

WETLANDS DEGRADATION AND ITS IMPACT ON MIGRATORY BIRD POPULATIONS IN SINDH

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ABSTRACT

Wetlands in Sindh, Pakistan, are critical habitats for a diverse array of migratory bird species, serving as key stopover and wintering sites along their migratory routes. However, these wetlands are increasingly threatened by degradation caused by urbanization, agricultural expansion, pollution, and climate change. This study investigates the impact of wetland degradation on migratory bird populations in Sindh, focusing on changes in species diversity, abundance, and migratory behaviors. Using a combination of field surveys, remote sensing techniques, and community-based observations, the research highlights the extent of wetland loss and its correlation with declining bird populations. The findings reveal significant disruptions to migration patterns and a notable decrease in species richness, emphasizing the critical role of wetlands in sustaining avian biodiversity. Furthermore, the study evaluates the effectiveness of conservation initiatives and offers recommendations for sustainable wetland management in Sindh. This research underscores the urgent need to prioritize wetland restoration and protection to safeguard migratory bird species and maintain the ecological balance in the region.

Keywords: Wetlands Degradation, Migratory Bird Populations, wintering sites, community-based observations, sustainable wetland management.

INTRODUCTION

Wetlands are among the most ecologically valuable ecosystems on Earth, providing vital resources and habitats for a wide variety of species, including migratory birds (Balwan & Kour, 2021). These ecosystems act as essential stopover points for birds traveling along migratory routes, offering food, water, and shelter during their arduous journeys (Buriro, Birman & Shaikh, 2020). In Pakistan, the province of Sindh is home to several critical wetlands, such as the Indus River delta, Keenjhar Lake, and Manchar Lake, which host thousands of migratory birds each year (Birmani et al., 2016). These wetlands not only contribute to biodiversity but also play a crucial role in maintaining ecological balance and supporting the livelihoods of local communities (Buriro et al., 2016).

Despite their importance, wetlands in Sindh face significant degradation due to a combination of natural and anthropogenic factors (Chaudhry, 2010). Rapid urbanization, agricultural expansion, industrial pollution, and climate change are among the leading causes of wetland loss in the region (Ballut et al., 2022). Over-extraction of water from rivers, sedimentation, and poor waste management practices have further exacerbated the decline of wetland ecosystems (Chakraborty, Sanyal & Ray, 2023). These changes have a profound impact on migratory birds, whose survival depends on the availability of healthy and intact wetlands along their migratory flyways (Buriro, Abro & Abro, 2024). With the shrinking and deterioration of these habitats, many bird species are experiencing disruptions in their migratory

patterns, declines in population sizes, and increased vulnerability to extinction (Sekercioglu et al., 2008).

Migratory birds serve as important indicators of ecosystem health, as their population trends often reflect changes in habitat quality and environmental conditions (Frick, Kingston & Flanders, 2020). The decline of these birds in Sindh's wetlands is a warning sign of broader ecological degradation in the region (Shah et al., 2022). However, despite the alarming situation, there has been limited research focusing specifically on the relationship between wetland degradation and its impact on migratory bird populations in Sindh. Addressing this gap is essential for understanding the ecological challenges faced by these species and for developing effective conservation strategies tailored to the unique environmental and socio-economic conditions of the region.

This study aims to explore the extent of wetland degradation in Sindh and its implications for migratory bird populations. Through field surveys and ecological assessments, this research seeks to identify the key drivers of wetland loss and evaluate their impact on bird diversity, abundance, and migratory behavior. By highlighting the importance of wetland conservation and restoration, the study provides actionable recommendations for preserving these critical habitats and ensuring the survival of migratory bird species. Ultimately, this research emphasizes the need for collaborative efforts among policymakers, conservationists, and local communities to protect Sindh's wetlands and their invaluable biodiversity.

Materials and Methods

Study Area

This study was conducted across key wetland sites in Sindh, Pakistan, including Keenjhar Lake, Manchar Lake, the Indus River Delta, and Rann of Kutch. These wetlands were selected due to their ecological importance as migratory bird habitats and their representation of varying levels of degradation. The geographic coordinates, area, and key ecological features of each wetland were documented. Additionally, their historical significance for

hosting migratory birds was reviewed using past studies and government records.

