution	Member

	Control Board	
6	Deputy Director, Local Government	Member
7	One Local Expert (to be nominated by the committee)	Member
8	Divisional Forest Officer (Wildlife). In Districts where there is no Divisional Forest Officer (Wildlife), Divisional Forest Officer (Territorial) is Convener/Member Secretary	Convener/Member Secretary

Source: Department of Forests and Wildlife Preservation, Govt. of Punjab, 2018.

The District Level Wetland Management Committee in Punjab is organized in a collaborative and multi-stakeholder approach to wetland protection and management. The Deputy Commissioner chairs the committee, signifying the district administration's leadership role in managing wetland-related operations. The presence of key participants such as the Deputy Director of Fisheries, District Development Panchayat Officer, and Executive Engineer from Irrigation (Drainage) emphasizes the necessity of bringing together knowledge from the fisheries, rural development and irrigation sectors. With the involvement of an Environmental Engineer from the Punjab Pollution Control Board and a representation from the Local Government, the group also benefits from environmental scrutiny.

The committee's selection of a Local Expert enables the inclusion of local knowledge and community opinions. The Convener/Member Secretary is the Divisional Forest Officer (Wildlife) or Divisional Forest Officer (Territorial), who is in charge of organizing committee activities. This comprehensive structure brings together numerous government agencies and local knowledge to address the many facets of wetland management, such as ecological conservation, sustainable resource use and pollution control. The makeup of the committee emphasizes a comprehensive and inclusive approach to the preservation and sustainable management of wetlands in the different districts of Punjab.

This district-level committee recommends to the Punjab State Wetland Authority for approval of any development and management-related activity of any wetland within its jurisdiction. On certain occasions, the committee invites professionals and specialists in the technical and scientific sectors to work on projects and conduct research. The district-level committee also creates a brief document on targeted wetlands as well as a zone of impact delineation. This district-level committee is also

in charge of establishing a district wetland inventory team to gather data, as well as delineating the boundary and zone of influence of enlisted wetlands to allow for field validation. The evaluation team also includes data from stakeholder consultations and indigenous traditional knowledge, as well as data from scientific samples. To maintain standardization, the team prepares a concise report on prioritized wetlands after a thorough evaluation.

The district-level committee also oversees and monitors the water sources available in all of the districts, as well as the eco-system monitoring service, facts impacting wetlands, analysis of wetland management needs, and so on. This committee also works with the revenue, forest, agricultural engineering, public works, water supply and drainage board and municipal governments. Furthermore, the district-level committee serves as an advisory body for the state wetland authority's smooth operation.

Ultimately, the conservation and management of wetlands in India, particularly the Kanjli Wetland in Punjab, necessitate a multifaceted strategy at the international, national, and state levels. The Ramsar Convention is important because it designated Kanjli Wetland as a Ramsar Site in recognition of its international significance. This designation draws global attention and dedication to conservation initiatives, highlighting the importance of long-term management approaches. Furthermore, the National Wetland Conservation Program (NWCP) at the national level and the Punjab State Wetland Authority at the state level highlight the comprehensive plans and actions in place to handle the plethora of wetlands' concerns.

Partnerships between environmental organizations like WWF India and corporations like Danone are also important in bringing specific conservation projects forward. WWF India and Danone India's collaboration for the Kali Bein protection Reserve, with an emphasis on Kanjli Wetland, shows how public-private partnerships may help with wetland protection. These projects seek to deal with not just immediate issues but also to create extensive sustainability through integrated management plans, community engagement, and awareness campaigns. Local community involvement and the formation of conservation reserves reflect a commitment to the holistic protection of wetland ecosystems, which includes ecological, economic and social aspects.

The district-level approach exhibited by the Punjab State Wetland Authority and district-level committees demonstrates the value of localized efforts in wetland management. The collaborative and inclusive form of these groups, which include officials from various government ministries, local specialists and community members, shows a bottom-up approach to conservation. These committees help the effective implementation of wetland preservation measures by prioritizing data-driven decision-making, monitoring pollutants and incorporating stakeholders at all levels. Overall, the combination of international conventions, national programs, private-sector collaborations, and state-level authorities demonstrates a concerted effort to ensure the long-term conservation of wetlands in India, with a particular emphasis on the unique ecological landscape of Kanjli Wetland in Punjab.

5.2.2 Community-Level Initiatives for the Management and Conservation of the Kanjli Wetland

For all wetlands, communities are an essential component. Although community best practices can have a negative impact on the biological functions of wetlands, but they can also have a positive impact on their deterioration, protecting biodiversity and strengthening livelihood resilience at the same time. In the framework of 'communities of practice,' learning is viewed as active participation, wherein individuals are involved in actions and interactions that are deeply rooted in culture and history. These engagements can either affirm or alter social practices (or beliefs) and the corresponding understanding of the environment (Wostl and Hare 2004, Wenger 1999). Often, community-based conservation recognizes a direct linkage between conservation and livelihood. For example, as the value of species and conserved areas increases, they make an immense contribution to local livelihood and well-being (Mishra and Rao, 2011). Despite the numerous conservation initiatives that have been started over the years, along with national and international rules and guidelines, governments still struggle to protect wetlands, and degradation is still happening quickly, particularly in urban and peri-urban areas. It is becoming more and more evident that multifaceted initiatives are necessary for effective conservation. The Kanjli Wetland, is an important ecosystem that supports local livelihoods, offers a habitat for a variety of resident and migratory bird species, and aids in preserving the ecological balance in the area. The primary threats to the wetland include the proliferation of weeds like Eichhornia crassipes, diminished

water flow, contamination from sewage, deforestation, sedimentation, and encroachment. These issues have deterred migratory birds and other visitors from frequenting the wetland. It is imperative that both government and non-governmental organizations implement sustained conservation and management efforts to safeguard this crucial wetland in Punjab (Kaur,2022).Numerous community-level initiatives have been started to ensure the protection and sustainable management of this wetland since it is crucial to do so. These initiatives can be divided under the following subheadings:

A. Local Awareness and Education Programmes

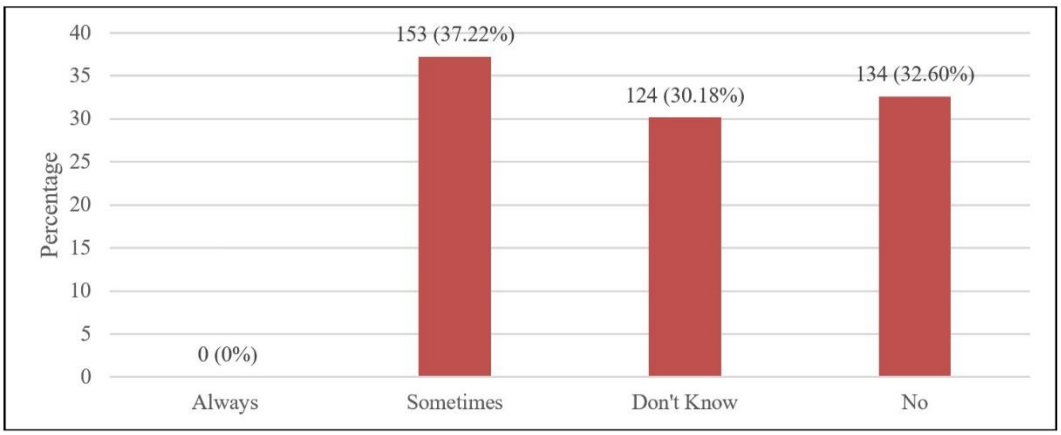
Local awareness campaigns involve the people who live around the wetland. They educate locals on the biodiversity, significance, and possible dangers to the wetland. Conservation initiatives led by the community may result from awareness campaigns. Initiatives for habitat restoration, clean-up campaigns, and citizen monitoring may fall under this category.

a. Community Participation Workshops

Local groups and environmental authorities organize workshops and seminars to raise consciousness amongst the resident populations regarding the significance of the Kanjli Wetland. They inform visitors about the ecology, the bird species it supports and its function in preserving the health of the environment.

The Given figure (5.1) depicts the respondents' perception about the safeguarding of the wetland from contamination. The figure (5.1) shows that put pf the 411 respondents, a significant proportion (37.22%) admits that contamination happens occasionally, while a substantial proportion (30.18%) indicates confusion or ignorance of the problem. Remarkably, none of the interviewees asserted that contamination "always" occurs, which suggests a lack of awareness of the seriousness of the problem or an overly positive outlook. Furthermore, (32.60%) of the respondents reject that the wetland has been contaminated. These varied viewpoints highlight how complex public attitudes and knowledge of environmental issues are, pointing to the need for focused education and awareness campaigns to dispel myths and encourage a more knowledgeable and proactive approach to preventing contamination of the Kanjli Wetland.

