Global Research journal of Natural Science and Technology (Grjnst)
Volume: 03 - Issue 3 (2025)
p.ISSN: 2790-7643 e.ISSN: 2790-7651
www.grjnst.com

Survey and conservation of Mangroves in Khobar Creek Keti Bander, District, Thatta Sindh

Dhani BuxMashori
Department of Zoology , Govt College University, Hyderabad, Sindh, Pakistan
dhanibux.mashori @gcuhedu.pk
Ali Raza Soomro
Department of Zoology Govt Degree College KN Shah *Sindh, Pakistan*
ar83soomro@gmail.com
Shaukat Ibrahim Abro
Department of Soil & Environment, Sindh Agriculture University Tandojam, Sindh, Pakistan
abro.shaukat@gmail.com
Bakhtawar Soomro
Department of Zoology , Govt College University, Hyderabad, Sindh, Pakistan
bakhtawarsoomro145@gmail.com
Mohmmad Aqil
Department of Botany, Govt College University, Hyderabad, Sindh, Pakistan
Aqilahmed.992@gmail.com

Kiran
Department of Zoology , Govt College University, Hyderabad, Sindh, Pakistan
Kiransiddiqui81@gmail.com

Corresponding author: abro.shaukat@gmail.com **(Dr. Shaukat Ibrahim Abro)**

Abstract

Khober Creek situated in the Keti Bander district of Thatta, Sindh, Pakistan, is part of the Indus Delta Mangrove Reserves, hosting a diverse and vital population of mangroves. The predominant (Horned Mangrove) 7=1.870829 and *Rhizophora mucronata* 5=1.581139 contribute significantly to the ecological integrity of the region. These mangroves play a critical role in protecting coastlines from erosion, providing habitats for marine and avian species, and maintaining water quality. Their dense root systems serve as nurseries for aquatic organisms and attract diverse bird populations, including the rare collared kingfisher. Conservation efforts, including reforestation, pollution control and availability of fresh water are essential to preserve this biodiversity hotspot, particularly in light of threats like climate

change and reduced water flow from the Indus River. Statistical analysis of the mangrove population 2022 reveals seasonal variations across species, with *Avicennia marina* being the most abundant. The study underscores the ecological and economic importance of mangroves in sustaining biodiversity, promoting coastal fisheries, and enhancing the natural beauty of the Indus Delta.

Key words: Mangrove conservation, Restoration efforts, Khober Creek, Indus Delta.

1. INTRODUCTION

. An ecological study of aquatic flora occurring in khober creek Indus River delta was carried out from January 2022. The coastal area of Sindh Southzone is about 350 kilometers, encompassing the eco-region of the Indus Delta. This study aims to examine the impact of the freshwater discharge from the Indus River into the Arabian Sea on the Aquatic flora and fauna in this region (Gleeson et al,. (2020). Sindh's deltaic region, the world's seventh-biggest, gives a rich environment to the rearing and producing of thousands of marine species, going about as a characteristic incubation center (Johnson, et al,. (2020). The Indus delta is prestigious internationally for its high efficiency, i.e., its ability to change over brilliant energy into biomass, which upholds the vocation needs of over a portion of 1,000,000 individuals. It assumes a crucial part in creating mangrove ranger service and saving great many lots of sediment, silicate, iron, phosphorus, and calcium carbonates, in this way keeping up with the marine mudflats environments (Garcia et al,. (2021).

The climate change is a gradual or of sudden change in environmental conditions which drastically affect the lives and livelihood of people as well as impacts on the (Intergovernmental Panel on Climate Change (2021). While the rising earth’s surface temperatures are melting the glaciers and increase the sea levels, the seawater is also heating up to alter the wind and rain patterns. As a result there has been seen an unprecedented increase in the frequency and intensity of cyclones along the Sindh coast during first two decades of 21st century (Mahar et al,. (2020). The studies indicated that lot of changes in lives and livelihoods are happened due to climate change, pollution, over exploitation of natural resources and freshwater scarcity at Sindh coastal zone in Pakistan. There is keen

need of strong attentions to the state, research organizations, NGOs and general public to mitigate for saving the lives and livelihoods. The negative impacts of climate change and other factor have drastically affected the flora specially (mangroves) of the region. The proposed study is the baseline and the first attempt which may be benefited and help full for the future planning, development, conservation and adaptation aspects to face the future challenges of climate change patterns as well as the solution measures (Smith et al l,.(2024).