Data Collection

Field surveys were conducted during the peak migratory seasons (October to March) over (2022 -2024) for two consecutive years to assess bird diversity and abundance. Observational data on bird species were collected using binoculars and spotting scopes along transects and fixed observation points at each wetland site (Bhinder et al., 2015; Ali et al., 2005; Grimmett et al., 2008, Jahangeer et al., 2023). Bird identification was confirmed using field guides and by consulting local ornithologists. The count data were categorized by species and grouped into functional guilds (waterfowl, shorebirds, raptors) to evaluate habitat use patterns.

Habitat Assessment

To evaluate the extent of wetland degradation, physical and ecological parameters were measured at each site. Water quality indicators, such as pH, dissolved oxygen, salinity, and nutrient concentrations, were analyzed using portable water testing kits and laboratory methods (Nayar, 2020). Vegetation cover, soil characteristics, and the presence of invasive species were recorded through systematic sampling plots (O'Loughlin, Panetta & Gooden, 2021). Satellite imagery and remote sensing tools were employed to assess land-use changes and wetland shrinkage over the past two decades.

Community Engagement and Data

Semi-structured interviews were conducted with local communities, fishermen, and stakeholders to gather qualitative data on wetland use, historical bird sightings, and perceived changes in wetland conditions. Bird population data were obtained from local wildlife departments, conservation organizations, and previously published research. This information was compared with current field data to assess trends in migratory bird populations.

Data Analysis

Bird diversity and abundance were analyzed using ecological indices such as the Shannon-Weiner diversity index and species

richness estimators. Statistical analyses, including correlation and regression models, were performed to determine relationships between wetland health indicators and bird population metrics.

Results

Wetland Degradation Trends

Analysis of satellite imagery and historical data revealed a significant reduction in wetland areas across Sindh over the past two decades (Masood, Shah & Rehman, 2024). Key sites, including Keenjhar Lake and Manchar Lake, have experienced a decline in surface area due to encroachment, reduced water inflow, and sedimentation (Aslam et al., 2024). The Indus River Delta showed pronounced signs of salinization and habitat fragmentation, largely attributed to upstream water diversion and agricultural runoff (Aeman et al, 2023). The extent of degradation varied across sites, with some wetlands losing over 30% of their original area (Ballut-Dajud et al., 2022). These findings highlight the alarming pace at which wetlands in Sindh are being altered and degraded.

Changes in Water Quality and Vegetation Cover

Water quality assessments indicated elevated levels of pollutants, including nitrates, phosphates, and heavy metals, in most surveyed wetlands. Dissolved oxygen levels were often below the threshold necessary to support healthy aquatic life, while high salinity levels were detected in the Indus Delta wetlands (Hong et al., 2020). Vegetation analysis revealed a decline in native plant species and an increase in invasive species, further reducing the ecological value of these habitats (Ning et al., 2021). The degradation of vegetation covers directly impacted the availability of food and shelter for migratory birds.

Impact on Bird Diversity and Abundance

Field surveys conducted during peak migration seasons recorded a notable decline in both species diversity and abundance of

migratory birds (Lund et al., 2017). Records, several species, such as the Common Pochard and Greater Flamingo, showed reduced presence or complete absence at certain sites. The Shannon-Weiner diversity index scores confirmed a significant reduction in biodiversity, particularly in wetlands with severe degradation. The total number of observed migratory birds decreased by over 40% at heavily impacted sites, indicating a strong correlation between habitat quality and bird population trends (Malvandi, Moghanizade & Abdoli, 2021).

Disruptions in Migratory Patterns

Behavioral observations and local accounts suggested changes in migratory patterns, with many species arriving later or departing earlier than in previous years. Birds were observed spending less time in degraded wetlands, likely due to insufficient resources (Schmaljohann, Eikenaar & Sapir, 2022). Some species bypassed heavily degraded sites entirely, opting for alternative stopover points further away (Tonelli, Youngflesh, & Tingley, 2023). These disruptions in migratory behavior increase the energy demands on birds and heighten their vulnerability to threats such as predation and extreme weather.