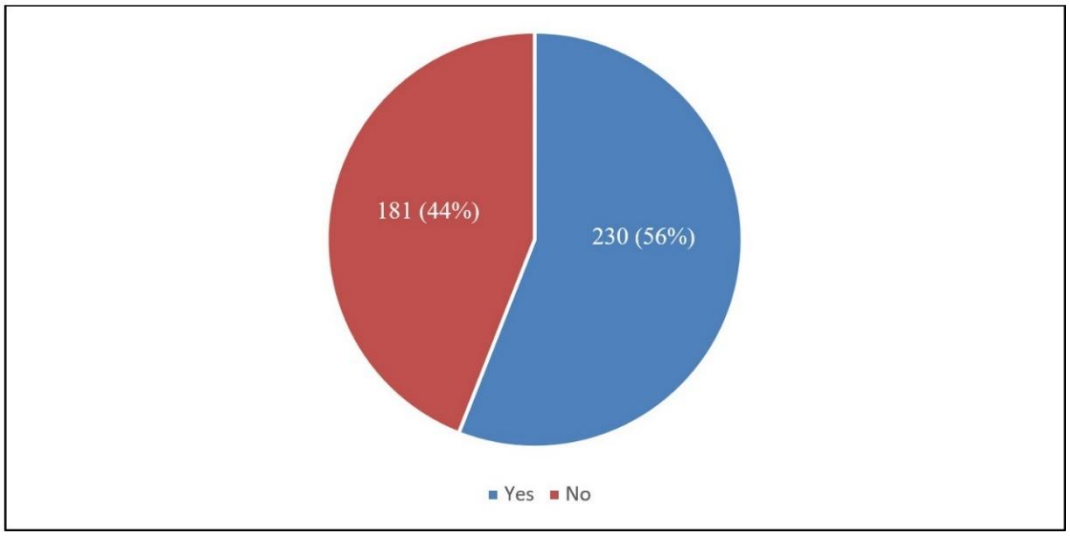
Figure: 5.1
Kanjli Wetland: Perception of Respondents Regarding Protection of Wetland from Contamination



Source: Field Work, 2023.

The given below figure (5.2) reflects the perceptions of respondents regarding activities conducted to raise awareness about natural resources in their village. 230 (55.96%) of the 411 respondents gave a yes response, demonstrating their involvement in or recognition of such activities. In contrast, 181 people (44.04%) gave a negative response, indicating that they were not aware of or involved in activities related to natural resource awareness. The figure indicates that there is a split viewpoint in the community; while a sizable minority of people are ignorant of or uninterested in these activities, a considerable part of them is open to them.

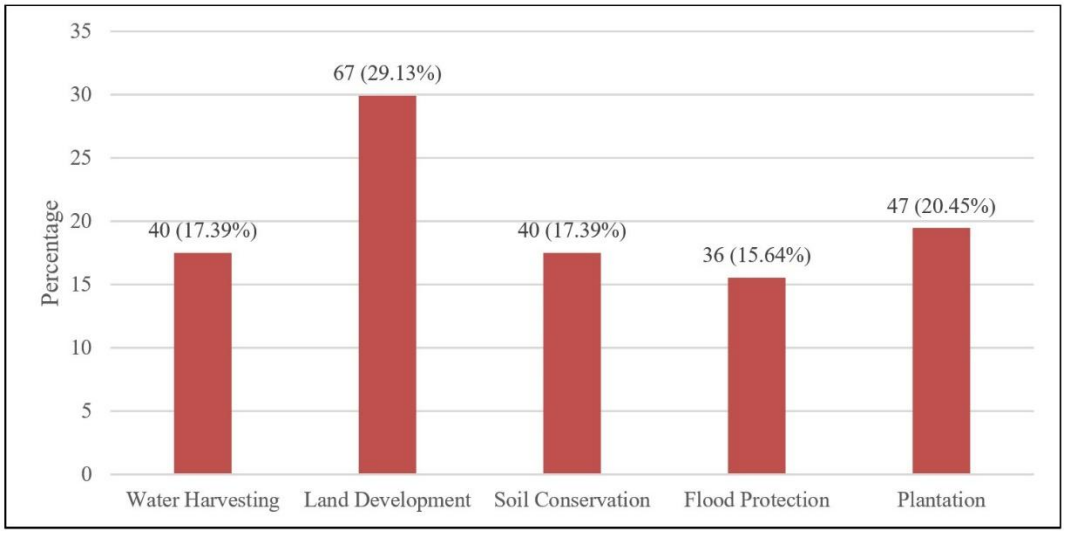
Figure: 5.2
Kanjli Wetland: Perception of Respondents Regarding Activity Conducted Related to Awareness to Natural Resources



Source: Field Work, 2023.

From the above figure (5.2), it is very clear that 230 out of 411 respondents agreed on the fact that there are activities conducted in their villages related to awareness of Kanjli Wetland, and further, these 230 respondents were asked about the type of activity that is conducted in their villages. The figure (5.3) given below shows that,among all the activities, land development (29.13%) earned the highest proportion of any activity, suggesting a substantial perceived significance. Plantation (20.45%), water harvesting (17.39%), soil conservation (17.39%), and flood protection (15.64%) were activities that came a close second. This information sheds light on the priorities and worries of those engaged in or influenced by natural resource management-related activities in the Kanjli Wetland region. The different percentages illustrate regions that may need more attention or comprehensive strategies in the protection and responsibleutilization of natural resources within this wetland environment. They also highlight the varied viewpoints and focus placed on different activities. Gaining an understanding of these beliefs is essential to creating customized and successful plans that maintain Kanjli Wetland's ecological integrity and functionality while fulfilling.

Figure: 5.3
Kanjli Wetland: Perception of Respondents Regarding Types of Activities Conducted Related to Natural Resources



Source: Field Work, 2023.

b. School Outreach Programmes

Educational institutions in the vicinity of the wetland often integrate environmental studies into their curricula, encouraging students to take responsibility for the environment. Students are given hands-on exposure to the wetland's biodiversity

through structured field trips and nature hikes. Education initiatives aid in the local population's comprehension of the wetland's ecological value, including its role in preserving biodiversity, sustaining livelihoods, and bolstering the ecosystem. Through imparting knowledge on the dangers that the wetland faces—such as pollution, encroachment, or unsustainable practices—these initiatives enable people to take the initiative in protecting the wetland. Education encourages people to adopt sustainable and environmentally friendly behaviour that lessen their negative effects on the wetland. By educating people about the value of protecting wetlands and the effects of human activity on natural ecosystems, these practices also function as instructional tools. They offer chances to teach the local population the value of protecting the Kanjli Wetland.

c. Community-Based Monitoring and Research

People are invited to take part in data collection and monitoring activities in community-based monitoring and research projects known as citizen science initiatives. This information is useful for scientific studies and aids in the monitoring of ecological changes in wetlands. Through community-based monitoring, local people are given the opportunity to share their indigenous knowledge about the ecology, biodiversity and traditional uses of the wetland. Involving the community in research projects promotes a sense of accountability and ownership for the preservation of the wetland. The breadth and depth of information acquired are improved when the community is involved in the data gathering process. Making well-informed decisions on the preservation of the wetland is made easier by the thorough understanding of its health that this data offers.

d. Local Research Collaborations

To comprehend the natural processes of the wetland, researchers work with the neighbourhood residents. This participation not only produces valuable data but also gives communities the capacity to take charge of conservation initiatives. Collaboration across a range of stakeholders, including communities, NGOs, government agencies and researchers, is frequently fostered via community-based programmes. These collaborations improve the way conservation efforts and resource management strategies are carried out.

e. Sustainable livelihood opportunities

The Kanjli Wetland offers excellent ecotourism options that support biodiversity conservation and sustainable livelihoods. Programmes for developing skills might concentrate on wetland conservation methods, birding, guiding and hospitality. By utilising these programmes, the community and environment can gain from increased local empowerment, increased understanding of conservation and increased possibilities for eco-tourism in the area. The following is a detailed description of the same:

f. Eco-tourism Initiatives

Initiatives for eco-tourism: Through eco-tourism, locals are given the chance to make money. Tourism-related activities including bird viewing, boat cruises, and guided tours are planned to draw visitors and boost the local economy. The introduction of ecotourism projects and might provide local communities with alternate revenue streams. This lessens their reliance on practices like unsustainable fishing and land expansion that might damage the wetland. The local community is frequently involved in ecotourism activities by welcoming guests, leading tours, or offering lodging and other services. A sense of accountability and ownership for the preservation of the wetland is fostered by this involvement.

g. Skill Development Programmes

Programmes for skill development give locals more authority by improving their capacities. Giving them skills related to ecotourism or other sustainable livelihoods increases their earning potential and empowers local communities to play an importantpart in the conservation and management of wetland. Training programmes are started to give community people the skills they need for professions connected to wetland protection such as - guiding, operating boats and maintaining tourist infrastructure. Initiatives for skill development and ecotourism may reconcile economic growth with environmental preservation when they are run responsibly. They guarantee the preservation of the biological integrity of the Kanjli Wetland while providing chances for economic growth.