The Indus Stream downstream from Kotri is the essential wellspring of freshwater for a large number of individuals in Karachi, Hyderabad, Thatta, Sujawal, and Badin. Sindh territory in Pakistan is especially wealthy in oceanic assets, including the Middle Eastern Ocean, an immense useful estuary, the famous Indus Stream, and various lakes, dhands, dhoras, normal despondencies, water system channels. The mangroves are important to the Indus delta not only essential for biodiversity but also contribute to the dense root systems of the mangroves (Gleason et al,. (1991). Offer shelter and breeding grounds for fish, crabs, and other aquatic life, while also attracting a variety of bird species, including the rare collared king fisher. Conservation projects include reforestation initiatives and protecting the area from development and pollution (IUCN (2025). The mangroves are important to the Indus delta not only essential for biodiversity but also contribute to the region's natural beauty and ecological balance (WWF (2023). The mangroves are important to the Indus delta not only essential for biodiversity but also contribute to the region's natural beauty and ecological balance. Mangroves plays ecological a crucial role in coastal ecosystems by providing habitat and food for numerous organisms, including fish, crustaceans, and birds. It helps in nutrient cycling and contributes to the overall productivity and biodiversity of mangrove ecosystems region’s natural beauty and ecological balance.(*Forests*. MDPI (1999). Mangroves plays ecological a crucial role in coastal ecosystems by providing habitat and food for numerous organisms, including fish, crustaceans, and birds (*World Wildlife Fund (WWF)*. It helps in nutrient cycling and contributes to the overall productivity and biodiversity of mangrove ecosystems (*Forests* MDPI. (2018).

2. Materials and Methods

Environmental Parameters

The sampling stations were selected in the command area of estuarine water khober creek. The samples of water and various body parts and No. of mangroves were collected identified and distribution in the forestry. The sample were collected and preserved according to standard methods (Anang Dwi Purwanto at el,.(2019).

FIGURE 2.1KHOBAR CREEK /KETI BANDER MAP OF SAMPLING COLLECTION RESEARCH AREA (GOOGLE MAP)

The sample were collected and preserved according to standard methods. The water quality parameters were tested on spot i.e. pH, temperature of water, salinity, Total Dissolved Solids (TDS) Dissolved Oxygen

(DO) Water samples were collected for assessment of chemical variables. Few of parameters were examined on the spot and further were analyzed in the laboratories (FWC/FW (2005).Temperature of air and water (ºC) was measured through digital thermometer model CE TP101. The samples of water, mangroves plants, were collected counted on seasonal basis during 2022. The sample were collected and preserved according to standard methods describe by (APHA et al,. (2017). The water quality parameters were tested on spot i.e. pH temperature, total dissolved solids (TDS), Hc digital meter were used for testing the temperature and humidity.pH of water were measured by digital pH meter model WTW 320 A. Total dissolved solids TDS were measured with the help of conductivity bridge WTW320 A. Salinity of water were recorded with the help of HM digital meter model SB1500pro.

Biological parameters

Field visits were conducted for data collection of population mangroves involve local communities in the survey and integrate indigenous knowledge about mangroves for conservation, protection, pollution impact assessment, climate change phenomenon observations of khober creek in 2022. Samples of water were also collected for quality assessment, biodiversity existence and ecological significance, impact and the socio-economic conditions of khobar creek area. A Tidal creek is a meandering channel in a coastal wetland subject to bi-directional tidal currents. Khobar Creek is a tidal creek and is located in Sindh, Pakistan. The estimate terrain elevation above seal level is 1 meters. Variant forms of spelling for Khobar Creek. It are located at an elevation of 1 meter above sea level. Khobar Creek is also known as Khobar Creek, Khober Creek. Its coordinates are 24°3'15" N and 67°23'33.The samples of water, mangroves, were collected counted on seasonal basis during 2023. The sample were collected and preserved according to standard methods (FWC/FW (2005)

FIGURE 2.1 Population of Mangroves in Khober Creek

RESULTS

1. Population of Mangroves in Khober Creek

Khober creek, located on the Keti bander district Thatta Sindh Pakistan. Mangrove Reserve, also known as Indus delta in khober creek. This area boasts a significant population of mangroves, which are crucial for the local ecosystem. The mangroves in this creek are predominantly *Avicennia marina*, commonly known as grey mangroves or white mangroves.

These mangroves play a vital role in protecting the coastline from erosion, providing a habitat for various marine and bird species and maintaining water quality by filtering pollutants. The dense root systems of the mangroves [62] offer shelter and breeding grounds for fish, crabs, and other aquatic life, while also attracting a variety of bird species, including the rare collared kingfisher. Conservation projects include reforestation initiatives and protecting the area from development and pollution. The mangroves are important to the Indus delta not only essential for biodiversity but also contribute to the region's natural beauty and ecological balance.