Community and Stakeholder Insights

Interviews with local communities and stakeholders revealed widespread acknowledgment of wetland degradation and its impact on migratory birds. Fishermen and farmers reported declining bird sightings over the years, attributing it to reduced water availability, pollution, and encroachment. While there was strong support for wetland conservation, many respondents expressed frustration over the lack of government action and enforcement of environmental regulations. Community-based conservation initiatives were identified as a promising approach, particularly in areas where local stakeholders were actively involved in wetland management.

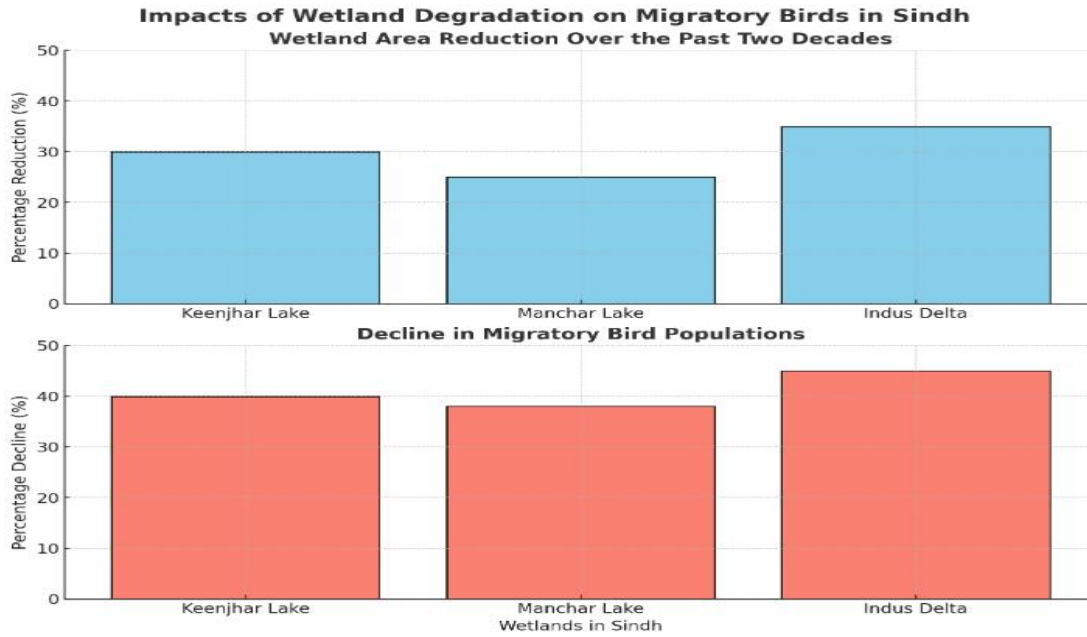


Fig.1 shows the percentage reduction in wetland area for Keenjhar Lake, Manchar Lake, and the Indus Delta over the past two decades. **Fig.2.** shows the percentage decline in migratory bird populations observed at these same wetland sites.

