

Supplementary Document

Mangrove Conservation in Balochistan- HCV and Biodiversity Assessment



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SUMMARY

This document is a supplementary document attached with the Socio-Economic Assessment for Balochistan, and examines the ecological significance, conservation challenges, and management strategies for Balochistan's mangrove forests using the High Conservation Value (HCV) framework. It highlights their role in biodiversity preservation, local livelihoods, and climate resilience, while identifying threats to their sustainability.

In Balochistan, the most significant mangrove forests are critical ecosystems which serve as breeding grounds for marine life, including commercially valuable fish and shrimp species, and offer vital habitats for migratory birds, endangered species, and marine biodiversity. The report highlights how mangroves act as natural barriers against coastal erosion, storm surges, and rising sea levels, thereby protecting coastal communities from extreme weather events.

In addition to their ecological functions, mangrove forests play a crucial role in carbon sequestration, storing large amounts of carbon and mitigating the effects of climate change. The report emphasizes the unique biodiversity of these forests, including rare, threatened, and endangered species such as the Olive Ridley and Green Turtles, along with a diverse avian population that depends on these habitats for nesting and foraging.

An in-depth analysis of land-use changes affecting Balochistan's mangrove forests, particularly over the past few decades. It identifies variations in mangrove cover, with some areas experiencing expansion due to conservation efforts, while others, notably Jiwani, have suffered a decline in mangrove cover due to reduced freshwater inflows, coastal erosion, and increasing human activity. In contrast, other mangroves like Sonmiani and Kalamat Khor have shown positive trends in mangrove regrowth, reflecting the success of afforestation and reforestation initiatives undertaken by environmental organizations and government agencies.

Key threats to these ecosystem include deforestation, excessive harvesting, and limited freshwater availability from dams and river diversions as key drivers of mangrove degradation. Rising sea levels, increased salinity, and unregulated fishing further threaten these ecosystems, while coastal development and land encroachment accelerate habitat loss. Urgent conservation efforts and sustainable management are needed to protect Balochistan's mangroves. To address these challenges, HCV-based strategies should align with community needs, promoting eco-tourism, aquaculture, and afforestation, while stakeholder engagement remains crucial for long-term protection.

I. INTRODUCTION

I.1. Sustainable Mangrove Management Through the HCV Framework

I.1.1. High Conservation Value (HCV): Definition and Importance

High Conservation Value (HCV) refers to attributes of forests that hold significant ecological, social, or cultural importance. The concept of High Conservation Value Forests (HCVFs) was initially developed by the Forest Stewardship Council (FSC) in 1999. Instead of focusing on specific forest types or logging methods, HCV identifies the key values that make forests ecologically and socially important. By recognizing these values, forest management strategies can be designed to maintain or enhance them while ensuring sustainability.¹

HCVs are classified into six categories: species diversity (HCV 1), landscape-level ecosystems and mosaics (HCV 2), rare or endangered ecosystems and habitats (HCV 3), critical ecosystem services (HCV 4), community needs (HCV 5), and cultural values (HCV 6). These classifications help guide conservation efforts, ensuring that areas with high biodiversity, crucial ecosystem services, or cultural significance are adequately protected.¹¹ This document aims to assess the identified mangrove sites in Balochistan according to the noted categories, assessing their HCV and attributes.

Mangroves are designated as High Conservation Value (HCV) areas due to their significant ecological and socio-economic contributions. One of their most crucial roles is in climate change mitigation, as they are among the most carbon-rich ecosystems on Earth. With an estimated 6.23 gigatonnes of carbon stored in their biomass and soils, mangroves play a vital role in global climate strategies, including those under the Paris Agreement and REDD+ initiatives. Additionally, their presence along coastlines provides essential protection against extreme weather events such as storms, cyclones, and tsunamis. By reducing wave energy, storm surges, and coastal erosion, they safeguard human settlements and biodiversity in vulnerable coastal regions.^{2,3}

Beyond their protective functions, mangrove forests are critical for biodiversity conservation. They support a wide range of species by serving as habitats, spawning grounds, and nurseries for marine organisms, sustaining high primary production that benefits entire food webs. This ecological richness translates into direct economic benefits for many coastal communities that

¹ WWF, 2017. *HCVF Toolkit: A practical guide for identifying, managing, and monitoring High Conservation Value Forests*. Available at: https://www.fsc.org/downloads/hcvf_toolkit_2017_eng.pdf.

² Ismail, M., Rossi, A. and Geiger, N., 2011. *A Compilation of Bioenergy Sustainability Initiatives: Update*. Rome: Food and Agriculture Organization of the United Nations (FAO).

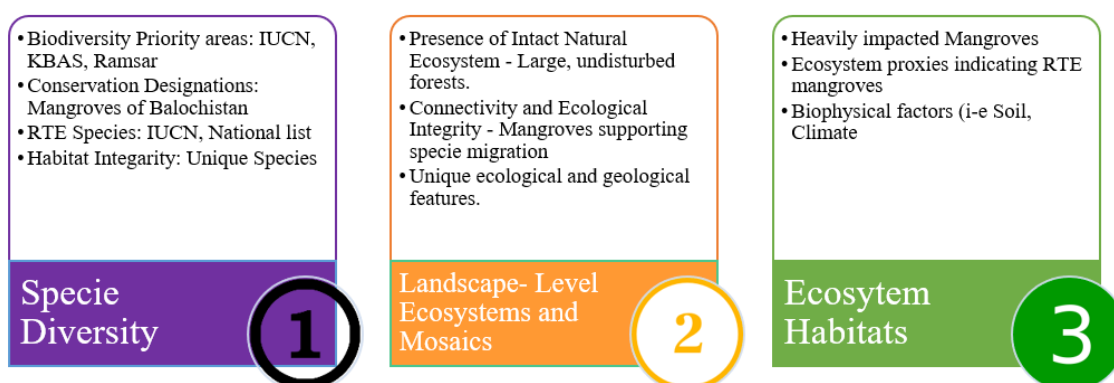
³ Forest Stewardship Council (n.d.) 'High Conservation Values'. Available at: <https://by.fsc.org/by-en/for-forests/high-conservation-values>

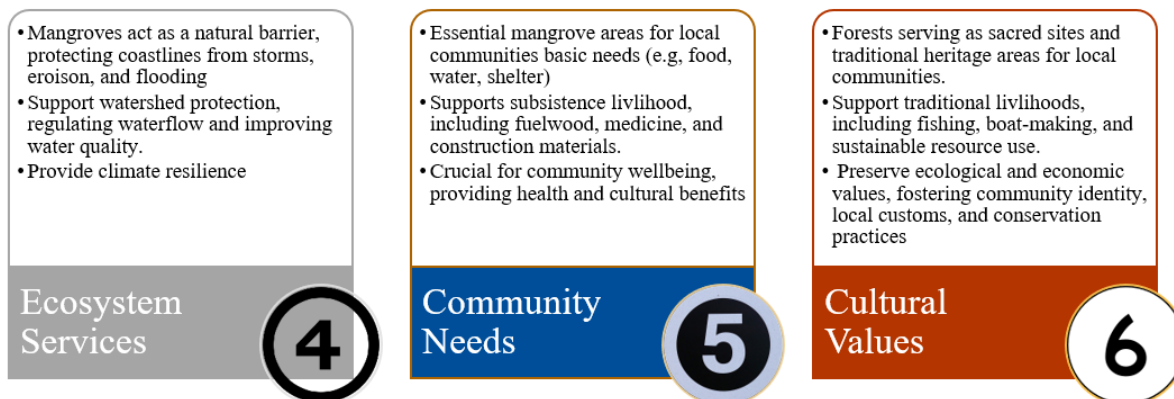
depend on mangroves for fisheries, fuelwood, and ecotourism. Fisheries, in particular, benefit from the shelter and breeding grounds that mangroves provide for commercially valuable fish and shellfish species, supporting both subsistence and commercial fishing industries.¹²

Due to their immense ecological and economic significance, mangroves are central to global conservation and restoration initiatives. Programs such as the UN Decade on Ecosystem Restoration and various national restoration efforts recognize their value in achieving Sustainable Development Goals (SDGs) related to poverty reduction, climate action, and biodiversity conservation. However, despite their importance, mangroves continue to face significant threats from aquaculture, agriculture, and coastal development. Conservation efforts are increasingly focused on integrating mangrove protection into broader land-use planning and climate resilience strategies to ensure their long-term survival. Their designation as HCV areas underscores the urgent need to prioritize mangrove conservation, restoration, and sustainable management for the benefit of both ecosystems and human societies.¹²

1.2. Methodology for Identification of High Conservation Values

The HCV assessment will adopt a tiered approach, beginning with a desktop review and secondary data collection. This phase will aim to gather evidence supporting the existence and importance of each HCV category within our mangrove project sites in Balochistan.





This desk-based High Conservation Values (HCV) assessment methodology uses readily available data to identify potential HCVs. It's efficient and cost-effective, allowing for broad-scale planning and prioritization. However, it's a preliminary approach and requires further verification and stakeholder engagement. This assessment serves as a starting point, but should not replace comprehensive HCV assessments that incorporate primary data collection and community engagement.

1.3. Biodiversity and Ecological Importance of Balochistan

Balochistan, the largest province of Pakistan, spans 347,190 km², covering 44% of the country's total land area. It lies in the southwestern region of Pakistan and serves as a transition zone between the Oriental and Palearctic zoogeographical regions, resulting in a rich and diverse biodiversity. The province's landscape includes deserts, mountains, coastal ecosystems, and mangrove forests, each contributing to its ecological significance. Balochistan's coastal districts, particularly Gwadar and Lasbela, support mangrove forests, which are essential for both biodiversity and local livelihoods. These mangroves provide wood, food, and grazing areas for camels, while also acting as nurseries for shrimp and other marine species. Despite their ecological importance, these mangroves require conservation efforts, including the adequate supply of freshwater to sustain them⁴.