Table 3.1 Mangroves population in khober creek in Indus River Delta per 100 square feet

S. No	Genera	Autumn	Winter	Summer	Spring	Mean	STDEV
1	*Avicennia marina*	13	10	11	12	11.5	1.118034
2	*Rhizophora mucronata*	4	6	3	7	5	1.581139
3	*Aegiceras corniculatum*	4	7	9	8	7	1.870829

(Per species).

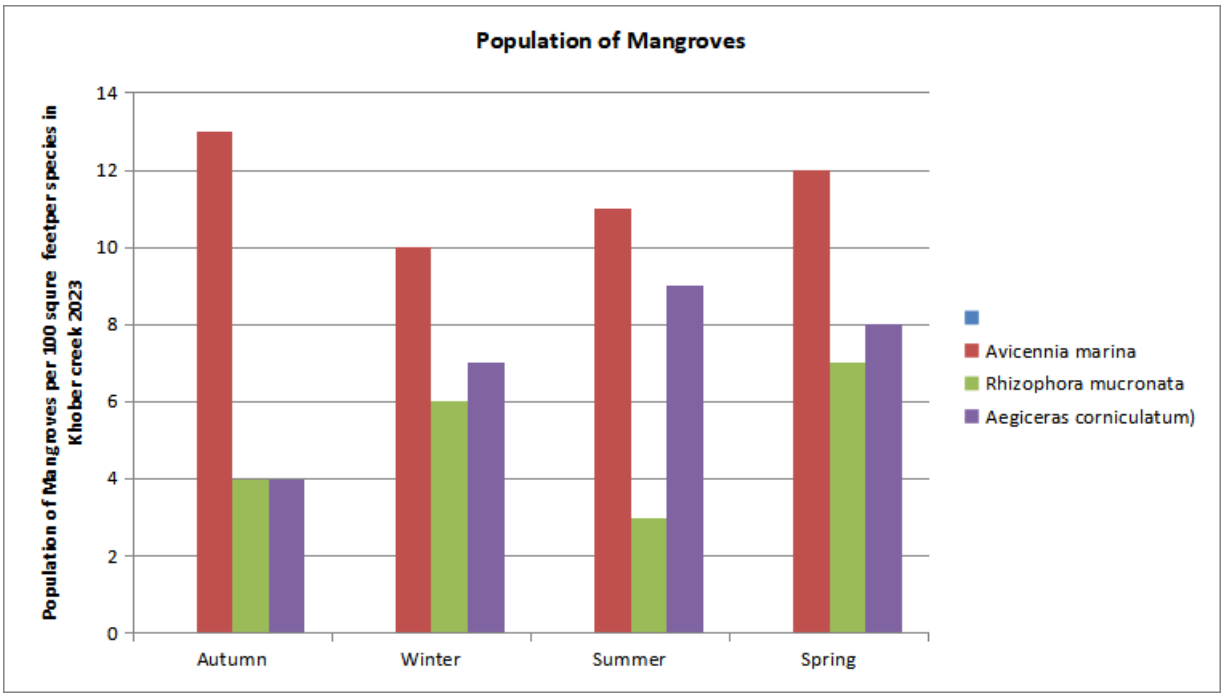

Fig.3.1 Population of Mangroves in Khober Creek

Fig 3.2Types of various mangroves leaf

Avicennia marina

Avicennia marina, commonly known as the Grey Mangroves is a species of mangrove tree in the family Acanthaceae, Genus Avicennia. It is commonly found in intertidal zones along coastlines, estuaries, and tidal flats in tropical and subtropical regions. It is a medium-sized evergreen tree with distinctive adaptations to its saline environment. Its roots are specialized to cope with high salinity and oxygen-poor soils. The leaves are oval-shaped, thick, and leathery, with a distinctive pale underside.

Aegiceras corniculatum

Aegiceras corniculatum is commonly known as "black mangrove" or "river mangrove." It is a species of mangrove plant related with family Primulaceaenative to coastal areas. Found in estuaries, tidal flats, and along riverbanks in tropical and subtropical regions. The leaves are leathery, glossy, and elliptical to lanceolate in shape, arranged oppositely on the *Aegiceras corniculatum* is common name "horned mangrove." typically found in mangrove ecosystems, particularly in estuaries, tidal flats, and along riverbanks in tropical and subtropical regions. This plant is related with Verbenaceae family of found in coastal area of khober creek keti bander zone. *Aegiceras corniculatum* plays ecological a crucial role in coastal ecosystems by providing habitat and food for numerous organisms, including fish, crustaceans, and birds.It helps in nutrient cycling and contributes to the overall productivity and biodiversity of mangrove ecosystems.The dense root systems of mangroves like *Aegiceras corniculatum* serve as nurseries and breeding grounds for many marine organisms, contributing to coastal fisheries.