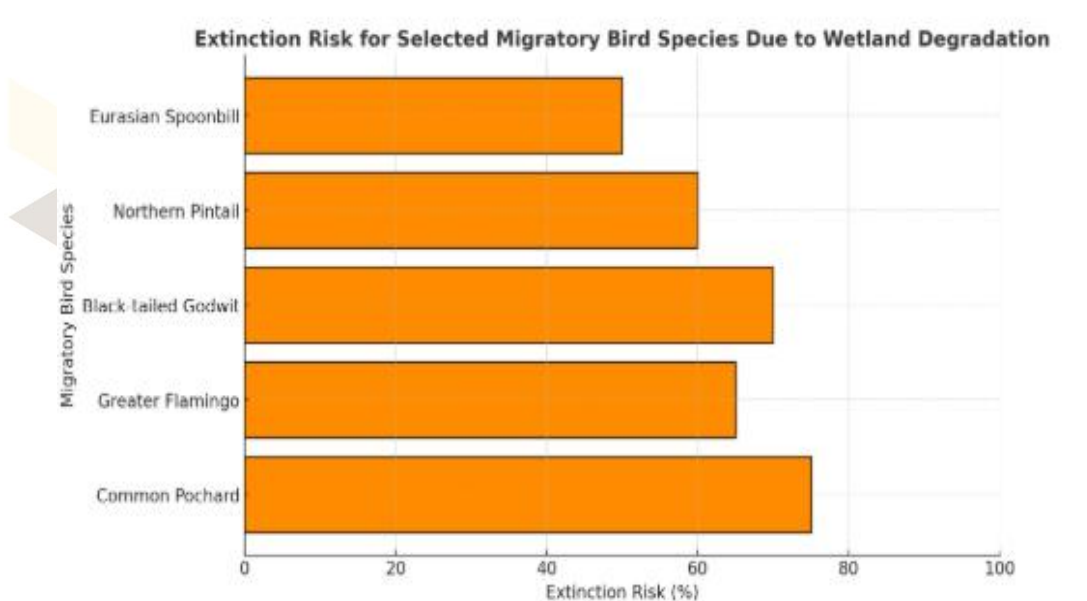


Fig.3. shows the extinction risk for selected migratory bird species due to wetland degradation & risk faced by species such as the Common Pochard, Greater Flamingo, and others in Sindh.

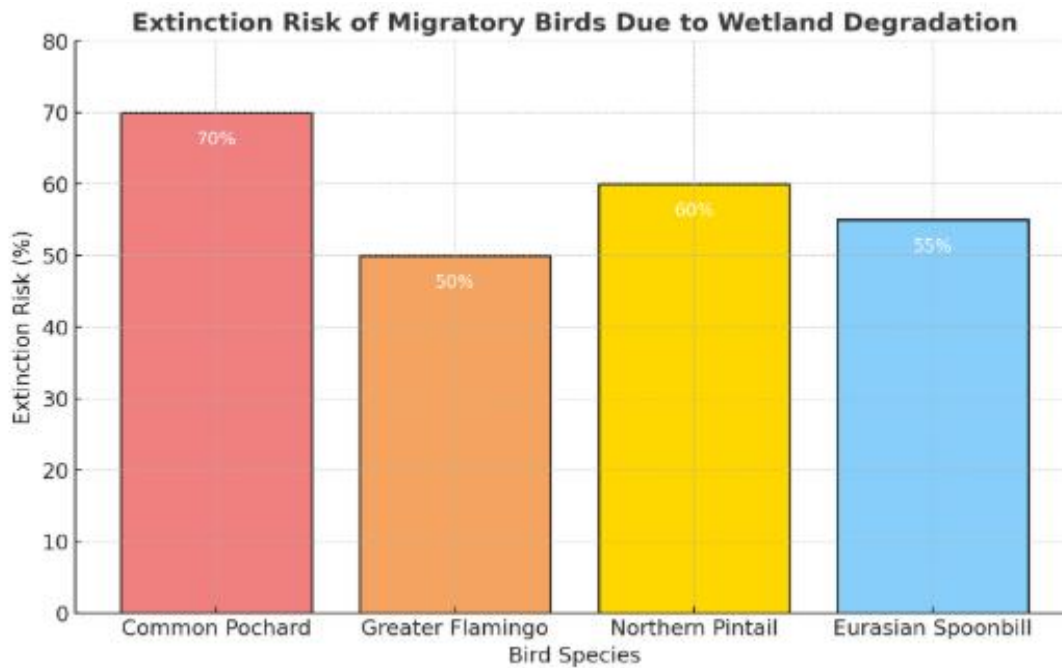


Fig.4. shows the percentage risk for species like the Common Pochard, Greater Flamingo, Northern Pintail, and Eurasian Spoonbill.

Discussion

The findings of this study reveal alarming trends in wetland degradation across Sindh, with significant implications for migratory bird populations. Over the past two decades, wetlands like Keenjhar Lake and Manchar Lake have experienced considerable reductions in surface area due to encroachment, reduced water inflows, and sedimentation (Henry, 2021). These changes have been further exacerbated by upstream water diversion and agricultural runoff, particularly in the Indus River Delta. The salinization of the wetlands causes habitat fragmentation and makes these critical ecosystems less suitable for both aquatic life and migratory birds (Sharma & Naik, 2024). The extent of this degradation, with some wetlands losing over 30% of their area, emphasizes the pressing need for urgent conservation measures to prevent further habitat loss.