The province is home to at least 1,750 known plant species and a wide variety of animal species, including 71 mammals, 356 birds, 94 reptiles, 8 amphibians, and 61 freshwater fish species. The diverse geography of Balochistan contributes to its rich ecosystems. The Seistan Desert Basin lies to the west, while the Cholisthan and Thar Deserts are found in the east. The Himalayan Mountain ranges are located in the north, whereas the Arabian Sea borders the

⁴ Sherani, S.H. (2020) 'Biodiversity and its Conservation in Balochistan, Pakistan', *Haya: The Saudi Journal of Life Sciences*, 5(11), pp. 260–264. Available at: https://saudijournals.com/media/articles/SJLS_511_260-264.pdf

south. These distinct geographical features have given rise to unique habitats and ecosystems, making Balochistan a critical region for biodiversity conservation in Pakistan.⁵

1.4. Mangrove Habitats: Key Coastal Ecosystems of the Makran Region

Forests cover approximately 4.58 million ha in Pakistan. Of these, 0.132 million ha are coastal mangrove forests.⁶ Pakistan is recognized as having the 7th largest mangrove forest in the world. These forests are one of the primary features of coastal ecosystems and are widely spread across the coast of Pakistan.⁴⁰ The coastline of Pakistan is 1,050 km long and 40–50 km wide shared by the provinces of Sindh (350 km) and Balochistan (800 km).⁷

Pakistan's shrimp fisheries are heavily reliant on mangrove ecosystems, contributing nearly USD 100 million in annual export revenue. Coastal communities living near these mangrove-rich areas depend on mangrove resources not only as their primary livelihood source but also for subsistence needs, helping to supplement their income. Beyond fishing, mangroves provide fodder for livestock and serve as an essential source of fuelwood. Approximately 200,000 people, primarily fisherfolk, reside in areas adjacent to mangrove mudflats, with over 60% of the population relying on *Avicennia marina* for firewood and as a building material for hut construction.⁸

The mangrove forest in Balochistan is found in Gwadar and Lasbela along the coast. In Balochi language, the term 'Khor' or 'Hor' is used for water channels. Mangrove ecosystems lie between 24° 10' and 25° 37' latitude N and 61° 38' and 68° 10' longitude E.⁹ The Balochistan coast extends from the Hub River to the border of Iran and is formed by five bays beginning at Sonmiani Bay and ending at Gwader Bay. Mangrove forests are found in three different patches, and only found in lagoons, Miani Hor, Kalamat Khor and Gwader bay in Balochistan.¹⁰

1. Sonmiani: 95 km from Karachi,
2. Kalamat Khor: 315 km from Karachi
3. Jiwani: 515 km from Karachi

The mangrove forests of Balochistan constitute 3% of Pakistan's total mangrove cover¹¹, with Miani Hor accounting for 25%, Kalamat Khor 21%, and Gwadar Bay 8%. Miani Hor is unique

⁵ Government of Balochistan and IUCN Pakistan (2000) *Balochistan Conservation Strategy: An Overview*. Karachi: IUCN Pakistan. Available at: <https://portals.iucn.org/library/sites/library/files/documents/WCS-PK-034-ann.pdf>

⁶ Ahmad, S., Mian, O., Hai, A.A., Khurshid, N., Qadir, A.R., & Noor-un-Nisa. (2004). *Pakistan: Mangroves*. In P. Stedman-Edwards (Ed.), *Root Causes of Biodiversity Loss: An Analytical Approach* (pp. 1-20). WWF-Pakistan. Available at: https://www.wwf.org.pk/pdf/forest_mangrove_rcpakistan.pdf

⁷ Shah, A.A., Kasawani, I., and Kamaruzaman, J. (2007) 'Degradation of Indus Delta Mangroves in Pakistan', *International Journal of Geology*, 1(3), pp. 27-34. Available at: <https://www.naun.org/main/NAUN/geology/ijgeo-06.pdf>

⁸ Vistro, N., 2000. Mangrove forests: an important woodfuel resource of the coastal belt. *Wood fuel Production and Marketing in Pakistan. Regional Wood Energy Development Programme in Asia*, pp.103-106.

⁹ Adhikari, B., Baig, S.P. and Ifthikhar, U.A., 2010. The use and management of mangrove ecosystems in Pakistan. *The Journal of Environment & Development*, 19(4), pp.446-467.

¹⁰ Mukhtar, I. and Hannan, A., 2012. Constraints on mangrove forests and conservation projects in Pakistan. *Journal of Coastal Conservation*, 16, pp.51-62.

¹¹ Rafique, M.U.H.A.M.M.A.D., 2018. A review on the status, ecological importance, vulnerabilities, and conservation strategies for the Mangrove ecosystems of Pakistan. *Pak. J. Bot.*, 50(4), pp.1645-1659.

as it supports *Rhizophora mucronata*, *Ceriops tagal*, and *Avicennia marina*, making it the only location in Pakistan where *R. mucronata* and *C. tagal* grow naturally. In contrast, Kalamat Khor and Gawatar Bay exclusively support *A. marina*. The Balochistan coast is home to 12 species of halophytes and 3 types of algae, alongside a rich diversity of marine organisms, including 3 shrimp species, 4 oyster species, 8 gastropod species, and 3 crab species. An estimated 90% of commercially significant marine species rely on mangrove ecosystems at some stage in their life cycle, highlighting the crucial role of mangroves in sustaining marine biodiversity.⁷

Some migratory birds use the branches and roots of mangrove trees as habitats during their seasonal migrations. These areas provide shelter, nesting sites, and food sources for the birds. The dense, tangled roots of mangroves offer protection from predators, while the leaves and branches provide a place for the birds to rest and build nests. Additionally, mangrove ecosystems are rich in small fish, insects, and other food sources that support the survival of these migratory species during their journey.

Common Name	Scientific Name	IUCN Status	Migration Pattern
Bar-Headed Goose	<i>Anser indicus</i>	Least Concerned (Decreasing)	Central Asia to South Asia
Black Stork	<i>Ciconia nigra</i>	Least Concerned (Moderately depleted)	Europe & Central Asia to Africa & South Asia
Greater Flamingo	<i>Phoenicopterus roseus</i>	Least Concerned (Increasing)	Short-distance migration
Common Teal	<i>Anas crecca</i>	Least Concerned (Unknown)	Eurasia to subtropical/tropical regions
Eurasian Wigeon	<i>Anas penelope</i>	Least Concerned (Decreasing)	Europe & Asia to South Asia & Africa
Common Sandpiper	<i>Actitis hypoleucos</i>	Least Concerned (Decreasing)	Europe & Asia to Africa, South Asia, Australia
Great White Pelican	<i>Pelecanus onocrotalus</i>	Least Concerned (Unknown)	SE Europe & Africa to South Asia
Common Coot	<i>Fulica atra</i>	Least Concerned (Increasing)	Resident & migratory populations

Table 1.1 Migratory Bird Species and Patterns in Balochistan Mangroves ¹²

The coastal population dependent on mangrove forests in Pakistan is approximately 1.2 million, with 300,000 people residing along the Balochistan coast. The number of households in this region is estimated at 30,000, with over 90% of the population engaged directly or indirectly in fishing. Due to the high economic returns from fisheries, rapid population growth

¹² Farnsworth, M. (2023). 22 Birds to Watch in Balochistan. The World's Rarest Birds. Available at: <https://theworldsrarestbirds.com/birds/birds-in-balochistan/> (Accessed: 27 February 2025).

has been observed, with coastal populations increasing at an annual rate of 6-8% over the past decade.¹³

1.4.1. Ecological and Economic Significance of Mangrove Forests in Pakistan

In Balochistan, Pakistan, serve as natural coastal buffers, carbon sinks, and breeding grounds for marine species. These ecosystems provide vital ecosystem services, including coastal protection, carbon sequestration, and fisheries support. Mangroves act as natural barriers, safeguarding shorelines from storm surges, tidal waves, and erosion, thereby protecting human settlements and biodiversity. Additionally, they play a significant role in carbon sequestration, mitigating climate change by storing atmospheric carbon.¹⁴ A study published in Nature Communications highlights the importance of mangrove conservation to maximize their carbon storage potential. Furthermore, these ecosystems are nursery grounds for shrimp, fish, and other marine species, directly supporting local fisheries and coastal economies. Recognizing mangrove forests as HCVs emphasizes the need for sustainable management to maintain their ecological and economic benefits.¹⁵

Despite their importance, Pakistan's mangrove ecosystems have suffered severe degradation over the past 50 years due to freshwater diversion for agriculture, industrial and urban water pollution, and overfishing.⁸ These challenges are exacerbated by national policies prioritizing agriculture and industrial development over coastal conservation, neglecting the essential ecological functions of mangroves. Given these threats, Sustainable Development Goal 14 (SDG-14) underscores the need for the protection, conservation, restoration, and sustainable management of global mangrove forests. Target 14.2 of SDG-14 specifically calls for urgent action to protect and restore mangrove habitats, reinforcing their role in climate resilience and biodiversity conservation.¹⁶

Considering their high conservation value, the mangrove forests of Balochistan and other coastal regions of Pakistan require sustainable management approaches, including community-based conservation efforts, improved national policies, and stricter environmental regulations. Recognizing and integrating HCV principles into mangrove forest management can help

¹³ Ahmad, S., Mian, O., Hai, A.A., Khurshid, N., Qadir, A.R., & Noor-un-Nisa. (2004). *Pakistan: Mangroves*. In P. Stedman-Edwards (Ed.), *Root Causes of Biodiversity Loss: An Analytical Approach* (pp. 1-20). WWF-Pakistan. Available at: https://www.wwf.org.pk/pdf/forest_mangrove_repakistan.pdf

¹⁴ Raza, S.A., Zhang, L., Zuo, J. and Chen, B., 2024. Time series monitoring and analysis of Pakistan's mangrove using Sentinel-2 data. *Frontiers in Environmental Science*, 12, p.1416450.

¹⁵ Goldberg, L., Lagomasino, D., Thomas, N. and Fatoyinbo, T. (2023) 'Priority areas to protect mangroves and maximise ecosystem services', *Nature Communications*, 14, Article 41333. Available at: <https://www.nature.com/articles/s41467-023-41333-3>

¹⁶ WWF Indonesia (2003) 'Valuing Forests on the Ground: An Example from High Conservation Value Forests (HCVFs) Assessment in Riau, Sumatra, Indonesia'. Available at: <https://www.wwf.org.id/assets/panda.org/downloads/hcvfindonesia.pdf>

mitigate climate risks, enhance biodiversity, and secure the livelihoods of coastal communities while ensuring that their ecosystem services are maintained for future generations.

2. ASSESSMENT METHODOLOGY

2.1. Data Collection and Curation

This desk-based assessment leverages secondary data sources to evaluate biodiversity and ecological conditions within the mangrove forests of Lasbela and Gwadar districts, Balochistan Province, Pakistan, specifically for the delineation of High Concentration Values (HCVs). This approach facilitates a comprehensive understanding of conservation challenges, species distributions, and land-use patterns by synthesizing information from peer-reviewed literature, governmental reports, remotely sensed environmental datasets, and institutional databases.

A rigorous literature review and data curation process ensured the credibility and relevance of source materials. Studies published within the past 20 years were prioritized to incorporate the most current ecological assessments. The geographic scope was delimited to Balochistan Province, focusing exclusively on the mangrove forest ecosystems of Lasbela and Gwadar districts. Inclusion criteria encompassed key ecological parameters relevant to HCV identification, including: dominant invasive species impacting local biodiversity (e.g., *Avicennia marina*), critical wildlife refugia, fluctuations in flora and fauna populations, obligate species dependent on mangrove ecosystems, documented occurrences of IUCN Red List species, assessments of key ecological characteristics, evaluations of afforestation initiatives, analyses of watershed protection functions, and an assessment of local community reliance on forest resources for livelihood.