B. Practices for Conservation Managed by Communities

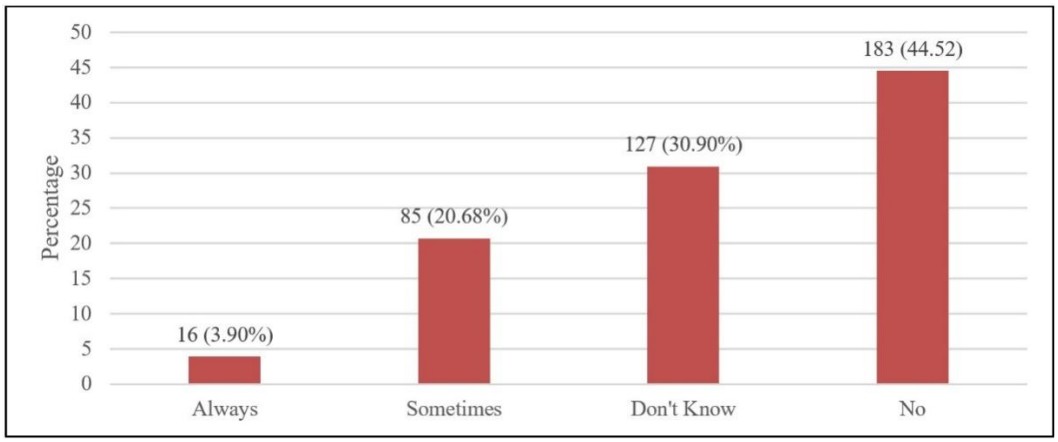
Wetlands truly belong to communities since they are the ones that use and benefit from them. Wetland habitats are preserved by community-led wetland clean-up

campaigns that increase local awareness and participation. Controlling invasive species with community-based methods promotes ecological balance and native biodiversity restoration. By enabling people to participate in the conservation activities, these programmes guarantee the long-term health of wetland ecosystems. The following are the main efforts that fall under this category:

a. Wetland Clean-Up Drives

Community members regularly clean up the wetlands by removing plastic garbage and other contaminants. Locals develop a sense of duty as a result of these motivations. Cleanup drives assist in clearing the wetland region of collected waste, debris and pollutants. By taking this step, water pollution is avoided, which might endanger aquatic life and damage the ecosystem of the wetland. Frequent cleanups enhance the wetland's aesthetic appeal and promote appropriate use by both locals and visitors. This encourages a feeling of communal pride and control over their surroundings. By removing pollutants and non-biodegradable garbage, we may preserve the wetland's biodiversity and provide a better environment for animals, plants, and microbes. Participating in clean-up campaigns and managing invasive plants gives the local community the ability to actively contribute to the preservation of the wetland. It encourages community members to take on a sense of ownership and duty.

Figure: 5.4
Kanjli Wetland: Perception of Respondents Regarding Maintenance and Cleanliness of Wetland



Source: Field Work, 2023.

The above given figure (5.4) suggests that respondents' perceptions of the Kanjli Wetland's maintenance and cleanliness vary, from favourable affirmations to doubt

and discontent. It depicts the respondents' opinions on the maintenance and cleanliness of Kanjli Wetland across several categories. Diverse opinions were expressed by the respondents: out of the 411 respondents, (3.90%) said the wetland was always maintained, while a sizable (20.68%) said it was occasionally kept up. Notably, a sizable (30.90%) of respondents said they were unaware of the wetland's maintenance state, which may point to a lack of knowledge or inadequate information. However, the majority, constituting (44.52%), expressed a negative perception, stating that the wetland was not maintained adequately. The large proportion of people who are unaware of the wetland's state indicates that public education or outreach programmes are necessary to address any concerns that may arise or to keep the public informed about the wetland's maintenance. Enhancing openness and actively engaging the community may help to foster a more knowledgeable and encouraging approach to the preservation of this natural ecosystem.

b. Control of invading Species

Wetland natural plants and animals are threatened by invading species. Communities cooperate to combat these threats. Manual eradication and encouraging the development of native plants are included. Native plants and animals may be outcompeted by invasive species, upsetting the ecosystem's natural equilibrium in wetland areas. Maintaining the richness and ecological integrity of the Kanjli Wetland depends on keeping these invasive species under control. Native environments may be restored by the management of invasive species, which is beneficial for the survival of native plants and animals. Degradation of the habitat might result from invasive species changing the wetland's physical composition. Keeping them under control aids in preserving the wetland's inherent benefits and functions.

C. Support for Regulations and Advocates

Communities' participation in committees and lobbying are examples of support for regulations and advocates. Community committees work with neighborhood organizations to enforce rules, encourage community involvement in decision-making, and promote laws that benefit the general public. By providing information, enlisting support, and advocating for certain legislative or policy changes that are in

line with particular interests or causes, lobbying and advocacy work to sway legislators. The description of the major initiatives under this category is as given below:

a. Community Committees

Local groups frequently establish committees or associations to protect the Kanjli Wetland. These organizations collaborate with governmental organizations to promote laws and policies that advance the interests of wetlands. Advocacy, lobbying, and community groups are essential to the preservation of natural areas like the Kanjli Wetland. These initiatives act as a link between environmental organizations, legislators, and local communities. Committees provide direct awareness of the importance of the wetland to people's lives by representing the views and concerns of the local community. By including residents in committees, conservation methods are guaranteed to be in line with community needs, encouraging a sense of accountability and ownership. Committees have the ability to plan awareness campaigns that inform locals of the value of sustainable practices and the preservation of wetlands.

b. Lobbying and advocacy

Community leaders communicate with governmental organizations on their behalf, urging them to develop and enforce laws that protect wetlands. The goal of lobbying is to persuade decision-makers to pass legislation or other measures that will save wetlands. Proponents say that rules are necessary to guarantee sustainable management. The goal of advocacy is to secure funds or resources for conservation initiatives, highlighting the social, ecological and economic advantages of wetland preservation. Engaging a range of stakeholders, like as NGOs, government representatives and the commercial sector, is the process of lobbying in order to form coalitions that support conservation initiatives. Committees and supporters can work to pass legislation designating the wetland as a protected area, guaranteeing its long-term preservation through lobbying. Public support is generated via community groups and advocacy campaigns, which unite people in support of the cause and give conservation efforts a boost. Committees can help to ensure that rules are followed, monitor the wetland, and report any dangers or infractions to the appropriate authorities. In the end, community committee cooperation and advocacy work

enhance the Kanjli Wetland conservation goal. By combining local expertise, public backing, and policy power, it develops a more all-encompassing strategy to guarantee the long-term sustainability of this crucial environment.

D. Traditional Wisdom and Methods

Traditional wisdom provides comprehensive answers for sustainability, health and social peace. It is beneficial for incorporating historical knowledge into contemporary practices. Integration is the process of combining conventional knowledge with new methods to promote creativity. Cultural events function as venues for showcasing and commemorating this wisdom, safeguarding legacy and fostering mutual understanding among disparate populations. The following is a description of the main elements that fall under this category:

a. Integration of Traditional Wisdom

Wetland management practices use traditional ecological knowledge possessed by local populations. Understanding the natural processes of the wetland typically benefits greatly from having this information. Indigenous societies frequently have extensive ecological knowledge of the plants, animals and interactions between them in the wetland. Sustainable methods and insightful information may be obtained by incorporating this knowledge into conservation plans. Crop rotation, water management and biodiversity preservation are examples of sustainable practices that are frequently emphasized in traditional approaches. Including these practices can help keep the wetland healthy. Including local communities, who possess traditional knowledge, encourages a feeling of accountability and ownership for conservation initiatives. Participation in preservation efforts and sustainable practices may be promoted by this involvement.

