

## REVIVING THE INDUS DELTA: ASSESSING ECOLOGICAL DECLINE AND PATHWAYS TO SUSTAINABLE REHABILITATION

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**Abstract**

The Indus Delta, spanning 2880 kilometers, becomes a large region essential to the lives of millions in Pakistan. Yet, it encountered several challenges including the migration of people to urban areas and severe environmental degradation across all sides. Tracing back to the Harappa culture, the region's historical significance is juxtaposed with the mystery of city abandonment around 1800 BCE, potentially linked to factors impacting the Indus floodplains. Diving deeper into history, the settlements between 2600 and 1600 B.C. suggest a complete transformation from an urban system to a de-nucleated pattern of living. These theoretical underpinnings thus brush aside the complexities that followed in the development of infrastructure such as dam construction, water mismanagement and forced migrations. With the Indus Delta having a significant economic impact, both the Turkish and Chinese governments are also economically interested in a resolution to enhance development through the formation of economic zones that can facilitate rehabilitation based on employment opportunities despite the adversities in this area. Therefore, in responding to identified constraints, this research will focus not only on restoration of the Indus Delta ecosystem but particularly the rehabilitation of families and the mangroves that encompass it. The multifarious problems as seen through the in-depth literature analysis shows that the region call for interdisciplinary and sustainable solutions. This research seeks to find answers regarding migration and economic resources within the Indus Delta by exploring ways of restoring the Delta. They reflect both economic growth and ecotourism as a strategy for recovery; they also embody community empowerment through environmentally friendly practices. This proposed approach is a combination of primary and secondary research, with results validated through various qualitative and quantitative methods of analysis. Thus, this research hopes finally to generate a roadmap for sustainable development that will improve people's livelihood and protect the environment in Indus Delta, perhaps changing dialogue on delta management across the world.

**INTRODUCTION**

The Indus River, spanning 2880 kilometers, sustains millions in Pakistan, with its delta in southern Sindh and the Kutch Region of India.

The fifth largest globally, the delta is vital for agriculture, utilizing 90% of the river's water resources (Janjua et al., 2021). Historical

significance traces back to the Harappa culture, flourishing 4000 years ago but mysteriously abandoning cities around 1800 BCE, possibly due to various factors impacting the Indus floodplains. (Woods Hole Oceanographic Institution, 2018) Investigating settlements between 2600–1600 B.C., a study reveals a shift from urban to de-nucleated patterns, emphasizing the need for integrated analyses. (Green & Petrie, 2018) This analysis explores the causes of Indus Delta deterioration, considering historical climate-induced migrations and settlement changes. Understanding these dynamics is critical for comprehending the present impacts on ecosystems, habitats, and human communities, laying the foundation for effective conservation and sustainable development strategies.

#### Theoretical Background:

Dam construction and water mismanagement where freshwater flows are being wasted and the flow is uncontrollable leading to soil erosion and more. (Ebrahim, 2020) This has reduced river flows, caused delta shrinkage, and threatened both human life and ecology. Moreover, forced migrations, disease outbreaks, and land erosion are also further issues that require urgent attention. In addition, the degradation of mangrove forests, sea intrusion, over-fishing, and insufficient socio-economic structure also add on to the issues faced by the Indus Delta region. However, the Turkish and Chinese governments have shown great interest in forming economic relationships with Pakistan if it is willing to work upon improving this region. (Karrar, 2021) Therefore, although conservation efforts and water accords offer glimpses of hope, challenges persist, that require a comprehensive research approach which can be worked upon if we are willing to form meaningful partnerships. This research emerges in response to the aftermath of identified constraints, focusing on an alternative ecosystem to restore and sustain the Indus Delta. The mangroves, despite their ecological and economic significance, suffer due to a lack of understanding of their value. Diminished freshwater flow exacerbates sea intrusion, impacting agriculture and

livelihoods, while destructive fishing practices and illegal wildlife trade further contribute to the delta's woes. Additionally, a dearth of basic education, health services, and market access compounds the vulnerabilities of the local population. Hence, there is a huge gap in understanding the reasons for these issues in-depth, something this research aims to tackle to help work towards better livelihood and community building for economic growth.

#### Literature Review:

The academic literature on the Indus Delta provides a comprehensive understanding of the multifaceted challenges faced by the region, particularly focusing on migration, rehabilitation, current problems, and sustainable solutions. Several key studies shed light on the various aspects of the Indus Delta ecosystem, its degradation, and the socio-economic implications on the local population. One study addresses the alarming degradation of the mangrove ecosystem in the northwestern part of the Indus Delta, emphasizing the impact of pollution and human activities. It compares polluted sites in Rehdri creek with unpolluted sites in Shah Bunder, highlighting differences in soil characteristics, nutrient levels, and vegetation growth. (Ahmed, 2015) The study underscores the urgent need for conservation efforts and sustainable management practices. Another perspective delves into the complex issues faced by the Indus Delta, including loss of fertile land, environmental degradation, and reduction of freshwater flows. This study connects these challenges with climate change, emphasizing the interconnectedness of socio-ecological factors. (Salik et al., 2015) The marginalized fishing communities' political discourse is explored, revealing how their voices are often overshadowed by other conservation and water management narratives.