2.2. Ecological Assessment

The ecological assessment of the mangrove ecosystems in Balochistan focuses on evaluating the health, extent, and biodiversity of mangrove forests across key sites. This evaluation considers land use and land cover (LULC) changes, species composition, natural regeneration, and the impact of environmental and anthropogenic pressures.

Key indicators such as vegetation cover, species diversity, and habitat changes have been analyzed using remote sensing data and historical records. The dominant species, *Avicennia marina*, is found across all mangrove sites, with *Rhizophora mucronata* and *Ceriops tagal* present in restricted areas. The assessment also incorporates Sen's slope estimation to classify NDVI trends, identifying areas of mangrove expansion, stability, and degradation.

Environmental stressors such as coastal erosion, rising sea levels, and fluctuating freshwater inflows have been identified as major challenges affecting mangrove health. Additionally, anthropogenic activities, including overharvesting for fuel and construction, have contributed to mangrove loss in certain areas, particularly in Jiwani. However, conservation efforts and natural regeneration have led to the expansion of mangrove cover in sites like Shabi & Ankara Creeks, Kalamat Hor, and Sahidi Khor.

Avian biodiversity was assessed using secondary datasets from regional ornithological studies, particularly those compiled in the Amjad (2007). These data provided insights into declining and stable populations of diverse avian species, birds such as Egrets and Strokes within the Lasbela and Gwadar districts.

Rare, threatened, and endangered (RTE) species and ecosystems, critical components of HCVs, such as the endangered Olive Ridley and Green marine turtles, were identified through a comparative analysis of local forest ecosystems against the IUCN Red List and Gilani et al (2021) research paper. Priority conservation areas, potentially qualifying as HCVs, were delineated based on their proximity to established reserve forests, embankments, and adjacent ecological zones. The inferred presence of certain RTE species within the study area, particularly in ecologically contiguous habitats, was based on documented occurrences in proximate locations and analyses of their habitat preferences.

This ecological assessment aims to provide a comprehensive understanding of mangrove ecosystem dynamics in Balochistan, supporting sustainable management and conservation strategies for the long-term resilience of these critical coastal habitats.

3. PROJECT OVERVIEW

This project aims to assess the viability and feasibility of an Afforestation, Reforestation, and Revegetation (ARR) project in Balochistan province, Pakistan. The project zone spans across Sonmiani Khor, Kalamat Khor, Sahidi Khor, Sawar Khor, Shabi, and Ankara Creeks, from which a suitable land parcel will be selected for implementation. The designated land parcels are situated within the districts of Lasbela and Gwadar.

Forest Area	District	Area (Ha)
Sonmiani Khor	Lasbela	82,503
Kalamat Khor	Gwadar	55,869
Sahidi Khor	Gwadar	617
Sawar Khor	Gwadar	200.5

Shabi & Ankara Creeks	Gwadar	707
Jiwani	Gwadar	8,062
Total		147,958.5

The geographical analysis and assessment cover the following key locations: Sonmiani Khor in Lasbela District, Balochistan, with central coordinates at 25.5343N latitude and 66.3945E longitude. The mangrove cover in the Sonmiani Khor is approximately 5,170 hectares (See Deliverable 2. Technical Feasibility), accounting for 6.26 of the total area, while 23.93% is potential blank area. the remaining space consists of water and barren mudflats. The mangrove stands are predominantly found on the northern and southern sides of Miani Hor, with dense to medium mangrove cover generally surrounded by sparse mangroves, except along water edges where density is higher. Kalamat Hor in Gwadar District, Balochistan, situated at coordinates 25°27'N and 64°05'E, is located approximately 320 km west of Karachi and is accessible via the newly built Coastal Highway. The mangrove cover in Kalamat Hor consists of 908 hectares (See Deliverable 2. Technical Feasibility). As per past assessments, 12 hectares (2.3%) classified as dense, 149 hectares (28.3%) as medium, and 365 hectares (69.4%) as sparse. Previously, the area received freshwater from the Basol River, which was 15 km east of Hor; however, geological activities in recent years have altered its course, leaving the mangroves dependent on small nullahs from surrounding hills for freshwater supply. Jiwani (Gwadar Bay) in Gwadar District, Balochistan, with central coordinates at 25.1678N latitude and 61.7558E longitude, has a geographical area of 80 km².¹⁷ Mangrove cover spans 464 hectares (See Deliverable 2. Technical Feasibility). For breakdowns of land use across the sites please see Annex A.

This project seeks to evaluate the potential for afforestation and reforestation activities within these targeted regions by considering ecological conditions, land suitability, and freshwater availability. The findings will contribute to designing an effective ARR project that enhances environmental sustainability while addressing mangrove conservation challenges in these districts.

¹⁷ Hameed-Baloch, A., Haneef-Ur-Rehman, M.S., Kalhoro, M.A. and Buzdar, M.A., The Curious Case of Mangroves Forest at the Sonmiani bay Area, Lasbela District, Pakistan: A review.

4. SECONDARY HCV ASSESMENT

4.1. Regional Context

The status of Pakistan's mangrove cover was declared to be "protected forest" under Pakistan Forest Act 1927. The Balochistan Forest Department manages mangrove forests along the coastal areas of the province, primarily located in Somiani Hor, Kalamat Khor, Jiwani, Sahidi Khor, Sawar Khor, Shabi & Ankara creeks. These forests cover a total area of approximately 14,958 hectares (See Deliverable 2. Technical Feasibility). The coastal Balochistan region falls under the classification of a subtropical coastline or arid marine region and is further categorized as a subtropical maritime desert due to its ecological characteristics. The terrain consists of bays, lagoons, alluvial plains, deltas, mudflats, rocky shores, sandy beaches, sea cliffs, and marine terraces. The dominant mangrove species across all three locations is *Avicennia marina*, with additional occurrences of *Rhizophora mucronata* and *Ceriops tagal* in Miani Hor. These mangroves provide essential ecosystem services, such as coastal protection, biodiversity conservation, and support for fisheries. However, their sustainability is threatened by factors such as deforestation due to excessive wood cutting, reduced freshwater flow caused by hydrological developments including the Mirani Dam on the Dasht River and the planned Polari River Dam, encroachment of halophytes and algal mats, anthropogenic pressure from fishing communities, and climate-related impacts such as sea-level rise and decreased rainfall. Various conservation efforts, including mangrove plantation initiatives and community-based sustainable management projects, have been undertaken by organizations such as WWF, IUCN, and the Balochistan Forest Department to protect and restore these vital ecosystems.

This study will specifically focus on the mangrove forests located in Lasbela and Gwadar districts.

4.1.1. Lasbela District: It is located along the coastline of Balochistan, Pakistan, features a diverse topography divided into three distinct geographical zones: the Central Plain Area, the Porali Trough, and the Mountainous/Hilly Areas. The district has a population of approximately 680,977 people and spans an area of 15,153 km². The major economic activities in Lasbela include agriculture, forestry, hunting, and fishing, which contribute 35.4% to the local economy. Other significant sectors include community, social, and personal services (19.5%), construction (12.6%), and electricity, gas, and water supply (11.8%), while other industries account for 20.8% of the economic activity. The district

also has a substantial forested area covering 412,442 acres¹⁸, playing a crucial role in its ecological and economic landscape.^{19,20}

District	Forests	Mangrove Cover (Ha)
Lasbela	Sonmiani Khor	26,202

Table 4.1 Mangrove Distribution in Labela Ditric²¹

4.1.2. Gwadar District: It has a population of 263,514 people and covers an area of 12,637 km². The major economic activities in the district revolve around agriculture, livestock breeding, and fishing, which contribute 43.8% to the local economy. Other significant sectors include community, social, and personal services (21.6%), construction (16.2%), wholesale, retail trade, and restaurants (7.6%), as well as transport, storage, and communication (7.4%). The manufacturing sector plays a minor role, accounting for only 1.7% of economic activities, while other industries contribute 1.8%. The district also features a significant forested area covering 31,031 hectares, which is vital for environmental sustainability and local livelihoods.²²

District	Forests	Mangrove Cover (Ha)
Gwadar	Kalimat Khor	908
	Sahidi Khor	65
	Sawar Khor	1.5
	Jiwani	464
	Ankara & Shabi Creek	38

Table 4.2 Mangrove Distribution in Gwadar District¹⁹

¹⁸ Lasbela District Development Profile 2011

¹⁹ Commissioner Kalat Division. (n.d.). *Lasbela District*. Retrieved from <https://commissionerkalat.gob.pk/lasbela-district/>

²⁰ Pakistan Almanac. (n.d.). *Balochistan-Lasbela*. Retrieved from <https://pakistanalmanac.com/balochistan-lasbela/>

²¹ The Express Tribune (2020) *Study finds tremendous growth in mangroves*. Available at: <https://tribune.com.pk/story/2275495/study-finds-tremendous-growth-in-mangroves>

²² Pakistan Almanac. (n.d.). *Balochistan-Gwadar*. Retrieved from <https://pakistanalmanac.com/balochistan-gwadar/>