Rhizophora mucronata

This species inhabited in coastal area of keti bander area. It has creamy white sepals; it is related with the family Rhizophoraceae. The leaves are characteristically elliptical.12cm long and 2.4 cm wide in length.

3. Discussion

Environmental Parameters

The flow of water from the kotri downstream minimum of 250 cubic feet per second CFS to a maximum of 39,355 CFS. This season marks the transition from the monsoon period to cooler temperatures, leading to decreased discharge compared to the peak monsoon flows (Sindh irrigation department).Winter (1 November to 15 February). In winter, the discharge

levels decrease further, with a minimum of 1,735 CFS and a maximum of 27,010 CFS. This reduction in discharge is typical due to reduced precipitation and snowmelt in the upper reaches, as well as decreased agricultural demand. Spring (16 February to 15 April).During spring, as temperatures begin to raise, the discharge shows a slight increase compared to winter, ranging from a minimum of 4,510 CFS to a maximum of 6,475 CFS. This increase is often attributed to melting snow and early spring rainfall. Summer (16 April to 15 September).Summer sees a significant rise in discharge compared to the preceding seasons, ranging from a minimum of 1,425 CFS to a maximum of 33,480 CFS, increase is primarily driven by the onset of the summer monsoon, which brings heavy rainfall and increased water flow from the Kotri downstream (Sindh irrigation department (2022) These seasonal variations in the discharge of fresh water from Kotri Barrage it is single source of fresh, water shortage of fresh water, indicates the death of Indus River delta. Climatic factors, including precipitation patterns, temperature changes, human influence built by mega-dams on the Indus River Mangla and Turbela dams mega water stored big project and built flood canals are cause of death of the Indus river delta (WWF-Pakistan. (2018).The provided information outlines the seasonal variations in discharge from the Kotri Barrage and suggests a concerning trend regarding the health of the Indus River delta. Let's delve into the discussion around these points. The seasonal variations in discharge, ranging from the minimum to maximum values, reflect the dynamic nature of Indus River flow influenced by climatic changes. The decrease in discharge during autumn and winter is understandable due to reduced precipitation and snowmelt, while the increase in spring and summer correlates with rising temperatures and the onset of the monsoon. The fluctuating discharge patterns have significant implications for the Indus River delta ecosystem. The shortage of fresh water during certain seasons, particularly, autumn and winter, poses a threat to the delta's health. Reduced water flow can lead to saltwater intrusion, soil Stalinization, and loss of habitat for flora and fauna, ultimately contributing to the degradation of the delta ecosystem. The discussion also raises the issue of human intervention in river management, particularly through the construction of mega-dams like Mangla and Tarbela dams. These infrastructure projects alter natural flow patterns, regulate water discharge, and have downstream effects on ecosystems and communities reliant on river water. Additionally, the construction of flood

canals may further exacerbate water scarcity issues by diverting water away from downstream areas. Given the importance of the Indus River delta as an ecological hotspot and a crucial agricultural region, there is a pressing need for sustainable water management practices. Balancing the demands of agriculture, industry, and urban areas with the preservation of river ecosystems requires careful planning, equitable distribution, and consideration of environmental impacts. Climate change adds another layer of complexity to the discussion. Altered precipitation patterns, rising temperatures, and increased frequency of extreme weather events can further exacerbate water scarcity and impact river flow dynamics. Addressing the challenges posed by climate change requires adaptive strategies and international cooperation. The seasonal variations in discharge from the Kotri Barrage underscore the interconnectedness of natural and human systems, highlighting the importance of holistic approaches to water management and environmental conservation in sustaining the Indus River delta ecosystem (Syvitski et al,.(2007).