b. Cultural Events

Holding festivals and events centered on the wetland aids in the preservation and celebration of regional customs and practices, enhancing the ties that already exist between the community and the wetland. Cultural celebrations honouring the value of the wetland can serve as forums for informing residents and tourists about the ecological relevance of the area. The participants' sense of responsibility may be sparked by this understanding. Wetland-related traditional practices and cultural

festivities can serve as a vehicle for instilling conservation principles in the next generation and guaranteeing the ongoing protection of this important environment. Cultural events can function as gathering places for many stakeholders, such as government agencies, local populations, conservation organizations, and researchers. This encourages cooperation and information exchange for conservation initiatives that are more successful. Create holistic conservation strategies that honour local customs and use the most recent scientific findings by fusing traditional knowledge with cutting-edge scientific techniques. Participate in decision-making with the local community, honouring and incorporating their customs into conservation plans. In addition to ensuring that conservation activities remain relevant, this promotes a sense of cooperation. Make use of cultural events and conventional wisdom to your advantage while promoting laws that encourage environmentally friendly behaviour and conservation initiatives in the area. Conservation efforts for Kanjli Wetland may become more thorough, inclusive and successful in protecting this important environment for future generations by using traditional knowledge and cultural activities.

c. Collaborations and funding

Local communities involved in conservation initiatives must get resources through collaborations with NGOs, since these relationships offer critical access to financing, knowledge, and networks that are necessary for successful preservation. NGOs provide capacity-building programmes that equip communities with scientific knowledge and conservation approaches so they may take the lead on initiatives. NGOs also promote environmental causes, push for laws that will help them, and encourage cooperation amongst interested parties. While grants obtained through NGOs fund infrastructure, capacity building, and specific conservation projects like habitat restoration, water quality improvement and sustainable livelihood initiatives, their technical specialists oversee implementation, guaranteeing community benefits without compromising the integrity of the Kanjli Wetland.

Ultimately preservation of Kanjli Wetland is dependent upon diverse community-led programmes that combine conventional knowledge with cutting-edge conservation techniques. Communities operate as essential stewards, balancing actions that support the resilience and conservation of wetland ecosystems with those that may

unintentionally damage them. Learning becomes an entrenched cultural involvement by embracing the idea of "communities of practice," which shapes social practices and environmental interpretations. In the midst of global issues where wetlands are rapidly degrading despite conservation efforts, the Kanjli Wetland is an environment that is vital to biodiversity and local livelihoods. In response to threats like as pollution, encroachments, and invasive species, many community-level measures have been put into place. These include school programmes, educational outreach and local awareness campaigns that supportcommunities appreciate the value of wetlands and give them the confidence to support conservation initiatives. Citizen science programmes and other community-based monitoring and research programmes make use of local expertise to collect data and monitor the environment, strengthening community ownership and conservation tactics. Opportunities for sustainable livelihoods, such as eco-tourism and skill development, minimize practices harmful to the wetland while providing viable economic options. Initiatives like invasive species removal programmes and wetland cleanup campaigns demonstrate the community's dedication to protecting the wetland at the same time. The protection of the interests of the wetland is ensured via lobbying and community committee advocacy. Conservation ideals are instilled and stakeholder participation is fostered via the incorporation of traditional wisdom into conservation efforts and the organisation of cultural events. Technical assistance and vital resources are provided through partnerships with NGOs, and infrastructure, capacity building, and focused conservation initiatives are supported by grant funds. This all-encompassing strategy, which fosters collaborations and combines ancient wisdom with contemporary techniques, offers a viable way to preserve the Kanjli Wetland's ecological integrity and protect it for future generations while also helping the local community. These neighbourhood-level initiatives are vital for the lasting preservation and sustainable management of this important wetland environment, in cooperation with government and non-governmental support.

5.3 Proposed Measures for the Conservation and Management of Kanjli Wetland

Recognition of values of wetland and benefits to humans has grown, yet economic development persists in the destruction or degradation of wetland systems. Wetlands are understood as integral components of broader ecological systems. To ensure

sustainability, management and conservation efforts must address the full range of processes operating within the landscape as a whole. Numerous factors must be considered in the immediate as well as the long run initiatives towardpreventing additional loss and enhance their environmental authenticity. Anall-inclusivemethodology must be adopted subsequently optimizing entirestructural attributes. Conservation activities for Kanjli Wetland, a nationally recognized wetland, have been ongoing for some time. However, it is evident that significant endeavours are needed to repair the environmental integrity of this wetland. Consequently, the Punjab State Council for Science & Technology (PSCST) suggests to carry onmanagement actions at Kanjli Wetland in collaboration with numerous implementing organizations across Punjab. The specifics of the proposed initiatives are outlined in the following sections:

A. Afforestation

The tree cover in wetlands offers vital microhabitats for a diverse array of wildlife. Additionally, aquatic ecosystems benefit from fish spawning, particularly under the shelter of trees. Nevertheless, the condition of forest cover in marsh areas is continuously deteriorating. Therefore, actions are necessary to restore environmental stability by planting a variety of indigenous trees such as Acacia, Terminalia, Syzygium, Salix, Pongamia, Morus, Azadirachta, Casuarina, Delonix, and others. To enhance the forestarea surrounding the Kanjli Wetland, the Punjab Department of Forest and Wildlife, in collaboration with local communities, should undertake tree planting initiatives in the region.

B. Wildlife Conservation

Wetlands serve as crucial reservoirs of wild genetic resources, and their ecological significance over the long term cannot be emphasized enough. However, the disappearance of wetlands leads to the loss of these ecological resources. The wildlife inhabiting Kanjli Wetland faces numerous challenges. To protect animal resources, the Punjab Animal Department is implementing conservation measures such as repairing broken fences around the wetland and installing barriers for area protection. Additionally, the department plans to construct wooden nests to support bird reproduction and wooden shelters for nature/wetland enthusiasts to minimize wildlife disturbance. Recent studies in various Western nations indicate that the

presence of certain bird species in wetlands influences the landing of other similar birds in that habitat. Given that birds play a pivotal role in ecosystems, the outcomes of such studies could help simulate bird landings artificially. Therefore, the Punjab State Council for Science and Technology should consider initially placing an adequate number of decoy birds at the Kanjli Wetland area.

C. Control and Management of Water Hyacinth

Water hyacinth, considered one of the most invasive weeds globally, has severely impacted Kanjli Wetland. Traditional manual methods have been employed thus far to manage this weed, but the lake quickly becomes reinfested. To preserve the ecological integrity of this environment, an integrated approach is proposed, combining physical subtractionby means of a conveyer beltpoweredstructure with biotic management. The objective of such initiative is to create a bearable, longstanding capability for controlling aquatic hyacinth. Short-term controller in specific areas will continue to rely on labour-intensive methods, while biological agents would be utilized for long-term management.

D. Water Quality Monitoring

The Punjab Pollution Control Board conducted an assessment of the river water and mud quality in the Kanjli Wetland region, determining that the water typically meets Class 'B' standards. However, occasional fluctuations result in water quality dropping to Class 'D'. It is crucial to maintain vigilance over the pollution levels, necessitating ongoing monitoring of the lake water. This continuous monitoring will contribute to a comprehensive understanding of the lake ecosystem's nature and dynamics in the future. The Punjab Pollution Control Board (PPCB) plans to sustain the quality of water measuring program for the next five years.

E. Conservation of Fisheries

The importance of wetlands extends to the production of fish species, which contributes significantly to their ecological status and functional values. Kanjli Lake is known to host 17 different fish species. However, without intervention to address declining water quality, these species could face extinction. Hence, there is a pressing need for a conservation program focused on preserving and restoring the diverse fish species in the lake. This initiative should alleviate existing pressures by introducing

additional fish species into the lake, while also ensuring that such introductions do not lead to unintended ecological consequences. The Department of Fisheries should spearhead these efforts at Kanjli Wetland.

F. Research Studies

The research and studies will provide comprehensive insights into the ecological system of the reservoir and its surrounding watershed, including the ecology of its plant and animal species, the influence of naturaldeterminants on the reservoir ecosystem, and the socioeconomic impacts of lake resource utilization. These research initiatives are crucial for enhancing ecological resilience, biodiversity, and ecological equilibrium within the lake system. The State Department of Science & Technology should actively encourage research endeavours focused on Punjab's aquatic ecosystems. These studies should aim to analyze the biotic elements, food web dynamics, and possiblechallenges to these ecosystems and their elements. Additionally, they should contribute to the formulation of sustainable long-term conservation strategies.