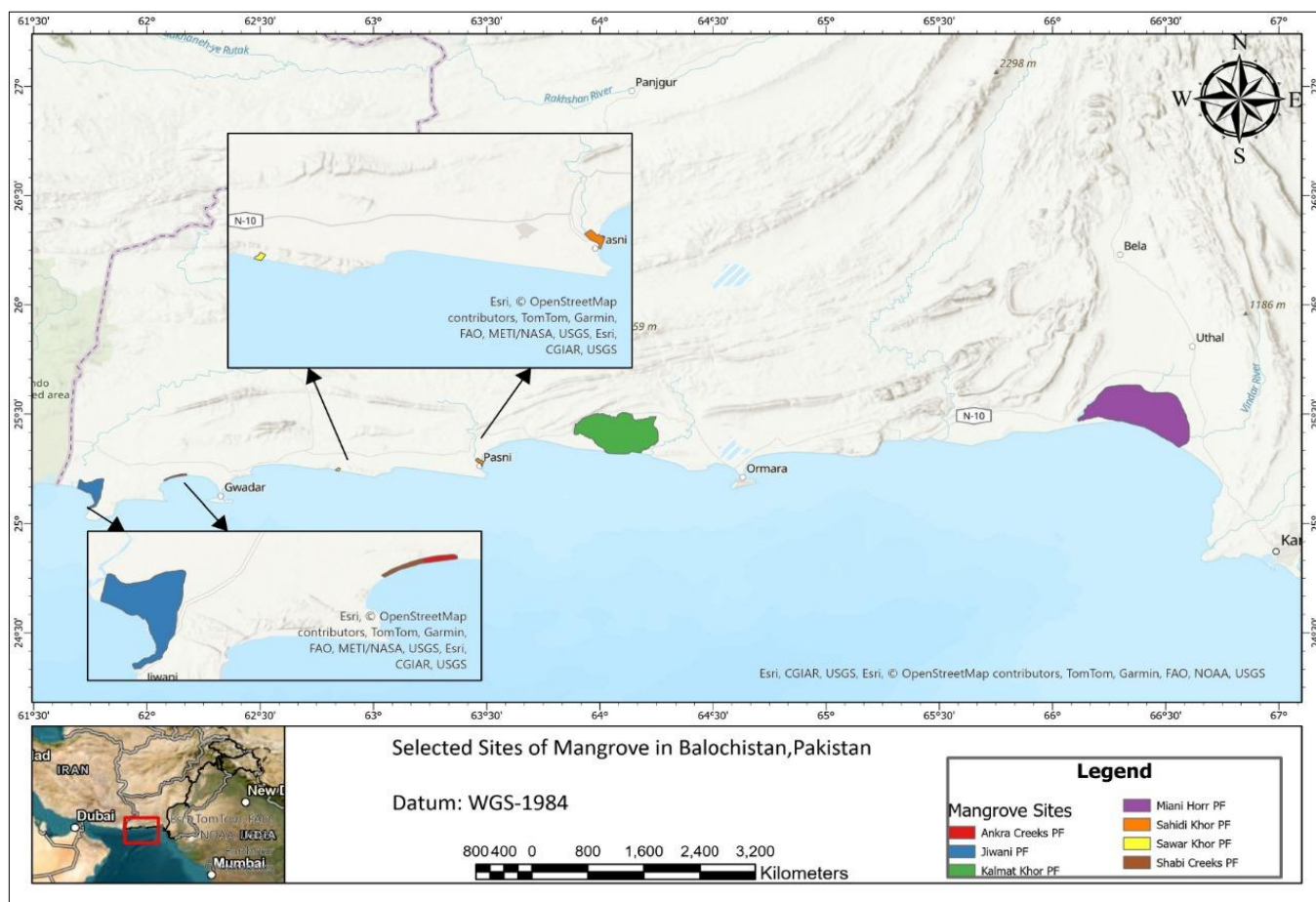


Figure 1 Mangrove Distribution Map (Project Sites)

4.2. HCV I – Species Diversity (Concentration of biodiversity including endangered species and endemic species)

This section discusses the concentration of biodiversity within the project sites, with a particular focus on endangered and endemic species. The mangrove forests provide critical habitat for a variety of flora and fauna, including commercially significant marine species, migratory birds, and vulnerable species such as Olive Ridley and Green Turtles. The assessment highlights the ecological importance of these forests in sustaining biodiversity and the threats posed by habitat degradation.

4.2.1. Floral and Fauna Diversity and Habitat Distribution in Mangrove Ecosystems

Sonmiani Khor, also known as Miani Hor, is a region of exceptional ecological significance in Balochistan, hosting a diverse concentration of mangrove biodiversity. The mangrove vegetation in this coastal lagoon consists primarily of three species: *Avicennia marina* (Forssk.) Vierh, locally known as timmar, which dominates 95% of the area; *Rhizophora mucronata* Lam., referred to as Kumri, covering 4%; and *Ceriops tagal* (Perr.) C. B. Robinson, known locally as Kain, which is present in only 1% of the area. Alongside these mangroves, salt bushes such as

Arthocnemum indicum (Iana) and *Suaeda monica* (garor) are also commonly found, contributing to the unique coastal ecosystem.²³

The mangroves in Sonmiani exhibit a distinct distribution pattern, shaped by environmental conditions and habitat characteristics. *Avicennia marina* is widespread throughout the lagoon, while *Rhizophora mucronata* forms a pure stand in the northeastern part, and *Ceriops tagal* tends to grow in mixed clusters with the other two species. Notably, Sonmiani/Miani Hor is the only location along Pakistan's coastline where all three mangrove species coexist within a restricted area. The ecological distribution of these species varies further within Miani Hor/Sonmiani, influenced by local soil and hydrological conditions. In Bargashi, *Arthocnemum indicum* dominates the shoreline, followed by *Avicennia marina* and *Rhizophora mucronata*, with *Ceriops tagal* appearing further inland. In contrast, in the Gut area, *Avicennia marina* is the primary species along the waterfront, with *Rhizophora mucronata* and *Ceriops tagal* forming a mixed belt further inland. Soil composition plays a key role in this variation, as Bargashi has predominantly muddy soil, whereas Gut has a combination of sandy and muddy conditions.²⁴

Further along the Balochistan coast, Kalamat Khor, located in Gwadar District, represents another important mangrove habitat. Unlike Sonmiani, Kalamat Khor supports only *Avicennia marina* as its dominant species. Although the area lacks the species diversity found in Sonmiani, its ecological uniqueness lies in its isolation from major deltaic influences, making it reliant on freshwater inflows from the Basol River.²⁵

Kalamat Khor	Fish Species
	Mugro, Mushko, Khago, Sua, Pagaas, Paplet, Kunn, Sonaab, Patan

Table 4.2.I Fish Species found in Kalamat Khor ³⁹

Fish Species	10 Years Back (Pieces)	2005
Paplet	200	10
Mushka	300-400	40-50
Chota Mangra	200	20-30
Ghalo	200	Extinct
Kunn	500	100
Sonab	40-50	10
Kaka Torr	100-200	Extinct
Khir Soota	10-15	Extinct

²³ Rasool, F., Tunio, S., Hasnain, S. and Ahmad, E., 2002. Mangrove conservation along the coast of Sonmiani, Balochistan, Pakistan. *Trees*, 16(2), pp.213-217.

²⁴ Hameed-Baloch, A., Haneef-Ur-Rehman, M.S., Kalhor, M.A. and Buzdar, M.A., The Curious Case of Mangroves Forest at the Sonmiani bay Area, Lasbela District, Pakistan: A review.

²⁵ Gilani, H., Naz, H.I., Arshad, M., Nazim, K., Akram, U., Abrar, A. and Asif, M., 2021. Evaluating mangrove conservation and sustainability through spatiotemporal (1990–2020) mangrove cover change analysis in Pakistan. *Estuarine, Coastal and Shelf Science*, 249, p.107128.

Patin	200	50
Pagass	6-7	Extinct
Gerk	20-30	Extinct

Table 4.2.2 Status of Fish Catch Per Boat Fishing Trip in Kalmat Khor ³⁹

Over time, several fish species such as Palwar, Pushant Khar, and Gawana have completely vanished, while others, including Kiddi, Kalri, and Sano, face a serious threat of extinction. Fishermen report a drastic decline in their catch; where they once caught 5000 pieces of Sano fish per trip, they now barely manage to catch 1000.

The decline in fisheries resources is primarily attributed to unsustainable fishing methods and harmful fishing gear. Exploitative techniques, such as small mesh nets, Boolo, Gujo net, plastic, and wire nets, are commonly used by outsiders, who employ modern fishing launches and trawlers. In contrast, local fishermen rely on traditional, less exploitative fishing methods and nets. According to the communities, the large-scale operations of these trawlers enable them to catch in a single day what the local fishermen take a month to achieve.

About a decade ago, the fishermen of Gur Sant village owned approximately 80-90 boats of various sizes. Today, that number has increased to around 150-200 boats, reflecting the growing pressure on the region's fishing resources.³⁹

Another significant mangrove site in Gwadar District is Jiwani, situated within Gwatar Bay. This region is characterized by two major natural habitats—mangrove swamps and sandy beaches. The predominant mangrove species here is *Avicennia marina*, which forms a crucial ecosystem supporting both marine and terrestrial biodiversity. Moreover, WWF-Pakistan have introduced *Rhizophora mucronate* from Miani Hor. ²³

Jiwani was designated as a Ramsar site in 2001, highlighting its ecological importance and its role in protecting endangered species. The area serves as a nesting ground for the Olive Ridley and Green marine turtles, both of which are classified as endangered.²³

Common Name	Scientific Name	IUCN Status
Olive Ridley	<i>Lepidochelys olivacea</i>	Vulnerable (Decreasing)
Green Turtle	<i>Chelonia mydas</i>	Vulnerable (Decreasing)

Table 4.2.3 IUCN Status of Fauna Biodiversity in Jiwani ^{23,26}

²⁶ International Union for Conservation of Nature (IUCN). *The IUCN Red List of Threatened Species: Species in Pakistan*. [online] Available at: <https://www.iucnredlist.org/search?landRegions=PK&searchType=species>

Usage Categories	Fish Species
True Residents	Mudskippers, occupying the mud flats permanently and grey mullets found in meandering channels.
Partial Residents	Grey mullets found in meandering channels, fish eggs and larvae, snappers, groupers, anchovies, half beak glassy perches, pony fish, some clupeids, cat fish etc.
Tidal Visitors	Bottom dwellers such as flat fish and flatheads, bottom feeders such as rays, skates, stone fish and scorpion fish.
Seasonal Visitors	Mugilids, some percoids and clupeids, sardinellas.

Table 4.2.4 Fish Species found in Jiwani ²⁷

Beside these natural stands IUCN also planted *Avicennia marina* and *Rhizophora mucronata* in Shadi Khor Basin and Ankara area of Gwadar district during last decade. The survival rate of *Avicennia marina* is comparatively higher then *Rhizophora mucronata* in these naturalized stands.²²

4.2.1.1 Avian Biodiversity

Beyond mangroves, Miani Hor and Jiwani are rated by ornithologists as the most important sites for migratory and resident birds.²⁸ More than 20,000 birds, representing 52 species, visit Sonmiani/Miani Hor during the winter season. Some of the commonly sighted bird species include grebes, pelicans, cormorants, flamingos, egrets, herons, storks, ibises, spoonbills, cranes, coots, shorebirds (waders), gulls, and terns. The presence of such a diverse avian population highlights the ecological importance of Sonmiani as a key habitat for biodiversity conservation.²⁸

Common Name	Scientific Name	IUCN Status
Common Teal	<i>Anas crecca</i>	Least Concerned (Unknown)
Lesser Flamingo	<i>Phoenicopterus minor</i>	Near Threatened (Decreasing)
Greater Flamingo	<i>Phoenicopterus roseus</i>	Least Concerned (Increasing)
Painted Stork	<i>Mycteria leucocephala</i>	Least Concerned (Increasing)
Sarus Crane	<i>Grus antigone</i>	Vulnerable (Decreasing)
Common Coot	<i>Fulica atra</i>	Least Concerned (Increasing)
Black-headed Ibis	<i>Threskiornis melanocephala</i>	Least Concerned (Increasing)
Little Heron	<i>Butorides striata</i>	Least Concerned (Unknown)