The impact of reduced freshwater flows on the Indus Delta is emphasized in multiple studies, noting economic losses, land erosion, and coastal degradation. (Kanwal et al., 2019) The construction of dams and barrages upstream contributes to the loss of arable land and alters traditional livelihoods. The vulnerability of the delta to climate change, sea-level rise, and

extreme weather events is highlighted, posing threats to agriculture, fisheries, and overall socio-economic stability. (Awais et al., 2022)

Additionally, research underscores the need for comprehensive policies and laws to address economic deprivation in the delta. The consequences of decreased freshwater flow on mangroves, agriculture, and fisheries are explored, advocating for fair water policies to mitigate the effects of climate change and large-scale projects. (Jamali et al., 2023)

The socio-economic vulnerability of mangrove-dependent communities is a critical focus, evaluating the linkages between vulnerability indicators and community perceptions. The study conducted in Keti Bandar utilizes the Composite Vulnerability Index to assess exposure, sensitivity, and adaptive capacity. (Salik et al., 2015)

The research outcomes underscore the heightened vulnerability of coastal communities to the impacts of climate change, underscoring the critical significance of implementing effective adaptation strategies and bolstering overall resilience measures in response to these evolving environmental challenges. (Inayat, 2023)

In summary, the academic literature provides a nuanced understanding of the Indus Delta's challenges, incorporating ecological, economic, and social dimensions. The studies emphasize the need for interdisciplinary approaches, sustainable management practices, and inclusive policies to address the complex issues faced by the region. The insights gained from these studies contribute to a holistic understanding of the Indus Delta, guiding future research and conservation efforts.

#### **Purpose of Research:**

The Indus Delta region has always contributed significantly to our economic growth. Seeing the migration and wasting of resources raises several questions on how this can be tackled for potential growth in the future. Through deep analysis of case studies and past research, the reasons of migration of households became evident. One of the major reasons has been the lack of adequate resources and the land turned barren. (Pirzada, 2022) This makes it important

to conduct this research with a purpose to find viable solutions to rehabilitate the Indus Delta and utilize its potential towards the economic growth of the country.

In addition, the purpose of this research is to evaluate and recognize the need for rehabilitation and the potential of tourism at the Indus Delta region that can add to greater employment opportunities. Hence, investigating strategic ecotourism strategies that involve local communities in building a sustainable future through their own empowerment is something that needs to be researched upon evidently. Ultimately, it aims to suggest comprehensive outcomes addressing the economic, social, and ecological aspects of the Indus Delta region, counteracting ecosystem deterioration, outmigration, and habitat disturbances.

#### **Objectives:**

To study and Address the different causes of environmental degradation of ecosystem of Indus delta that compelled the community for mass migration.

To Analyze and evaluate the underlying factors such as family spilt, management of of Habitats and Scarcity of utility and resources.

To analyze the intricate dynamics that play an effects role in increasing salinity of water, land fertility, and agricultural opportunities.

To Explore the economic implications of the region's struggles on Pakistan's ongoing economic crisis.

To Analyze and assess the socio-economic consequences of diminishing fishery resources and mangrove forests on the lives of Indus Delta.

To Recommend possible guidelines for effective development, preservation of land fertility conservation of mangrove, and preventing intrusion of hard water.

To Identify institutional roles in managing and conserving the Indus Delta, rehabilitation and development of sustainable infrastructure.

#### **Research Questions:**

What are the primary factors driving migration in the Indus Delta Region, considering both environmental and socio-economic

aspects? How do Indus Delta habitat disturbances resulting from migration impact the ecological balance, specifically focusing on the consequences of increased salinity, loss of fishery resources, and mangrove forests in the region? In what ways does the scarcity of essential resources, such as fresh water, influence the viability of lifestyles and present challenges in the Indus Delta region, and what socio-economic implications arise from the loss of these resources? What comprehensive strategies, encompassing policies, institutional roles, and potential economic initiatives, can be recommended to address the deterioration of the ecosystem in the Indus Delta Region, considering both the current migration trends and habitat disturbances?

#### **Proposed Methodology:**

This research aims to work on understanding the Indus Delta region better to see possible reasons of the currently faced problems. Therefore, it becomes imperative that proper primary and secondary research is conducted to further strengthen the research. Information gathering comes across as an evident need to further conduct the research. Working to examine the reasons for the deterioration of the Indus Delta Ecosystem, this research requires both quantitative and qualitative data. Hence, in-depth information would be adapted through government census and data regarding the migration causes from the Indus Delta. This mass data would greatly help increase the validity and generalizability of the research in future context. Moreover, to better learn about the reasons for losing out the habitat as well as missing out on the agricultural opportunities, several reliable sources of information will be utilized including the studies by WWF as a key resource. In addition, other case studies from these delta regions will be adopted to analyze and evaluate potentially successful strategies towards rehabilitating this region.