Future wetland conservation initiatives will undoubtedly depend on the data obtained from research studies. Key areas of focus for research include investigations into the biodiversity of the wetland and its limnological parameters, as well as evaluations of habitat characteristics and the economic value of resources within the Kanjli Wetland, as outlined below:

To explore the influence of this wetland on the hydrogeology of the region, thorough research must be undertaken. This issue's economic productivity must be assessed and projected. The impact on faunal populations is catastrophic due to the resilient pressure on wetland areas caused by different reasons such as agricultural encroachment, pollution, and so on. The fisheries research program should be divided into five sub-programs: conservation of fish biology and biodiversity, aqua farming, socio-economic parameters, database development and fish stock valuation. Wetland conservation measures will be fruitful only if the communityimpression is favourable to the utilization of the ecological elements by the people who live nearby. Therefore, it is imperative to perform a social impact assessment of development versus conservation initiatives, along with an environmental impact assessment of diverse human activities conducted in the wetland area. Detailed

taxonomic examinations of the plant and animal species inhabiting this wetland are necessary. This will also aid in identifying any endemic species in this region that require special conservation attention.

G. Economic Valuation of Wetland Resources

According to the productive values and functional perspectives of the State, wetlands are currently one of the least understood, or even misunderstood, ecosystems. These are rapidly regained in the name of restoration. In Punjab, both man-made and natural wetland areas are under significant threat. The destruction of the environment of wetlands is at a critical level at the moment, even though Harike Wetland is one of six Indian Ramsar sites with global significance, Kanjli and Ropar Wetlands hold national significance, and PSCST has recognized five more wetland areas of state importance. Despite the concerted efforts of state and union governments to conserve and manage wetlands to ensure their long-term viability for the benefit of society, environmental deterioration persists. Wetlands play an indispensable role in supporting livelihoods on various fronts, making it essential to comprehend the specific functions and benefits of wetlands and their individual components rather than viewing them as a singular entity. However, effective incorporation of such knowledge into the overall planning process is necessary to maximize their benefits in agriculture, forestry, recreation, and other sectors. Adopting a three-stage wetland valuation approach can provide a comprehensive understanding of the role and value of each wetland. These stages include 'The overall, environmentally friendly, and Economical Evaluation,' 'Comprehensive Factor Examination,' and 'Specialized Concern Analysis,' each adapted to the specific peculiarities of the wetland habitat. Evaluating wetland ecosystem functional values includes assessing their 'Life Support Functions' in terms of their critical status, 'Social/Cultural Functions' encompassing recreational, aesthetic, and enlighteningmorals, efficiencypurposes related to livelihood and business products, among additional responsibilities indicative of their long-term significance.

H. Public Awareness

The involvement of the public in these programs will help to secure the conservation and management of wetlands. It is possible if the general population understands the significance of such ecosystems. Awareness can be raised by the media, instructional

materials, camps and other means. Non-governmental organizations (NGOs) can have a substantial impact on disseminating scientific concepts to the wider public. When the general public is well-informed, it can be a powerful force in adopting appropriate wetland management policies.

Conclusion

In conclusion, the Kanjli Wetland faces numerous problems, including urbanization and industry, pollution, invasive species and climate change. These challenges imperil the subtleequilibrium of the ecosystem, threatening the wetland's biodiversity and ecological functions. Overfishing, habitat loss, and a lack of education and awareness in the neighbourhood all contribute to the degradation. Despite these obstacles, collaborative efforts have been made in the conservation and management of the Kanjli Wetland by government agencies, environmental organizations and local people. Water hyacinth reduction initiatives include integrated approaches, tree plantations by the Forest Department, and the adoption of protective measures. Long-term solutions, on the other hand, necessitate ongoing research, community education and integrated wetland management that satisfies the needs of both humans and animals. It is critical that all stakeholders actively participate in these efforts to ensure the ecological integrity of Kanjli Wetland, thereby safeguarding its critical role in supporting diverse plant and animal life, water purification, flood control and recreational opportunities for present and future generations.

The Kanjli Wetland is under threat from a variety of sources, including anthropogenic pressures, invasive species, pollution and climate change. These issues elicited a thorough response at multiple levels, demonstrating a multifaceted approach to wetland conservation and management. The Ramsar Convention has played a critical role at the international level by classifying Kanjli Wetland as a Ramsar Site, stressing its worldwide significance. This designation not only promotes awareness about the importance of wetlands, but it also encourages worldwide collaboration for their long-term maintenance. Furthermore, both the National Wetland Conservation Program (NWCP) at the national and state levels exhibit a methodical and structured approach to tackling wetland challenges.These measures include weed control, afforestation, fencing, pollution monitoring, and public awareness campaigns. Furthermore, the coordinated efforts of environmental organizations such as WWF India and firms such as Danone highlight the

significance of public-private partnerships in furthering specific conservation programs. Through integrated management plans, community participation and educational efforts, the joint venture aims to not only solve current challenges, such as water hyacinth infestation but also to establish the groundwork for long-term sustainability. Local community involvement is critical, and the creation of the Kali Bein Conservation Reserve demonstrates a dedication to holistic wetland protection that takes into account ecological, economic, and social factors. Under the direction of the Punjab State Wetland Authority, district-level committees demonstrate a bottom-up approach to conservation by combining local knowledge and experience. These committees help to ensure that wetland preservation measures are implemented effectively by emphasizing data-driven decision-making, monitoring contaminants and incorporating stakeholders at all levels. In essence, the collaborative efforts of international conventions, national programs, private-sector collaborations, and localized authorities represent a united front aimed at ensuring the long-term conservation of wetlands in India, having a particular emphasis on the ecological uniqueness of Kanjli Wetland in Punjab.

The introduction of new fish species into the wetland is a strategic step intended to mitigate the negative effects of invasive species, increase biodiversity and support the local fishing community. In addition, the building of a biodiversity park and the erection of a bird watch tower have highlighted the wetland's importance as an educational and ecological hub. These facilities not only allow visitors to connect with nature, but they also raise awareness about the vital need for conservation activities to protect the wetland's fragile environment. In addition to conservation and educational efforts, the Kanjli Wetland has created eco-friendly tourism infrastructure, including nature-based cabins, walking paths, and restricted boating activities. These projects aim to improve the visitor experience while reducing the environmental impact, thereby preserving the wetland's ecological integrity. The addition of wooden nests and hideouts demonstrates the wetland's commitment to protecting wildlife, particularly bird species, by providing safe and undisturbed habitats. Collectively, these efforts transform the Kanjli Wetland into an example for how conservation and sustainable tourism may coexist, benefiting both the ecosystem and local economies.

Furthermore, the conservation and long-term management of the Kanjli Wetland necessitates a comprehensive and collaborative approach that actively engages local

populations. Various community-level efforts have been launched in recognition of the wetland's critical role in preserving biodiversity and sustaining local livelihoods. Educational programs, community-based monitoring and research, eco-tourism projects, skill development programs, wetland clean-up drives, and the incorporation of traditional wisdom are examples of these. These efforts not only raise awareness but also instill a sense of ownership and duty in the local community. Collaborations with non-governmental organizations (NGOs) are critical in providing the resources, knowledge, and networks required for successful preservation. These community-led activities offer a promising road to safeguarding the biological integrity of the Kanjli Wetland for future generations while also enhancing the well-being of the local population by integrating traditional knowledge with modern conservation approaches. The complexity of wetland conservation is reflected in the diverse structure of these efforts, emphasizing the importance of specialized, inclusive tactics for long-term success.

The Kanjli Wetland, a critical national wetland, requires a diverse and collaborative strategy to protection. Recognizing the increasing degradation of this important ecosystem, the Punjab State Council for Science and Technology (PSCST) has proposed a comprehensive set of actions to restore and protect the biological balance of the Kanjli Wetland. Afforestation is a key initiative to alleviate the declining tree cover in marsh areas. In conjunction with the community, the Punjab Department of Forest and Wildlife intends to plant a variety of natural trees, including Acacia, Terminalia, Syzygium, Salix, Pongamia, Morus, Azadirachta, Casuarina, and Delonix, to improve microhabitats and assist fish spawning. Wetlands are essential stores of wild genetic variety; thus, wildlife conservation is critical. To conserve animals, the Punjab Animal Department plans to improve area protection by repairing broken fences, establishing obstacles, and building wooden nests and shelters. Innovative tactics, such as the early placement of artificial birds, aim to increase bird landings while maintaining ecological balance.

Water hyacinth, a renowned weed, is rapidly spreading and poses a serious threat to the Kanjli Wetland. The suggested integrated solution includes both physical removals using a mechanical conveyor belt system and biological treatment to establish long-term sustainable control and resolve reoccurring infestations. Water quality monitoring by the Punjab Pollution Control Board (PPCB) is becoming increasingly important in tracking variations in water quality. Continuous monitoring

ensures a full understanding of the nature and dynamics of the lake environment, allowing for informed conservation decisions. The PPCB intends to keep this monitoring program running for the next five years. Recognizing the importance of wetlands in fisheries production, the Department of Fisheries intends to conserve the lake's present 17 fish species. A comprehensive program should be designed to introduce new fish species while avoiding unexpected consequences, thereby improving the wetland's ecological status and functional values.