²⁷ Rasool, F., 2016. Gwatar Bay: A potential site for trans-boundary marine protected area between Iran and Pakistan. [pdf] Available at: https://www.researchgate.net/profile/Fayyaz-Rasool-2/publication/292144428_Gwatar_Bay_A_potential_site_for_trans_boundary_marine_protected_area_between_Iran_and_Pakistan/links/56aa31ce08aeb4cefaef69/Gwatar-Bay-A-potential-site-for-trans-boundary-marine-protected-area-between-Iran-and-Pakistan.pdf

²⁸ Amjad, A.S. and Jusoff, K., 2007. Mangrove conservation through community participation in Pakistan: the case of Sonmiani Bay. *Int J Syst Appl Eng Dev*, 1(4), pp.75-81

Indian Pond Heron	<i>Ardeola grayii</i>	Least Concerned (Unknown)
Grey Heron	<i>Ardea cinerea</i>	Least Concerned (Unknown)
Great Egret	<i>Egretta albus</i>	Least Concerned (Unknown)
Little Egret	<i>Egretta garzetta</i>	Least Concerned (Increasing)
Eurasian Spoonbill	<i>Platalea leucorodia</i>	Least Concerned (Unknown)
Eurasian Coot	<i>Fulica atra</i>	Least Concerned (Increasing)
Great white Pelican	<i>Pelecanus onocrotalus</i>	Least Concerned (Unknown)

Table 4.2.7 IUCN Status of Migratory Species in Sonmiani Mangroves ²⁴

Common Name	Scientific Name	IUCN Status
Little Cormorant	<i>Phalacrocorax niger</i>	Least Concerned (Unknown)
Darter	<i>Anhinga melanogaster</i>	Least Concerned (Increasing)
Little Egret	<i>Egretta garzetta</i>	Least Concerned (Increasing)
Reef Heron	<i>Egretta sacra</i>	Least Concerned (Stable)
White Spoonbill	<i>Platalea leucorodia</i>	Least Concerned (Unknown)
Common Sandpiper	<i>Actitis hypoleucos</i>	Least Concerned (Decreasing)

Table 4.2.8 IUCN Status of Migratory Species in Jiwani Mangroves ²⁵

Mid-winter waterbirds count was made on two wetlands viz. Jiwani mangroves. Mid-winter waterbird counts made during the month of January, every year on two wetlands of Jiwani reveal that the population on the coastal wetland is stable and there is not much difference. About 4000 waterbirds use the area during the migratory season.²⁹

As mangroves expand, they gradually take over open coastal areas such as mudflats and shallow wetlands, which are essential feeding and resting grounds for migratory wading birds. These birds rely on exposed, soft surfaces to find food like small fish, insects, and crustaceans. However, as mangroves grow, they create dense root systems and raise the land level, reducing the availability of these open, shallow waters. This habitat loss makes it harder for birds to find food and suitable resting areas during their long migrations. While mangroves provide important environmental benefits, such as coastal protection and carbon storage, their unchecked expansion can unintentionally disrupt the delicate balance of coastal ecosystems, particularly for species that depend on open wetland areas. Therefore,

²⁹ Pandrani, A.T.T.A.U.L.L.A.H., Hasnain, S.A., Ghalib, S.A. and Ahmad, E.J.A.Z., 2005. Observations on the Waterbirds of Jiwani Wetland Complex, Makran Coast (Balochistan). *PAKISTAN JOURNAL OF ZOOLOGY*, 37(4), p.301.

conservation efforts should consider both the protection of mangroves and the preservation of key habitats for migratory birds.²⁵

4.3. HCV 2 – Landscape-level Ecosystems and Mosaics

This section explores the role of mangrove forests as landscape-level ecosystems within the project sites. These ecosystems function as interconnected natural mosaics, providing essential ecological services such as coastal protection, nursery grounds for marine life, and habitat connectivity. The assessment emphasizes the significance of these forests in stabilizing the coastal environment and mitigating the impacts of rising sea levels and extreme weather events

Mangrove forests in Balochistan represent landscape-level ecosystems, providing critical habitat mosaics that support diverse biodiversity and ecosystem functions. These coastal ecosystems are found in intertidal, estuarine, oceanic, and deltaic zones, where salinity levels are high. However, mangroves are not true halophytes; they are classified as facultative halophytes, meaning they can thrive in brackish conditions but do not necessarily require them for survival. Studies indicate that the optimal growth rate of *Avicennia marina* and *Rhizophora mucronata* occurs at 50% seawater concentrations, compared to both lower and higher salinity levels.²² Their ability to tolerate a broad salinity range, from freshwater to brackish environments, makes them a key component of landscape-level ecological mosaics in coastal Balochistan.

Balochistan's coastal landscape falls under the subtropical coastline or arid marine region of Pakistan. It is further classified as a subtropical maritime desert, characterized by bays, lagoons, alluvial plains, deltas, mudflats, rocky shores, sandy beaches, sea cliffs, beach ridges, and marine terraces.²¹ These diverse landscape features shape the distribution of mangrove ecosystems, forming mosaics of interconnected habitats essential for biodiversity conservation, fisheries, and coastal protection.

One of the most ecologically significant mangrove sites is Sonmiani Khor, where mangrove populations thrive on both northern and southern shores. These forests are classified into three density levels: dense, medium, and sparse, creating a heterogeneous ecosystem that supports diverse species. Dense and medium stands are typically surrounded by sparse mangroves, except along water edges, where the vegetation is most concentrated. The total mangrove cover in Sonmiani Khor is 2,500 hectares, with 460 hectares of dense mangroves, 840 hectares of medium cover, and 1,200 hectares of sparse mangroves. The northeastern

part of the lagoon is characterized by pure patches of *Rhizophora mucronata*, while *Avicennia marina* occurs throughout the Hor. *Ceriops tagal* does not form pure stands but is found mixed with other species, mainly towards the western part of the bay. The largest mangrove patches in Sonmiani Hor are concentrated along the northern shoreline, nourished by freshwater inflows from the Porali River.²¹

The mangrove ecosystem of Kalamat Khor presents a unique landscape within the Balochistan coastal mosaic. It differs from other mangrove stands in Pakistan due to its isolated nature and arid climatic conditions, with no deltaic influence. The Basol River historically provided freshwater inflows, sustaining the mangrove stands.²² However, geological changes have altered the river's course, forcing the mangroves to rely on small nullahs from the surrounding hills for freshwater supply. Despite these constraints, WWF-Pakistan's 2005 study reported a significant increase in mangrove cover, reflecting the resilience of the ecosystem and the role of conservation efforts in maintaining these landscapes.²²

Further west, Jiwani (Gwatar Bay) forms another crucial mangrove landscape, offering two major natural habitats: mangrove swamps and sandy beaches. This site supports *Avicennia marina* as the dominant species and plays an essential role in marine biodiversity conservation. Jiwani was designated as a Ramsar site in 2001, highlighting its importance in protecting coastal and marine ecosystems.²⁰ It also serves as a nesting ground for the Olive Ridley and Green marine turtles, both of which are endangered species. However, the construction of the Mirani Dam has significantly reduced freshwater inflows from the Dasht River, leading to habitat degradation and impacting the long-term sustainability of Jiwani's mangrove forests.²²

These landscape-level mangrove ecosystems—Sonmiani Hor, Kalamat Khor, and Jiwani—are integral to the ecological integrity of Balochistan's coastal region. They function as habitat mosaics that support diverse marine and terrestrial species, protect coastal zones from erosion, and sustain local livelihoods. However, their future depends on sustained conservation efforts, freshwater availability, and adaptive management strategies to ensure long-term ecosystem resilience.

4.4. HCV 3 – Ecosystems and Habitats (Rare, threatened, or endangered ecosystems, habitats, or refugia)

This section examines the status of rare, threatened, and endangered ecosystems within the project sites. Changes in mangrove cover over time, influenced by both natural and anthropogenic factors, are analyzed to assess habitat stability and vulnerability. The study

identifies key conservation areas that require urgent intervention to prevent further degradation and ensure the long-term sustainability of these critical ecosystems.

The status of Pakistan's mangrove cover was declared to be "protected forest" under Pakistan Forest Act 1927.⁹ The mangrove ecosystems of Balochistan have undergone significant changes over the years. Satellite data and ground surveys have revealed fluctuations in mangrove cover, with periods of decline caused by deforestation, sand deposition, and freshwater shortages, followed by phases of recovery due to conservation efforts. The region has experienced a combination of habitat destruction due to human activity and natural resilience where mangrove regrowth has been observed.²²

The temporal variations in mangrove cover across these sites have been influenced by multiple factors. The ecological distribution of mangroves in Sonmiani/Miani Hor was first reported in 1980, highlighting the role of natural and anthropogenic factors in shaping the region's mangrove landscape. Human exploitation has significantly influenced this distribution pattern, particularly in the Bargashi area, where local communities harvest timber from *Rhizophora mucronata* for fuel and fodder. Additionally, the bark of *Rhizophora mucronata* is traditionally used for dyeing fishnets, further impacting its population. In contrast, the Gut area remains relatively inaccessible due to high tides, allowing *Rhizophora mucronata* to establish dominant stands, whereas *Avicennia marina* is more widespread. ²² Over the past four decades, the precipitation patterns in coastal Balochistan have significantly changed, affecting the hydrology of Sonmiani/Miani Hor. The Porali and Windar Rivers, once the primary freshwater sources, have transformed into seasonal sand rivers, depriving the mangroves of critical freshwater input. This lack of freshwater has accelerated the deposition of sand and silt in mangrove-growing areas, resulting in habitat degradation and reduced marine water exchange, further challenging the sustainability of these forests. ²²

A spatial and temporal analysis conducted in 2005 using Terra and Landsat satellite images by the GIS Lab at WWF-Pakistan, Lahore, revealed the impacts of natural and human-induced pressures on the mangrove ecosystems of Sonmiani Bay and Kalamat Hor. Comparing satellite images with ground reconnaissance surveys of the north-eastern part of Sonmiani Hor, researchers observed encroachment by halophytes and dead algae, replacing previous mangrove coverage. Similar patterns were documented in the western part of the bay, where sparse halophytes and algal growth were overtaking mangrove-dominated zones.²²

In 1989, the total mangrove cover in Sonmiani Bay was estimated at 2,546 hectares, categorized as dense mangrove cover (551 ha, 21.6%), medium mangrove cover (749 ha, 29.4%), and sparse mangrove cover (1,246 ha, 49%). That same year, algal encroachment in Sonmiani Bay was measured at 2,293 hectares, compared to halophyte coverage of 357 hectares. By 2001, the mangrove canopy cover had expanded to 3,716 hectares, primarily due to plantation efforts by IUCN and other governmental and non-governmental agencies. The new distribution was dense mangrove cover (1,281 ha, 34.5%), medium cover (1,133 ha, 30.5%), and sparse cover (1,302 ha, 35%). Algal encroachment declined significantly, shrinking to 637 hectares along the outer peripheries and 972 hectares in the western parts of Miani Hor, reflecting a negative correlation between mangrove expansion and algal encroachment.²²

Satellite imagery of Sonmiani revealed that the largest patches of mangrove forests were concentrated along the northern shore of the lagoon, fed by the Porali River. However, due to anthropogenic activities, water from the Porali River is now diverted upstream for agricultural purposes, leading to a drastic reduction in freshwater availability for the mangrove ecosystem. Despite these constraints, Sonmiani Bay remains a natural stronghold for mangroves due to its swampy soil, which serves as a natural barrier against excessive human intervention. ²²

In 2000, the mangrove forests of Sonmiani Hor faced an unprecedented threat from "biological smugglers," who illegally transported thousands of *Rhizophora mucronata* propagules from Sonmiani/Miani Hor to the Indus Delta and the Middle East for reforestation projects. This illegal trade not only depleted the seed banks of these vulnerable species but also negatively impacted the reproductive potential of *Rhizophora mucronata* in Miani Hor, one of Pakistan's most unique mangrove habitats.²²

In Kalamat Khor, mangrove forests have undergone major changes over time. In 1990, the mangrove cover was 3.78 km², but by 1995, it had declined to 2.77 km², reflecting habitat loss and hydrological changes. On the other hand, Jiwani (Gwatar Bay) currently supports 4.64 km² of mangrove cover.