Temperature of air recorded in °C during 2022 the temperature of air was noted season wise properly in Autumn, Winter, Spring and Summer temperature was recorded in between (26-30°C) in autumn (13- 16°C) in winter (21- 25°C) in spring (31- 38°C) in summer it started decreasing autumn minimum low temperature of air recorded coldest (21°C) in winter and moderate in (31°C) in spring and hottest in summer recorded (38°C) minimum low temperature of air from the station 3&4 in winter and high temperature was measure. Temperature Climate change impact on the mangroves (Saifullah et al,. (2017). Temperature is a pertinent factor of air ecology. The temperature of air play great role and it is chief driving force of the mangroves forestry (Alongi et al,. (2002). Humidity in Air during in 2022 the humidity of atmosphere was noted in various seasons properly in Autumn, Winter, Spring and Summer humidity was recorded in autumn (44 to 58°) in winter (20-59°) in spring (24- 34) and in summer (40- 45) it started decreasing in high temperature and increase in low temperature or in rainy season or depend on the availability of the water autumn minimum low temperature of air recorded minimum low temperature of air from the in winter and high temperature was measures Alongi, D. M. (2009).Salinity Variations and Seasonal Impact. The study conducted from 2022 measured salinity levels in the Indus River across different seasons. The findings indicate that salinity concentrations were highest

during the pre-monsoon season, with a maximum recorded value of 0.5 mg/L. In contrast, the lowest salinity level, 0.0 mg/L, was observed during the summer, likely due to the heavy rainfall associated with the post-monsoon period, which dilutes the salt concentration in the river water. Specific data revealed that in khober creek experienced the highest salinity (0.5 mg/L) The study aimed to understand the climate impact on salinity levels and the subsequent effects on aquatic mangroves (Lovelock et al,. (2007). The study aimed to understand the climate impact on salinity levels and the subsequent effects on aquatic biodiversity.

Chemical parameters

The pH levels of water play a crucial role in ecological studies due to their significant impact on mangroves diversity (Wang et al,. (2018). In this study, pH values were measured pH is a significant factor influencing the health and diversity of aquatic ecosystems, particularly evident in the pre-monsoon, monsoon, and post-monsoon periods. The positive correlation between pH levels and mangroves underscores the importance of monitoring and managing pH levels to maintain ecological balance and support aquatic life. The measurement of dissolved oxygen (DO) in this study revealed seasonal variations. The recorded DO values across all stations ranged from 2.1 to 5.9 mg/L, which, although below the commonly cited requirement of less than 10 mg/L for most aquatic life, still indicates a favorable habitat for aquatic organisms. This range suggests that the aquatic environments can support biodiversity, despite seasonal changes and variations in DO levels. Understanding the impact of climate on DO is crucial for assessing the health and sustainability of aquatic ecosystems. Lower DO levels in summer could stress aquatic life, particularly sensitive species, while higher levels in winter may promote a more diverse and thriving ecosystem. Continuous monitoring and analysis of DO patterns are essential for protecting aquatic mangroves and managing the effects of climate variability on these environments. The minimum TDS concentration observed was 170 mg/l in autumn, while the maximum was 261 mg/l in spring. This seasonal fluctuation in TDS levels can be attributed to reduced evaporation rates (Hossain et al,. (2018).

Climate change is a major threat to Mangroves, especially in areas of Khober Creek. The lack of water flow in the Indus River downstream from Kotri is a critical issue. Reduced water availability affects the entire ecosystem, threatening various species and their habitats. To address this, it is crucial to take urgent actions. Reducing global temperatures through climate action, protecting and restoring mangroves habitats, and promoting conservation efforts are essential steps. These measures will help preserve biodiversity and maintain ecosystem health. For example, restoring water flow in the Indus River can revive wetlands and support estuarine aquatic life. Protecting surrounding habitats ensures that mangroves species have a place to thrive. Conservation initiatives, such as creating protected areas and supporting sustainable practices, can safeguard estuarine plants for future generations. Overall, immediate and concerted efforts are needed to mitigate the impacts of climate change and water scarcity on biodiversity in the Kotri downstream to Khober Creek area.

Biological parameters

Mangroves in the Indus delta, including species such as *Avicennia marina, Rhizophora mucronata and Aegiceras corniculatum.* In conclusion, the diverse array of mangroves plant species in the Khober creek. Indus delta of Sindh, Pakistan, supports a complex ecosystem with various ecological functions. Conservation efforts are crucial to maintaining the balance and health of these wetland habitats.

Conclusion

Present study was carried out in khober creek. The khober creek was visited. The creek were evaluated with temperature, pH, salinity, total dissolved solids, dissolved oxygen and climate impact on the Mangroves. The sample was collected seasonally. The study recorded climate impact on Mangroves. The hot and cold seasons. However, they were abundant in moderate weather conditions. Much population of Mangroves was commonly reported during present study. The study revealed that most of the flow of water from the Kotri bed downstream to Indus river delta. The flow of water suitable for the animals and plants (mangroves). Therefore the authorities may come in action and need strong attention on the discharging sufficient water as survival source of flora and fauna they exist in kotri downstream command area up to delta only sufficient of fresh water is pivotal for Indus River delta.

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