The State Science & Technology Department should enable research investigations that will provide in-depth insights into the ecology and biology of flora and fauna, environmental repercussions, and socioeconomic ramifications of Kanjli Wetland resource usage. These studies are critical for establishing long-term conservation policy and assuring the viability of future wetland conservation efforts.

Given the misunderstood ecological functions of wetlands, economic valuing of wetland resources becomes critical. A three-stage wetland valuation technique includes ‘The overall, environmentally friendly, and Economical Evaluation,’ 'Detailed Parameter Analysis' and 'Specialised Concern Analysis,' with the goal of understanding the different roles and benefits of each wetland and effectively incorporating this information into planning processes.The importance of public knowledge in ensuring the conservation and management of wetland ecosystems cannot be overstated. The PSCST should propose public participation through media, instructional materials, camps and volunteer organizations. Informed public participation can be a powerful advocate for suitable wetland management strategies. As a result, the proposed actions include afforestation, wildlife conservation, water hyacinth control, water quality monitoring, fisheries conservation, research studies, economic valuation and public education. When implemented collectively, these projects will provide a holistic and sustainable strategy for preserving the Kanjli Wetland, safeguarding its biological integrity and benefiting both wildlife and the community at large.

CHAPTER- 6
SUMMARY OF CONCLUSIONS AND SUGGESTIONS

6.1 Abridgment

Wetlands are critical to India's natural balance, providing numerous benefits such as carbon sequestration, flood control and water purification. However, human activities like urbanization, agriculture and industry pose a threat to these critical ecosystems. This poses a severe threat to the rural population's livelihoods, as they rely significantly on wetlands for basic needs such as food, water and transportation. Economic activities such as sand mining and timber harvesting highlight the importance of wetlands as sources of revenue for residents. Wetlands in India are extensively degraded as a result of government policies that promote industrial and agricultural expansion, frequently at the expense of environmental conservation. The Kanjli Wetland in Punjab, which is noted for its rich biodiversity, has been negatively impacted by recent construction activities. Habitat loss due to building and infrastructure development has resulted in a decrease in species diversity and overall ecosystem health. Additionally, pollution from industrial waste and agricultural runoff has harmed the wetland's natural filtration capacities, affecting water quality and the health of its residents. The increase in human activity, fuelled in part by tourism, has accelerated the destruction of Kanjli Wetland. While ecotourism and bird watching are popular, they have disrupted indigenous fauna's natural habitats, putting their survival at risk. Construction activities have also harmed the cultural legacy of adjacent villages that rely on the wetland for survival and livelihood.

Therefore, the present study intends to explore several issues related to the Kanjli Wetland, like land use change, ongoing development initiatives, the effects of degradation on neighbouring communities and government actions to address emerging issues and challenges. To achieve this goal, an extensive literature review has been done that extended global, national and regional levels on the significance, degradation, conservation and management of wetlands. The review of the literature reveals a significant lack of studies that particularly address various issues related to the Kanjli Wetland. Despite the availability of studies on the importance of wetlands, their degradation and conservation efforts on a larger scale, a comprehensive study focusing on the specific complexity of Kanjli Wetland is significantly lacking.

As a result of the insights gained from the literature review and the identification of research gaps, the following objectives have been formulated for this study: *1) To examine the changing land use of Kanjli wetland from 1990 to2022. 2) To study the impacts of development activities on the Kanjliwetland. 3) ToanalyzetheimpactofdegradationofKanjliwetlandareaonpeople'slivelihood. 4)To examine the conservation policies and to suggest recommendation for conservation and management of wetland.*

To meet the above-mentioned objectives, the following research questions were formulated: 1) How the land use pattern of Kanjli wetland area has been changed since 1991 to 2022? 2) What are the impacts of development activities on the Kanjli Wetland? 3) How does the degradation of the Kanjli Wetland area affect people's livelihoods? 4) What conservation policies exist for the management of the Kanjli Wetland, and what recommendations can be suggested to enhance conservation efforts?

The present study employs an **objective-wise methodology** to achieve its objectives. To achieve the **first objective**, satellite images for the years 1990, 1999, 2010 and 2022 were used. The results have been analyzed in conjunction with fieldwork conducted in the wetland area to investigate the factors influencing land use change. To accomplish the **second objective**, an attempt was undertaken to assess the impact of development operations on the Kanjli wetland. Both primary and secondary data sources have been used to accomplish this objective. Primary data was collected through intensive fieldwork in 411 households across eleven villages in the study area. Fieldwork was carried out to collect data for the **third objective**.

During the fieldwork, 411 households in 11 villages were surveyed to determine their perspectives on the impact of Kanjli Wetland degradation on people's livelihoods; a thorough description of the results is presented in Chapter 4 under the following sub-themes: Degradation of the Kanjli Wetland, its causes, people's reliance on wetlands for socio-economic and cultural values and the impact of degradation activities on livelihoods. To achieve the **fourth objective**, an attempt has been made to assess the numerous threats, difficulties, conservation and management methods of Kanjli wetland. In recent years, the wetland has faced several problems, including decreasing water inflow, weed infestation, excessive grazing, deforestation and encroachments along the bank. To accomplish this objective, a variety of government reports, policy documents and research papers, as well as fieldwork, were analyzed

and discussed under the categories that follow: Threats, Conservation and Management.

The present study has been divided into six chapters: **Chapter 1 - "Introduction"** covers an introduction, conceptual and theoretical framework, statement of the problem, review of literature, study area, research objectives, research questions, data sources and objective-wise methodology, the significance of study and tentative chapter scheme.

Chapter 2- "Land Use of Kanjli Wetland" includes both primary as well as secondary data. This chapter provides a comprehensive examination of land use and land cover changes in the Kanjli Wetland area over 32 years, utilizing satellite imagery from four different years. Cropland became the major land use beginning in 1991, followed by fallow land, mixed land use and built-up areas. Over the following years, there is a noticeable shift in land cover dynamics, with vegetation increasingly supplanting fallow land and becoming the second most dominating class by 2010. The analysis emphasizes cropland's long-term dominance, which reflects the region's strong agricultural heritage. Notably, there has been a large increase in built-up areas due to urbanization, infrastructure development and population growth.

Examining land use change across decades reveals shifting trends, including noteworthy conversions between cropland, fallow land and vegetation, which represent socioeconomic and environmental impacts such as agricultural push, economic development and conservation initiatives. Furthermore, the chapter investigates the root causes and effects of these land use shifts. Natural forces such as changed rainfall patterns, temperature variations and floods, as well as human-caused variables such as agricultural growth, urbanization and infrastructure development, all play important roles in shaping the landscape. These changes have significant consequences, such as biodiversity loss, deteriorating water quality, soil erosion and effects on local communities. To address these issues, the chapter promotes mitigation and management solutions, emphasizing the significance of pollution control measures, sustainable agriculture practices, urban planning rules, habitat restoration and community engagement. The chapter emphasizes the importance of supporting comprehensive approaches to land use management and conservation in the Kanjli Wetland area and beyond to preserve the long-term viability of both natural and human ecosystems.

Third chapter, "Impact of Development Activities on Kanjli Wetland," provides a detailed description of the impacts of development activities on the wetland. The chapter is organized under the following headings: General Information of the Households, Development Activities in the Wetland, Positive and Negative Impacts of Development Activities in the Wetland, and Respondents' Perceptions. The Kanjli wetland is currently undergoing a variety of developmental operations. These activities include infrastructural development, agricultural techniques, aquaculture, tourism development, flood control measures and restoration initiatives. According to the data, infrastructure development—both built-up infrastructure and road networks—is primarily responsible for the expansion of developmental activities on other land uses. It is important to note that, while beneficial outcomes are conceivable, responsible and sustainable development techniques are required to reduce negative impacts on wetland ecosystems. Environmental guidelines, careful planning and monitoring are all required to preserve the long-term health and preservation of wetlands. Thus, development in the Kanjli wetland area can result in positive consequences such as enhanced wealth, job creation, improved transportation, financial security and other advantages. By balancing development and conservation, these desirable results can be realized while protecting the ecological integrity of wetland ecosystems.

Third objective of the present study has been accomplished in the chapter four entitled **"Impact of Wetland Degradation on People's Livelihood"** covers the following topics: degradation in the Kanjli Wetland, the causes of degradation, people's reliance on wetlands for socio-economic and cultural values, and the impact of degradation activities on their livelihood. Human activities such as water extraction, agricultural development and garbage dumping have severely harmed the Kanjli Wetland, affecting local communities that rely on it for a living. This deterioration has resulted in declining fish populations, which are critical to local fishermen's revenue, as well as decreasing water availability for irrigation, damaging agricultural production and farmer incomes. Furthermore, water shortage in the surrounding areas has caused farmers to rely on contaminated groundwater, resulting in low water quality and crop yields. Pollution in the marsh has further harmed water supplies, endangering the health of local populations and animals. Furthermore,

biodiversity loss, such as decreasing bird species, has had a severe influence on tourist and local economy.