The Jiwani site was also listed as a Ramsar site in 2001, highlighting its significance in supporting endangered wildlife. The area serves as a nesting ground for endangered turtles, as noted in Table 03. However, the construction of the Mirani Dam has reduced freshwater inflows from the Dasht River, adversely affecting mangrove health. The total mangrove cover in Jiwani currently stands at approximately 4.64 km² (See Deliverable 2. Technical Feasibility and Annex A), and is noted to have an annual growth rate of 3.39%.

The Land Use Land Cover (LULC) analysis of Balochistan's mangroves further emphasizes transformations in key coastal sites, including Jiwani (Gwadar), Shabi & Ankara Creeks, Sawar Khor, Sahidi Khor, Kalamat Hor, and Miani Hor. Satellite analysis from 2016–2023 identified areas of mangrove gain (green), mangrove loss (red), and stable zones (gray).³⁰

- Sahidi Khor and Shabi & Ankara Creeks have seen substantial mangrove expansion, largely due to natural regeneration and limited human interference.
- Kalamat Hor and Sawar Khor have maintained moderate stability, indicating a balance between natural growth and environmental stressors.
- Jiwani (Gwadar) and Miani Hor exhibit patches of mangrove loss, primarily due to coastal erosion, rising sea levels, and land encroachment related to fishing activities.³⁰

³⁰ Raza, S.A., Zhang, L., Zuo, J. and Chen, B., 2024. Time series monitoring and analysis of Pakistan's mangrove using Sentinel-2 data. *Frontiers in Environmental Science*, 12, p.1416450.

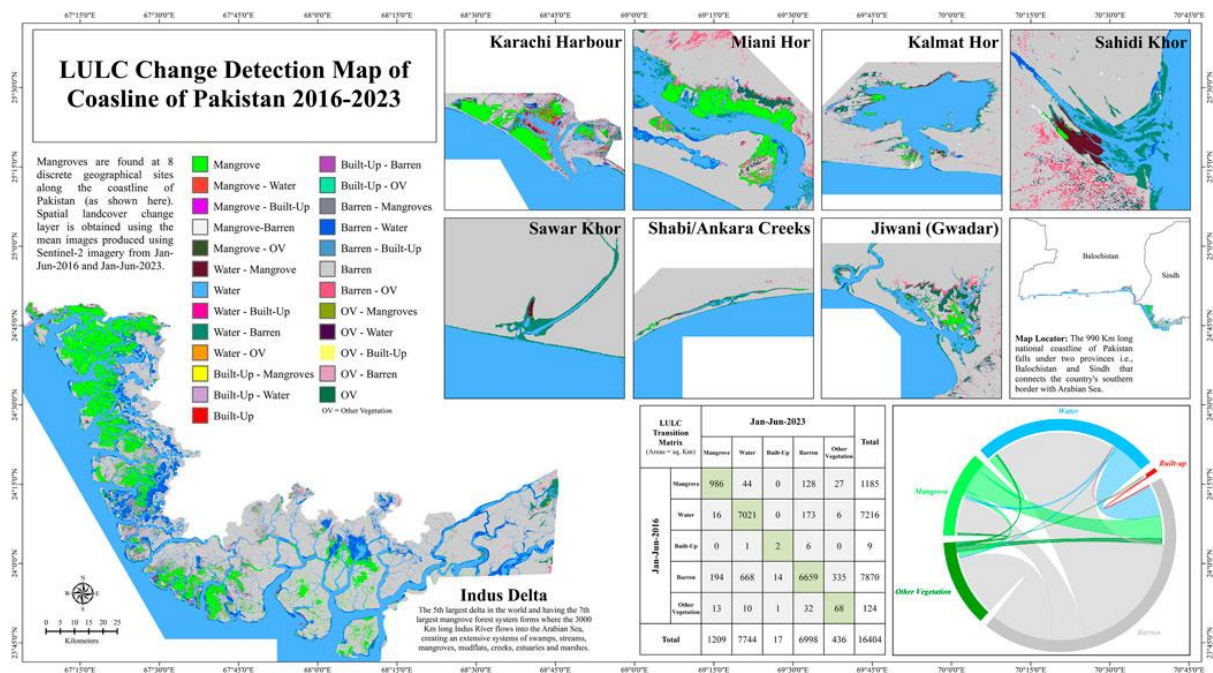


Figure 01: The LULC transition matrix further quantifies mangrove land use changes, revealing that some areas have been converted into water bodies, other vegetation, and even built-up areas. These findings highlight the urgent need for targeted conservation strategies to protect vulnerable mangrove habitats and promote natural mangrove regeneration in Balochistan's coastal ecosystems. (Extracted from: Raza et al., 2024)

A detailed analysis using Sen's slope estimation classified the mangrove NDVI trends into four categories—significantly increasing (0.1–1), weakly increasing (0–0.1), weakly decreasing (0 to -0.1), and significantly decreasing (-0.1 to -1)—to assess the health and extent of mangrove forests in Balochistan. Notably, Sahidi Khor and Shabi & Ankara Creeks show significantly increasing trends, reflecting healthy growth and expansion likely supported by minimal human disturbance and robust natural regeneration. In contrast, Kalamat Hor and Sawar Khor exhibit weakly increasing trends, indicating stable ecosystems with moderate growth over time. However, Jiwani (Gwadar) stands out as an area experiencing both weak and significant declines, with patches of mangrove loss potentially driven by coastal erosion, rising sea levels, and localized human activities. These findings underscore that while several regions are thriving, targeted conservation efforts are necessary in Jiwani to prevent further degradation and ensure the long-term sustainability of these critical coastal ecosystems.²⁸

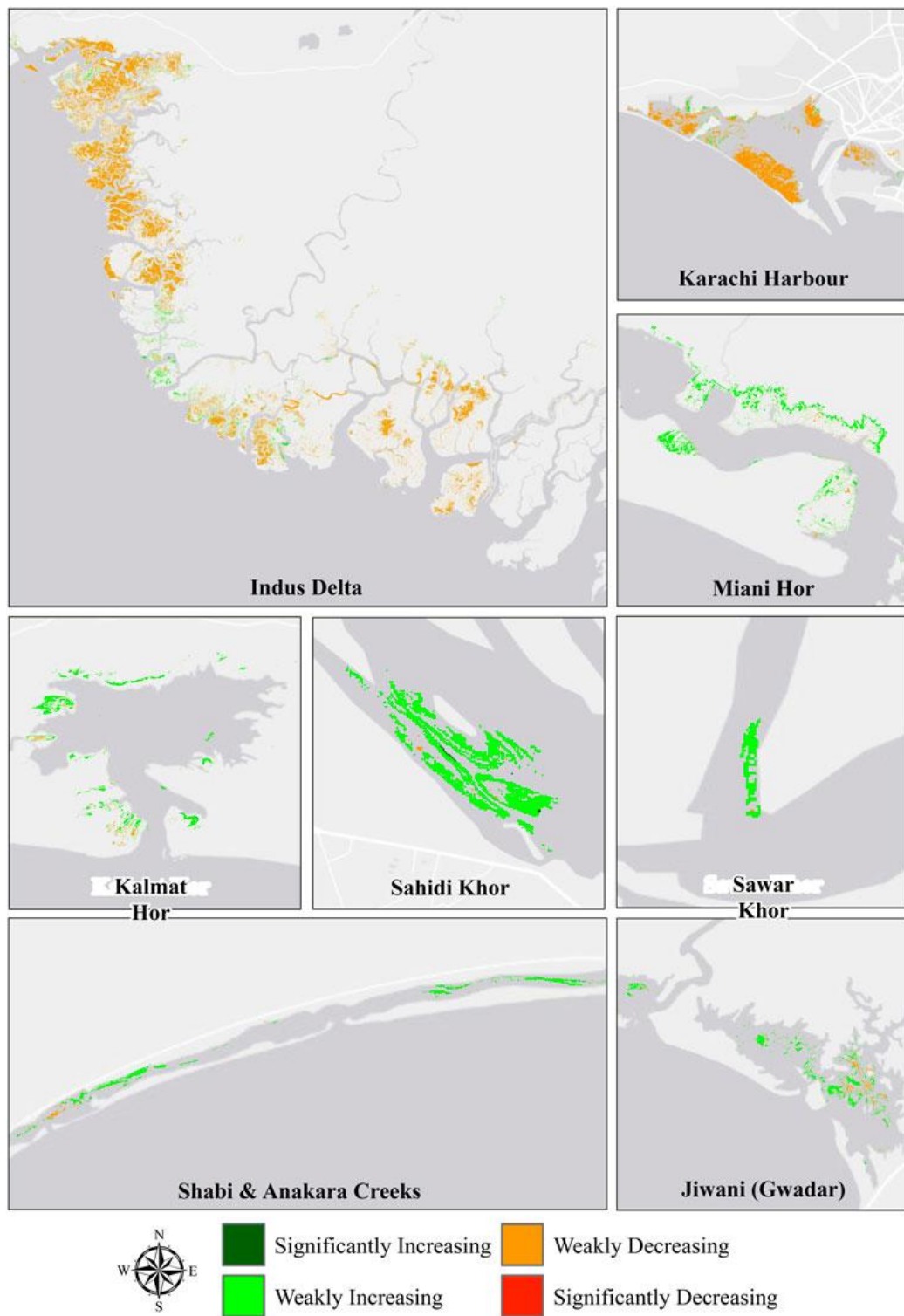


Figure 02: NDVI of Project Sites (Extracted from: Raza et al., 2024)

In Miani Hor and Jiwani, the unsustainable exploitation of mangroves has been identified as a major threat to the ecosystem. Coastal erosion, illegal poaching of turtle eggs, and hunting for shells pose significant risks to these endangered reptiles. Additionally, the unauthorized

sale of coastal land for commercial development in Jiwani further endangers ecologically sensitive coastal areas.³¹

4.5. HCV 4 – Ecosystem Services: Watershed Protection and Erosion Control

This section highlights the vital role of mangrove forests in providing essential ecosystem services such as water regulation, flood control, and soil stabilization. These forests act as natural barriers against storm surges and coastal erosion, helping to protect local communities from environmental hazards. The hydrological assessment of key mangrove sites evaluates the impact of freshwater availability and changing climatic conditions on the health of these ecosystems.