In addition to these secondary research methodologies, primary research would be conducted evidently to ensure accuracy and reliability. Keeping this in consideration, a sample would be chosen from people who lived

in these areas. Thus, on-site interviews would be conducted within the current living population in the Indus Delta alongside the migrated households to better grasp on the reasonings for migration. Detailed and structured questionnaires and surveys approved by the Research Ethics Committee of Pakistan will be circulated amongst the masses to ensure gathering of quantitative data to better understand the migration patterns. Similarly, interviews will be taken from experts who have in-depth knowledge on addressing environmental problems within the Indus Delta Region to ensure reliability and better access to information. These experts would include scientists who have experience in research within the Indus Delta region to get a greater grasp of information associated to the area. In addition, any further information gathered and organized for this research would be adopted from both print and electronic media sources including books, articles, and journals to ensure well-rounded information for this research.

This research would further be analyzed through various systems such as SPSS to ensure validity while subjective research would be devised into proper reasoning of the migration and rehabilitation possibilities. Moreover, outliers would be identified through standard deviation techniques where variability of responses would be calculated to ensure reliability and validity of the research. Following this, relevant Guidelines could further be devised based on this information to improve the Indus Delta region and utilize it as an important resource.

#### **Problem Statement:**

The Indus Delta Ecosystem is undergoing serious migration and disturbances of habitats based on several complex ecological, economic, and social factors that is leading to a loss of potential growth. Hence, it is imperative to introduce sustainable policies that can help build better lifestyles to encourage rehabilitation leading to better economic growth outcomes.

## Future Research Contributions and Results:

The Indus Delta regions have always been a subject of conversation with the economic, ecological, and social potential it holds. Thus, this research on the Indus Delta makes substantial academic contributions across various domains, offering insights that can impact the shaping of future endeavors. This research delves into understanding the complex socio-ecological challenges of this region which presents a comprehensive analysis of factors including migration, habitat disturbances, and environmental degradation. Shedding light on these essential issues, the contribution of this research lies in bridging the gap between institutions in fostering conservation and sustainable development policies and local communities to promote rehabilitation and ecotourism. Through evidence-based solutions, the research provides actionable measures for infrastructure development that can greatly provide a base for future academic research to question whether those measures were implemented, had an impact, or other solutions should be devised.

Beyond its academic implications, this research on the Indus Delta holds the potential for profound impacts across diverse disciplines and sectors. One significant area of influence is in the realm of environmental and conservation policies. The evidence-based solutions and insights generated by this study can serve as a guiding framework for policymakers, not only in Pakistan but globally, grappling with similar ecological challenges. By addressing the intricate socio-ecological dynamics, the research lays the groundwork for the development of effective management plans that extend beyond the Indus Delta. These insights could inform policies related to deltaic ecosystems worldwide, contributing to a broader understanding of how to manage, conserve, and rehabilitate vulnerable regions facing similar threats. Furthermore, the research's emphasis on collaboration with international partners, such as China and Turkey, opens avenues for cross-cultural and cross-disciplinary collaborations. This collaborative spirit could extend beyond academia, fostering partnerships

between nations for joint initiatives, technological exchanges, and shared solutions to address complex environmental issues. In essence, the impact of this research transcends academic boundaries, holding the promise of influencing real-world policies, international collaborations, and sustainable practices that resonate far beyond the Indus Delta.

Hence, contributing to a broader understanding of the Indus Delta ecosystem, this research enriches the global discourse on delta management, conservation, and rehabilitation by providing meaningful insights into human activities, natural processes, and the effects of climate change in shaping landscapes. Overall, the potential impact of the research extends beyond the academic realm, promising a roadmap for sustainable development, improved livelihoods, and environmental protection in the Indus Delta region and serving as a guiding light for future research and conservation efforts worldwide.

## Proposed Guidelines:

Create actionable recommendations based on infrastructure development to mitigate habitat disturbances caused by migrations in the Indus Delta through tackling issues including freshwater reduction, salinity, and development of horticulture effectively by introducing phenomenon plants. Work collectively with National and International donors to fund the proposed development including economic zone developments and energy generation to enhance economic outputs facilitating rehabilitation in the Indus Delta Region. Comprehend initiatives towards conservation and institutional involvement to preserve and protect mangroves by supporting conservation projects and getting institutions involved to preserve land diversity and allow more people to benefit from it. Develop effective plans to accommodate the wildlife sanctuary by integrating community efforts towards them to safeguard ecosystems of fishing population, bird populations, and overall wildlife. Successfully facilitate the rehabilitation of by the implementation of sustainable housing to accommodate local community members by offering greater employment opportunities within the Indus Delta Region.

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