Chapter 5 entitled **"Conservation and Management of Kanjli Wetland"** has been discussed under the following headings: 5.1 Threats to Kanjli Wetland, 5.2 Conservation and Management of Kanjli Wetland, 5.2.1 Government Initiatives for the Conservation and Management of Kanjli Wetland, 5.2.2 Community-Level Initiatives for the Management and Conservation of the Kanjli Wetland and 5.3 Proposed Measures for the Conservation of Kanjli Wetland. The Kanjli Wetland faces numerous threats, including urbanization, industry, pollution, invasive species and climate change, all of which threaten its fragile ecological balance and biodiversity. To address these difficulties, several organizations, including government agencies, environmental organizations and local communities, have launched joint initiatives. These efforts include a variety of tactics such as water hyacinth reduction, tree planting, pollution monitoring and public awareness campaigns. Furthermore, international accords like the Ramsar Convention and national programs like the National Wetland Conservation Program play critical roles in wetland conservation. Public-private partnerships and community-led projects highlight the value of incorporating local populations in conservation efforts. The recommended actions for restoring and protecting the Kanjli Wetland include afforestation, wildlife protection, water quality monitoring, fisheries conservation, scientific studies, economic appraisal and public education. These combined methods attempt to conserve the wetland ecosystem, benefiting both animals and local populations while promoting long-term conservation goals.

Chapter 6, titled **"Summary of Conclusions and Suggestions"** includes a summary of the conclusions of all chapters, suggestions and recommendations and scope for further research. In conclusion, this study investigated Kanjli Wetland's land use dynamics, developmental impacts, livelihood implications, conservation techniques and overall management. Chapter 1 established the study's aims, methods, and significance. Chapter 2 examined the trajectory of land use over three decades, emphasizing cropland's dominance and the growth of urban areas. Chapter 3 studied the impact of development initiatives on the wetland ecosystem, highlighting the importance of sustainable practices. Chapter 4 described the consequences of wetland degradation on local livelihoods, emphasizing the negative effects on

agriculture, fisheries, and water quality. Chapter 5 detailed conservation activities, which included government initiatives, community involvement, and suggested wetland protection measures. The results were finally summarized in Chapter 6, which also addressed recommendations and suggested possibilities for further research. This detailed study emphasizes the importance of balancing development and conservation efforts to protect the ecological integrity and socioeconomic vitality of Kanjli Wetland and its surrounding areas.

6.2 Suggestions and Recommendations

- Collaborate with local communities to implement the planting of a diverse range of evergreen trees around the Kanjli Wetland. This initiative aims to improve habitats, support fish reproduction, and reduce soil erosion, contributing to the overall ecological health of the wetland.
- Undertake repairs of existing fences, install protective barriers, and construct wooden nests to safeguard wildlife. Additionally, innovative approaches such as the use of decoy birds should be explored to attract and maintain a balanced bird population.
- Employ a multifaceted approach to water hyacinth control, combining mechanical methods such as conveyor belt removal with biological management techniques to prevent the resurgence of this invasive species.
- Implement a comprehensive monitoring program to rigorously assess lake water quality over the next five years. Consistent monitoring will inform decision-making processes regarding ecosystem protection measures.
- Develop and implement a strategic plan focused on the protection of various fish species within the Kanjli Wetland. Fish species introduction should be conducted cautiously, based on the specific needs and conditions of the wetland, to enhance the ecosystem without causing adverse impacts.
- Support and promote extensive research on the flora, fauna, and human interactions within Kanjli Wetland. Utilize research findings to formulate long-term management and conservation policies that address both ecological and socio-economic aspects.

- Conduct a thorough economic valuation of the wetland using a systematic three-step approach. Understanding the wetland's role in environmental conservation and income generation will guide future planning and policy development.
- Enhance public awareness about the significance and value of wetlands through targeted media campaigns, educational materials, and community events. Encourage active community participation in wetland conservation activities.
- Engage the local community in educational programs, clean-up initiatives, and eco-tourism activities. Foster collaboration with local, national, and international organizations to integrate traditional knowledge with contemporary conservation practices.
- Promote investment from the Punjabi NRI and diaspora communities to support the conservation efforts for Kanjli Wetland. This approach aims to cultivate a sense of ownership and responsibility towards the wetland's preservation.

To further enhance the conservation and protection of Kanjli Wetland from human encroachment, the following additional recommendations are proposed:

- Implement strict zoning regulations and enforce legal frameworks to prevent unauthorized land use and encroachment activities within the wetland boundaries. Regular patrols and surveillance measures should be established to ensure compliance.
- Establish buffer zones around the wetland to act as protective barriers against urban development and agricultural expansion. These zones should be clearly demarcated and monitored for any illegal activities.
- Promote sustainable agricultural practices in surrounding areas to minimize nutrient runoff and pollution entering the wetland. Encourage the adoption of organic agriculture methods and the utilization of natural fertilizers.
- Develop and implement an integrated wetland management plan that incorporates community-based approaches, traditional ecological knowledge, and scientific research. This plan should outline specific strategies for habitat restoration, species conservation, and pollution control.
- Enhance wastewater treatment facilities in nearby urban and rural areas to reduce the discharge of untreated sewage and industrial effluents into the wetland.

Encourage the use of constructed wetlands for wastewater treatment as a natural filtration method.

- Foster partnerships with academic institutions, non-governmental organizations, and government agencies to conduct regular biodiversity assessments and ecological studies. These assessments will provide valuable data for adaptive management and conservation planning.
- Introduce and enforce educational programs in local schools and communities to raise awareness about the ecological importance of wetlands and the need for their conservation. Incorporate wetland conservation topics into school curricula and organize field trips to the wetland.
- Establish a dedicated conservation fund to support ongoing wetland management and restoration projects. This fund could be sourced from government grants, private donations, and contributions from environmental organizations.
- Develop eco-friendly tourism initiatives that promote sustainable visitation practices and generate revenue for conservation efforts. Ensure that tourism activities are carefully managed to avoid negative impacts on the wetland ecosystem.
- Implement habitat restoration projects to rehabilitate degraded areas of the wetland. Activities could include reforestation, removal of invasive species, and re-establishment of native vegetation.
- Strengthen community engagement by forming local wetland conservation groups that actively participate in monitoring, maintenance, and protection activities. Provide training and resources to empower these groups in their conservation efforts.
- Utilize geospatial technologies, such as Geographic Information Systems (GIS) and remote sensing, to map and monitor changes in land use, vegetation cover, and water quality. This information can be used to identify and address emerging threats to the wetland.
- Advocate for policy reforms at the regional and national levels to prioritize wetland conservation and integrate it into broader environmental and land-use policies. Lobby for increased funding and support for wetland protection initiatives.
- Develop and implement a comprehensive disaster management plan to mitigate the impacts of natural disasters, such as floods and droughts, on the wetland. This plan should include early warning systems and community preparedness programs.

By adopting these comprehensive recommendations, the conservation and management of Kanjli Wetland can be significantly improved, ensuring its protection from human encroachment and its sustainable use for future generations.

6.3 Future Scope of Research

- Future studies could explore wetlands in different regions, considering their unique characteristics and challenges. Comparative analyses could help develop a broader understanding of the impact of development activities on wetlands.
- Conducting more frequent and detailed analyses on smaller time scales could capture finer variations and events within each decade. This would offer a more sophisticated comprehension of the dynamics pertaining to changes in land cover and usage in Kanjli Wetland.
- Collaboration with experts from diverse fields such as ecology, sociology and hydrology could enrich the study by incorporating a more holistic perspective. Interdisciplinary approaches can uncover complex relationships and interactions shaping wetland dynamics.
- Extending the temporal scope of the research beyond a decade could help capture long-term trends and changes. Furthermore, a prospective strategy that takes into account potential future trends and threats—including the effects of climate change—would increase the study's applicability for conservation and management plans.
- Expanding the study to include a more comprehensive assessment of various dimensions of impact, including the psychological and social aspects of local communities, would provide a more holistic understanding of the consequences of wetland degradation.
- Involving perspectives from various stakeholders, including governmental bodies, non-governmental organizations and industries, could offer a more comprehensive view of wetland conservation challenges. A thorough understanding of the challenges to conservation and the execution of initiatives might help establish effective policies and action plans.
- Investigating the difficulties in implementing government initiatives into action would provide insights into gaps between policy creation and practical

application. Identifying these challenges is crucial for developing strategies to overcome barriers to successful wetland conservation.