The ability of mangroves, colloquially known as "*timar*," to sequester carbon—by absorbing carbon dioxide from the atmosphere and storing it as biomass in the soil—is 18 times greater than that of other trees. This remarkable capacity not only highlights the role of mangroves in climate regulation but also underscores their importance as a natural solution for mitigating greenhouse gas emissions.²³

Consequently, mangrove forests rank among the most productive ecosystems on Earth. They are vital for both climate change mitigation and adaptation, acting as natural fortresses that provide essential protection against tsunamis and cyclones. Moreover, by buffering against sea intrusion and soil erosion, mangroves help maintain the cleanliness of creeks and water channels, thereby safeguarding coastal environments.²³

Mangroves, as one of the most productive and diverse ecosystems on Earth, play a crucial role in preventing floods that could affect 39% more people annually if they were absent.

In addition to their climate and coastal protection functions, mangroves play a crucial role in the water cycle. Like other wetlands, they absorb excess water during flood events, reducing the potential impact of flooding. Notably, the primary productivity of mangroves in deltaic areas is seven times higher than in coastal regions without them, emphasizing their significance in sustaining ecological balance and supporting vital ecosystem services.²³

The prop roots of *Rhizophora mucronata* provide support for a wide range of organisms and contribute to the biodiversity of the region. The species helps stabilize the coastal environment in Balochistan, particularly in Sonmiani, where it aids in protecting the coastline from erosion. Mangrove forests in Balochistan, especially in areas like Sonmiani, are crucial for

³¹ Ullah, Z., Jehangir, M. and Iqbal, J., 2016. Potential for Community Based Ecotourism (CBE) along Balochistan Coast, Pakistan. *Global Regional Review*, 1(1), pp.178-192.

coastal stabilization and for maintaining ecosystem services that benefit both local communities and wildlife.³²

4.5.1. HYDROLOGICAL ASSESMENT OF MANGROVE SITES

Mangrove development is best in areas that have significant freshwater run-off. Although the freshwater requirement of mangroves has not been established scientifically, one estimate prepared by Sindh Forest Department suggests that an average flow of 1 cusec (28 liters/second) of fresh water for each 100 acres is required for healthy growth. However, it is unclear whether this is a constant need throughout the year or whether occasional supplies, as might be expected during large natural riverine floods, are sufficient. Based on the estimated water requirement per unit of land and the Landsat estimates on area under mangrove cover together with area under mudflats (land that is potentially suitable for mangroves), the annual requirement for fresh water is about 6.8 maf.³³

The coastal areas of the country lack basic amenities such as drinking water, fuel sources, and road infrastructure. Over time, the coastal population has grown as a result of increased returns from fishing, despite the poor physical infrastructure. Consequently, the demand for fresh water for household consumption has increased several fold. Local authorities have not assessed the household demand for water, causing the meager water supplies from seasonal rivers on the Baluchistan Coast, in particular, to be under pressure due to population growth.³³

The hydrological assessment of Sonmiani Khor reveals that out of a total area of 830 km², 42.80 km² (5.16%) was covered by mangroves in 2020. The area receives freshwater from the seasonal run-off rivers, Porali and Windor, which only flood approximately once every five years.²⁵ However, significant changes in the precipitation pattern since the late 20th century have led to the transformation of these rivers into sand channels, drastically reducing freshwater inflow into the mangrove ecosystem. This has resulted in constant deposition of sand and silt in the mangrove-growing areas, depriving the forests of marine water access. Additionally, anthropogenic activities such as upstream water diversion for agriculture have further reduced the freshwater supply to Sonmiani Khor. Despite these limitations, the swampy soil in this area serves as a natural buffer against human interference, allowing the

³² Khan, D., Zaki, M.J. and Ali, S.V., 2021. Brief notes on the mangrove species *Rhizophora mucronata* Lam. (Rhizophoraceae) of Pakistan with special reference to sapling and leaf. *International Journal of Biology and Biotechnology*, 18(1), pp.197-218.

³³ WWF-Pakistan (n.d) *Forest, mangroves and resource conservation in Pakistan*. Available at: https://www.wwf.org.pk/pdf/forest_mangrove_rcpakistan.pdf

mangroves to persist. 45-50 ppt is unfavorable for the growth of most of the mangrove species. Salinity levels in the region range between 40-42 ppt, which is within the tolerance limit of *Avicennia marina* but can still induce stress over prolonged exposure, leading to slower growth and reduced productivity.²⁴

Kalamat Khor, a significant coastal wetland in Balochistan, spans an area of only 9.33 km² (1.67%) covered by mangroves in 2020.²⁴ The area is characterized by extensive mudflats that dominate the lagoon. These mudflats remain submerged under shallow water during high tides, influencing the hydrodynamics of the region. The Basol River, located 15 km east of Kalamat Khor, is the nearest freshwater source, but its contribution to the lagoon's water balance is minimal. However, due to a geological activity in 2005 altered the river's course, cutting off direct freshwater supply to the mangroves. Instead, the ecosystem now relies on several small seasonal streams (nullahs) originating from surrounding hills.²⁴ The continental shelf facing Kalamat Khor is narrow, measuring only 40 km in width, and Astola Island lies approximately 30 km offshore, further shaping the marine hydrology of the area.

The Balochistan coastline experiences an arid maritime desert climate, characterized by high temperatures throughout the year. During the summer months, temperatures exceed 30°C, while the winter season brings only a slight drop. The water pH remains alkaline, and dissolved oxygen concentrations reach approximately 4.0 mg/L. The soil composition of Kalamat Khor is rich in clay and silt (mud), with high organic matter content, which affects water retention, sediment transport, and nutrient cycling within the ecosystem.³⁴

Kalamat Khor receives little to no freshwater runoff from the mainland, leading to hypersalinity in the lagoon, with salinity levels ranging between 40-41 ppt.²⁴ This high salinity poses osmotic stress on mangroves, making water absorption challenging and potentially reducing seed germination and growth rates. The absence of freshwater inflows has directly impacted the mangrove ecosystem, where only one species, *Avicennia marina*, is found. The high salinity levels have resulted in the dwarf growth of mangroves, with an average height of 2 meters and a dominant diameter at breast height (DBH) between 10-15 cm. The lack of freshwater discharge means that tidal action is the primary hydrological driver in the area, controlling nutrient exchange, sediment deposition, and water circulation.³⁴

³⁴ Rasool, F. & Saifullah, S.M., 1996. Mangroves of Kalamat Khor, Balochistan. *Pakistan Journal of Botany*. Available at: <https://www.researchgate.net/publication/258846174>

Additionally, high rates of sedimentation and siltation are observed in the lagoon, originating from surrounding hills. During sporadic rainfall events, eroded sediments are transported into the lagoon, altering the water quality, increasing turbidity, and affecting mangrove regeneration.³⁴

The mangrove stand of Kalamat Khor is unique along the entire Pakistani coast due to its complete isolation from significant freshwater inputs and exposure to harsh climatic conditions. The absence of riverine discharge makes it comparable to mangrove ecosystems in the Red Sea, where extreme aridity and hypersalinity shape coastal vegetation. The hydrological limitations of Kalamat Khor, coupled with ongoing anthropogenic disturbances, pose significant challenges for mangrove conservation and sustainability in the region.³⁴

Jiwani encompasses 80 km², with mangrove coverage accounting for only 2.23 km² (2.79%) in 2020. Over the last 30 years, the area has never developed medium (1–2 km²) or large (>2 km²) mangrove forests, but small patches (<1 km²) have expanded from 0.15 km² in 1990 to 1.09 km² in 2020.²⁵ Mangrove forests require freshwater and silt for their long-term sustainability, growth, and propagation. Freshwater plays a crucial role in reducing the salinity of marine water, which is essential for the healthy growth of mangrove plants. Additionally, mud and silt provide a stable platform and supply necessary nutrients for the proper propagation of seedlings and mature plants.³⁵

The Jiwani mangroves primarily depend on the Dasht River, the largest seasonal river in Balochistan, as their main freshwater source. Before the construction of the Mirani Dam on the Dasht River, uninterrupted freshwater discharges from the river sustained the Jiwani mangroves, ensuring their growth and sustainability. However, the construction of the dam has altered the natural water flow, potentially impacting the freshwater availability to the mangroves.¹⁸

Additionally, high silt content in the water has further reduced freshwater and nutrient availability, intensifying stress on the trees. Jiwani's mangroves experience salinity levels of 40–42 ppt, which can result in leaf shedding, stunted root development, and overall weakening of the ecosystem. If these conditions persist, the less salt-tolerant species may experience dieback, compromising the long-term stability of the mangroves in this region.²⁴

³⁵ Akhtar, M.M., Mohammad, A.D., Ehsan, M., Akhtar, R., Rehman, J.U. & Manzoor, Z., 2021. Water resources of Balochistan, Pakistan—a review. *Arabian Journal of Geosciences*, 14:289. DOI: [10.1007/s12517-021-06502-y](https://doi.org/10.1007/s12517-021-06502-y).