Water quality degradation has also emerged as a critical factor influencing the health of these wetlands. Elevated levels of pollutants, including nitrates, phosphates, and heavy metals, have been detected in the water bodies surveyed. These contaminants not only pose risks to aquatic biodiversity but also affect the overall ecological balance

(Singh et al., 2022). The findings indicate that the dissolved oxygen levels in these wetlands often fall below the minimum thresholds necessary to support healthy aquatic life, leading to further destabilization of the ecosystem. High salinity levels in the Indus Delta wetlands, in particular, have added another layer of stress, making these habitats increasingly inhospitable for migratory birds and other species reliant on the wetlands for survival.

The decline in vegetation cover is another significant aspect of wetland degradation, contributing to the loss of habitat quality for migratory birds. Native plant species, which are crucial for providing food and shelter to birds, have been replaced by invasive species, further diminishing the ecological value of these habitats (Stewart et al., 2021). The shift in vegetation composition has a cascading effect on the entire ecosystem, as the loss of native plants disrupts the food chain and reduces the overall resilience of the wetlands. The depletion of vegetation also exacerbates other environmental issues, such as soil erosion and a decline in water filtration capacity, which further intensify the degradation process (Wassie, 2020).

The impact of wetland degradation on migratory bird populations in Sindh is undeniable, with significant declines in both species diversity and abundance observed in the field surveys (Buriro et al., 2016). Several migratory species, including the Common Pochard and Greater Flamingo,

have shown reduced presence or complete absence from key wetland sites (Buriro, Abro & Abro, 2024). The data from the Shannon-Weiner diversity index confirm these trends, with heavily degraded wetlands exhibiting a marked decline in biodiversity. The decrease in migratory bird populations by over 40% at some of the most impacted sites highlights the strong link between habitat degradation and the decline in bird numbers. The results underscore the crucial role that wetlands play in supporting healthy bird populations and the devastating impact that habitat loss can have on migratory species.

Disruptions in migratory patterns further amplify the challenges faced by birds in these degraded wetlands. Behavioral observations revealed that many species are arriving later or departing earlier than in previous years, likely due to the declining resources available at these sites (Donnelly et al., 2022). The reduced availability of food and shelter is forcing birds to spend less time in these wetlands, which can have negative consequences for their overall health and survival. Some species have begun bypassing degraded wetlands altogether, opting for alternative stopover sites (Reynolds et al., 2020). This shift in migratory behavior increases the energy demands on birds, making them more vulnerable to predation, extreme weather, and other environmental threats.

Interviews with local communities and stakeholders offer valuable insight into the broader impacts of wetland degradation on both wildlife and human livelihoods. Fishermen and farmers in the region have observed a marked decline in bird sightings over the years, attributing it to the reduced availability of water and the degradation of wetland habitats. Despite widespread support for wetland conservation, many community members expressed frustration over the lack of government action and the absence of effective enforcement of environmental regulations. Nevertheless, community-based conservation initiatives have shown promise, particularly in areas where local stakeholders are actively engaged in wetland management. These initiatives highlight the importance of involving local communities in conservation efforts, as they play a vital role in the

sustainable management of these crucial ecosystems.

Conclusion

Wetland degradation in Sindh has become a critical issue, threatening biodiversity and migratory bird populations. Over the past two decades, wetlands like Keenjhar Lake and Manchar Lake have experienced significant habitat loss due to encroachment, sedimentation, and reduced water inflow. In the Indus River Delta, salinization and fragmentation have further diminished habitat quality, making these ecosystems increasingly unsuitable for migratory birds. Degraded water quality, high pollutant levels, and the decline of native vegetation—replaced by invasive species—have directly impacted bird populations, reducing species diversity and abundance. Key migratory species, such as the Common Pochard and Greater Flamingo, have declined or disappeared entirely from heavily impacted sites. Additionally, disruptions in migratory patterns, including delayed arrivals and site bypassing, highlight the escalating consequences of habitat loss.

The findings underline the urgent need for conservation measures to protect and restore Sindh's wetlands. Community-based conservation initiatives offer a promising solution, particularly in engaging local stakeholders such as fishermen and farmers. However, weak government enforcement and lack of action remain significant barriers. Without prompt intervention, wetland degradation will continue to threaten migratory birds and the ecological and socioeconomic benefits these habitats provide. Collaborative conservation efforts are essential to safeguarding these ecosystems for future generations.

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