- In-depth exploration of the potential impacts of climate change on Kanjli Wetland would enhance the understanding of adaptive conservation strategies. This could include assessing changes in hydrological patterns, biodiversity and ecosystem services.
- In addition to the above, future research could also explore temperature shifts, precipitation patterns, and their impact on the ecosystem. Insights into geographical interactions can guide adaptive conservation strategies amidst environmental changes.
- Investigate the hydro-geographical dynamics of Kanjli Wetland, assessing water flow changes, sedimentation patterns and hydrological interactions. Understanding the spatial and temporal variations is essential for effective wetland management and conservation planning could help in future research.
- Delving deeper into the effectiveness and challenges associated with community involvement in wetland conservation initiatives would provide valuable insights. Understanding the dynamics of community participation and the factors influencing success or failure can guide the development of community-based conservation strategies.
- Explore innovative technologies and methods, like remote sensing and GIS, for continuous surveillance and mapping of wetland changes. These tools will enhance data accuracy and support informed decision-making.
- Assess the role of wetlands in improving water quality by acting as natural filters that remove pollutants from water. Research on the effectiveness of wetlands in maintaining water quality can support arguments for their conservation.
- Study the economic benefits of wetlands for local communities, including opportunities for eco-tourism, sustainable fishing, and agriculture. Quantifying these benefits can help in promoting the sustainable use of wetland resources.
- Evaluate the role of wetlands in carbon sequestration and their contribution to mitigating climate change. Research in this area can highlight the importance of wetlands in global carbon cycles and support conservation efforts.
- Investigate the potential of wetlands in flood control and their ability to alleviate the effects of thrillingmeteorological incidents. Understanding the

protective functions of wetlands can inform infrastructure planning and disaster management strategies.

- Examine the biodiversity supported by wetlands, focusing on the conservation of rare and endangered species. Research on the habitat value of wetlands can provide insights into maintaining biodiversity and ecological balance.
- Explore the cultural and recreational benefits of wetlands for local communities. Understanding the social and cultural importance of wetlands can foster community engagement and support for conservation initiatives.

Addressing these research areas will significantly contribute to the field of wetland conservation and management, providing a comprehensive and contextually relevant understanding of the dynamics involved in the Kanjli Wetland and similar ecosystems.

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Annexure 1.1

WETLANDS IN GEOGRAPHICAL CONTEXT: A CASE STUDY OF KANJLI WETLAND, PUNJAB

QUESTIONNAIRE

General Section

Q1. Village of the Interviewee: ____

Q2. Gender: ____

Q3. Age of the Interviewee: ____

Q4. Education:

No Education	Under Matric	Matric	Senior Secondary/Certificate	Graduation	PG	Other

Q5. Are you living with your family? **Yes/No**

Q6. Relationship to Head of Household

Head of household	Wife of the head of the household	Son/Daughter	Grandson/daughter	Other

Q7. No. of household members? ____

Q8. How long have you been here? ____

Q9. What is your or your family's primary source of income? ____

Q10. Do you own agricultural land? **Yes/No**

Q11. Do you rear cattle?**Yes/No**

Q12. What is the type of house you live in?

Kuccha	Pucca	Semi

THE IMPACT OF DEVELOPMENT ACTIVITIES

Q13. Is there any development activity in the area?**Yes/No**

Q14. What kind of development activity encroached on other land uses?

Agricultural	Infrastructural (Built-up)	Infrastructural (Road Network)	Other

Q15. Do you see any positive aspects of the development?**Yes/No**

Q16. What are the positive outcomes of the development?

Prosperity	Job	Ease of Transportation	Financial Security	Other

Q17. Do you see any negative aspects of the development? **Yes/No**

Q18. What are the impacts of the development?

Small land holdings	Dependence on Migrant Labourers	Unwillingness for practising agriculture	Oth er

Q19. Have you seen any change in the area during the last 15-20 years? If yes, which are those changes?

Q20. According to you, these developmental activities are environment-friendly or not? **Yes/No**

Q21. How do you see these developmental activities?

THE IMPACT OF DEGRADATION OF THE KANJLI WETLAND AREA ON PEOPLE'S LIVELIHOOD

Q22. How much dependency do you have on the wetland?

Not at all	Somewhat Less	Balanced	Somewhat More	Completely

Q23. How much the existence of the wetland benefits you?

Not at all	Somewhat Less	Balanced	Somewhat More	Completely

Q24. What recreational utilization of the wetland have you observed?

Hiking	Fishing	Bird watching	Boating	Nature photography	Other

Q25. What educational opportunities does this wetland possess?

Learning Experience to the Individuals	Learning Experience to the community	Researc her	Flora and Fauna Studies	Studies on Water Pollution

Q26. Have you spotted any cultural significance of the wetland?

Religious Ceremony	Social Customs	Spiritual significance	Others

Q27. What economic role of the wetland have you observed?

Tourism	Fisheries	Agriculture	Other

Q28. Does your area have a proper sewage disposal arrangement? **Yes/No**

Q29. Have you observed any waste drain flowing into the wetland?**Yes/No**

Q30. Since how long have you been observing any degradation in Kanjli wetland? ☐

Q31. What are the significant causes of degradation in the wetland?

Human activities, such as agriculture or urbanization	Natural causes, such as erosion or climate change	Othe rs

Q32. What are the key characteristics of the wetland ecosystem that are affected by degradation?

Water quality	Biodiversity	Soil composition	Vegetation

Q33. What is the current status of the wetland in terms of its health and functioning?

Changes in water quality	Loss of habitat for certain species	Any other

Q34. Are there any signs of degradation? **Yes/No**

Q35. What are the potential consequences of wetland degradation?

Impact at Community	Impact at Flora and Fauna	Impact at Larger Ecosystem and Environmnet	Oth er

Q36. What kind of natural problems arises due to the degradation of wetland?

Soil Erosion	Floods	Socio-economic impact	Other

THE CONSERVATION AND MANAGEMENT OF WETLAND

Q37. Whether your wetland is protected from any contamination?

Always	Sometimes	Don't Know	No

Q38. Do natural resources in the wetland area adequately maintained and cleaned?

Always	Sometimes	Don't Know	No

Q39. Is there any activity conducted related to natural resources in your village? **Yes/No**

Q40. If yes, then which activities are being conducted?

Water Harvesting	Land Development	Soil conservation	Flood protection	Plantatio n

Q41. Which departments or organizations are involved in these activities?

Q42. Is there a government-sponsored awareness campaign about the usage and maintenance of wetlands?

Q43. Are you aware of the problems which wetland areas suffer?

Q44. Are you aware that the state government-initiated management policies and programmes for this wetland?

Q45. Have the state government demarcated the wetland area for its management?

Q46. Do you understand the issues afflicting wetlands? if yes, please explain.

Q47. Are wetland conservation and management concerns discussed in your community by any social organizations, gram panchayat sabahas, or other clubs? **Yes/No**

Q48. Is there any dedicated board or committee in your area for the preservation and management of wetlands? If yes, please explain.

Q49. Are you volunteering in any way to protect and preserve wetlands? If yes, please explain.

Q50. Does the wetland area have security checks or police patrols to stop people from abusing it and lowering its quality?

Yes	No	if yes, how frequently

Q51. Do you believe that the management and conservation strategies in the area are sufficient to maintain the wetland's current state? **Yes/No**

Q52. What type of recommendations would you make for the management and conservation of the wetland?

Annexure: 3.1

Kanjli Wetland: Encroachment by Development Activities (Count)

Village	Development Activities Encroached				Total
	Agriculture	Infrastructural (Built-up)	Infrastructural (Road Network)	Other	
Badshahpur	0	10	3	1	14
Beja	0	3	0	0	3
Boot	0	35	15	12	62
Chuharwal	0	10	6	2	18
Dham	0	11	0	0	11
Hamira	0	109	32	24	165
Kanjli	0	15	6	3	24
Lakhan Kalan	0	25	27	15	67
Lakhan Khurd	0	20	0	2	22
Paharipur	0	6	4	3	13
Subhanpur	0	1	11	0	12
Total	0	245	104	62	411

Source: Fieldwork, 2022.

Annexure: 3.2

Kanjli Wetland: Positive Impacts of Development Activities (Count)

Gender	Positive Outcomes of Development					Total
	Prosperity	Job	Ease of Transportation	Financial Security	Other	
Male	54	62	77	55	2	250
Female	28	38	64	29	2	161
Total	82	100	141	84	4	411

Source: Fieldwork, 2022.