4.6. HCV 5 – Meeting Basic Needs of Local Communities (Subsistence, Health, and Livelihoods)

A social survey conducted by the WWF in 1998 revealed that the majority of the local population in Dam and Sonmiani belongs to the Lassi Baloch tribe. Although the land is owned by the Revenue Department of the Government of Balochistan, long-established coastal dwellers feel a strong claim over the coastal strip.²¹

Different kinds of fish and shrimp species are found in the coastal waters of Sonmiani as well as Dam Bunder. The major fish species, according to local communities, are *Loor*, *Mor Manger*, *Bhanbhor*, *Dandiyoan*, *Mushkan*, *Ghore*, *Khaga*, *Paplet*, *Chodi* and others while the shrimp species including *Patas*, *Jairo*, *Kiddi* and *Kaket*.²⁵

The fishing season starts from month of August and continues up to the mid of March while in June and July the fishing is off due to high tides in the sea and official breeding season ban. In summer season as the sea is closed for fishing due to high tides, the fishermen catch different kinds of crabs including Blue and Red Crab.²⁵

According to the locals there are three species of mangroves in Maini Hore area. They are locally known as *Timar*, *Kumri* and *Kain*. The local communities say that out of these species *Avicennia marina* (*Timar*) is not facing severe decreases, as there is little pressure of cutting and chopping on this species. Its fodder is nutrient for the cattle; therefore communities' prefer to use it as fodder. However, the *Rhizophoras mucronata* (*Kumri*) species is certainly on decline. It is because the *Kumri* wood is straight and is used in building houses etc. Similarly, *Ceriops tagal* (*Kain*) is also on decline due to cutting and browsing by the animals especially camels, belonging to Layari, Bhira and other villages.³⁶

In these three villages, 90–95% of the residents depend on fisheries for their livelihood, with the average household earning about 3,000 rupees per month (approximately US \$48). Mangroves are integral to the local economy, serving as a source of fuel, fodder, and materials for constructing thatched huts. The pressure on mangroves varies among species: while the leaves of *A. marina* are lopped for stall feeding—preferred by cattle due to their lower tannin content—the stems of *R. mucronata* and *C. tagal* are harvested for roof construction. During the fishing season (September–April), about 10,000 people migrate into the area from both the uplands and neighboring countries such as Bangladesh, Myanmar, and Afghanistan, and

³⁶ Brohi, S., Hasnain, S.A., Soomro, I., Rasool, F., Siddiqui, F.A., Jamali, H.K., Malah, W., Mahar, U., Maznani, H., Kiani, S., Jatoi, F., Bhatti, R., & Shaikh, S. (2005). Sonmiani Participatory Learning and Action (PLA) Report. WWF-Pakistan. Retrieved from https://www.wwf.org.pk/pdf/tp_kap_sonmiani.pdf

many of these migrants cut mangrove trees for fuel. In Bhira, 85% of residents are dependent on mangroves compared to 50% in the other two villages, a difference largely attributed to Bhira's remoteness. Additionally, the Bhira community rears camels (typically two to three per household) that mainly graze on mangroves, while residents of the other villages cut large stems of *A. marina* to support their boats, owing to the lack of proper jetties.²¹

In Sonmiani, where the local population is primarily engaged in fisheries during the season from August to May, the demand for mangroves as firewood is relatively low. This is because the main mangrove stands are located 2–3 km away from the villages, and a natural lagoon barrier further prevents easy access, making mangrove wood more expensive. Consequently, locals prefer using the more affordable wood of *Prosopis juliflora* (locally known as devi).²²

Local community members harvest small timber for boat making or other implements from the Mangrove forests of Miani Hor area. However, this practice is not prevalent on largescale. Balochistan Forest and Wildlife Department discourages this kind of practices. No commercial timber is extracted from Mangrove forests. Local community members sometime harvest dead, dry and fallen wood for fuel wood. However, this practice is also not prevalent on larger scale. In some areas of Mangrove forests that are close to the land, camels browse upon the trees, otherwise no grazing has been reported in these forests. However, community members do harvest Mangrove leaves from these forests for feeding to the camels and goats. Only leaves and succulent branches are harvested by local community members for feeding to their camels and goats. As such no grass is available in Mangrove forests. Local community members are using the Mangrove area for fishing. Damb and Sonmiani are very famous areas for fishing.

The preferred fuel-wood is *Devi* (mesquite), which is available at a much cheaper rate from vendors, as well as being freely available in the surrounding areas. According to villagers, the price of a maund of mangrove wood ranges between Rs. 100 -130, while the price of *Devi* ranges between Rs. 45 and 60 per maund (depending on season). Unsurprisingly, 45% of the households use *Devi* as fuel-wood, while coal (30 %), kerosene oil (5%), and LPG (20%) are also used as fuel by the better-off households. There are a few extremely poor households that use mangrove wood as fuel, collecting it on fishing trips. In total there are 40-50 house

holds (3% of total population) in the whole village that use mangrove wood for fuel and this amounts to approximately 70-80 maunds per month.³⁷

Fishing remains the predominant occupation for about 90% of the local people, with only a few employed in government sectors (such as fisheries, electricity, and education) or trade. To better understand the dynamics of overharvesting mangroves and fish resources, a household survey was carried out in the Indus Delta and Baluchistan Coast. In Baluchistan, 22% of the 73 surveyed households reported using mangroves, and overall, 37% of the 198 households indicated that they used mangrove wood, with usage for fuel decreasing as the distance from mangrove forests increases.¹¹

The total area of the village is 125.5 km². Mangrove forests are found abundantly in the village. The total area covered by mangrove in the village is about 3,000 ha in which 25 percentage of the area is occupied by mangrove forests while remaining area is barren and have water. There are 171 households in the village with a population of 1300. Most of population in the village is poor. Their main occupation is fishing and about 90 percent of people depend on fishing for their livelihood. Mangrove forests are in the coastal area of the village which provide the breeding ground for fishing and also use as a fence, fodder and fire wood. Three species of mangrove *Avicennia marina* locally called Timmer, *Rhizophoras mucronata* local name Kumri and *Ceriops tagal* locally called Kain are found in village. In these three species the *Avicennia marina* is most dominant plant and it occupies 95 percent of the area in the village, however *Rhizophoras mucronata* is found 4 percent and *Ceriops tagal* is in 1 percent. While some bushes and wild trees are also present in the village such as *Arthocnennum Indicum* (Lana) and *Suaeda Monia* locally called Garor. According to local community in the village that mangrove forests are being declined because of over harvesting. Such as the *Avicennia marina* is usually used as a fodder of animal so not harvested by local people at large extent. While the Kumri plant has straight wood used mostly for building house, framing of roof and for fences. So this type of plant is chopped by people largely. The Kain plant is also declining because the local community livestock used to graze this plant and also in the village Bhira every household has a camel who brows the plant.²⁶

Many type of fish and shrimp species found in the mangrove forests. According to local communities the main species of fish found in the Miani Hor , Sonmiani, Damb and village Bhira are *Dannthi*, *Giser*, *Goli*, *Suwa*, *Sisery*, *Ladyfish*, *Safaid paplet*, *Kiddi*, *Pitas*, *Taira*, *Tikori*, *Jelly*

³⁷ Adhikari, B., Baig, S.P. and Ifthikhar, U.A., 2010. The use and management of mangrove ecosystems in Pakistan. *The Journal of Environment & Development*, 19(4), pp.446-467.

fish, Morri, Mittoo, Chaky, Luer, Seem, Loor, Moor, Shrimp, Dandiyoon, Ghore, Khage, Paplet Chodi and others. The kinds of shrimps are Jaaro, Kalree, Patal, Kiddi and Kaket. The Shrimp has a great economic value. The local name of this fish is Sana. It is very famous among the fishermen and considered as main sources of income.²⁶

According to Balochistan fisheries Department statistics 11,000 metrics tons of fish was caught in the area of Sonmiani Bay and the surrounding village (Bhira, Damb, Sonmiani) in the 2003 which become total 9% of fish catch in Balochistan. In the area there were some other kinds of fish which disappeared with in the some years, such as *Palla, Mungro and Sood*. The main reason of their decline is the over exploitation of the fish resources and another major cause is the use of illegal nets during the fishing. The types of illegal nets which are common used by local fishermen are *Thukri, Raybiyoon, and Makhan rach*. Another cause of over exploitation is that in the fishing season people from neighborhoods countries such as Bangladesh, Burma and Afghanistan came into the village for fishing. They also use the illegal nets and cut the mangrove plants for the framing of their roofs and fences, fuel and fodder.²⁶

According to the villager the Government has approved 200 acres land for the villagers but still no person in the village has the ownership right of the houses. The total population of village is 1300.²⁶

The percentage is that 76.4 percent are labor and 21.8 are fishermen and 1.8 is others. So it indicates that mostly people are labor in the village and they depend for fishing for their livelihood.²⁶

Frequency of fish species catch by the local communities in the village that are *shrimp, Loor, Mor, Mukhansh, Ghore, Paplet and Chodi*. From the total sample size the percentage of fish species catch by people is 17.4% shrimp, 0.2% Loor, 12% Mor, 15.6% Mukhansh, 0.2% Ghore, 13.4% Palpet and 12.9% Chodi.³⁸

Use of Plant	<i>Avicennia marina</i> (%)	<i>Rhiphoroas mucronate</i> (%)	<i>Ceriops tagal</i> (%)
Fodder	49	25	20
Fire wood	47	23	13
For Sale	0	1.28	0.58
Fence	0.44	11	2.35
Framing of Roof	2.23	27	28

³⁸ Bibi, A. (2013). Role of Mangroves Ecosystem in Livelihood of Bhira Village, District Lasbela (Balochistan). Pakistan Institute of Development Economics (PIDE), Islamabad.

Honey	0	4.48	9.4
Other	0.89	8.3	27.3

Table 4.2.9 Situation of Mangrove Plant and their usage in Sonmiani ²⁶

The Kalamat Khor area includes two major villages; Gur Sant Village and Chandi Village. These villages are among the oldest settlements in the region and are located close to the coast, making them highly dependent on coastal resources, particularly fisheries and mangroves.

Gur Sant Village spans 30 acres and consists of approximately 130 households, with a total population of 1,130 residents—630 men and 500 women. The entire population is indigenous, and nearly 95% of the villagers are engaged in fishing as their primary occupation. In addition to fishing, some villagers own 15 camels, which primarily feed on mangrove leaves, further emphasizing the community's dependence on natural resources.

Chandi Village is home to 60 households, with a total population of 500 people—300 men and 200 women. Like Gur Sant, its residents are indigenous and rely on fishing and mangrove resources for their livelihoods. However, in the past two years, at least three families have migrated from Chandi Village to Pasni, citing chronic water shortages due to persistent drought and a lack of basic facilities as the primary reasons for their relocation.

Both villages rely on fishing and mangrove ecosystems for their survival. While the local fishermen adhere to traditional, sustainable fishing methods, they face conflicts with outside fishermen, particularly large trawlers from Karachi, who use harmful fishing nets. These trawlers are viewed as a threat to the villagers' livelihoods, and disputes have escalated into physical confrontations, including armed conflicts. Unfortunately, the local fishermen, with their small boats, are unable to chase or stop these well-equipped outsider trawlers from depleting their fishing grounds.

In Kalamat Khor, particularly in Gur Sant and Chandi, women play a crucial but often overlooked role in managing natural resources. They collect fuelwood from mangroves for cooking and heating, as well as fodder for livestock. While livestock ownership is generally assigned to women or shared with men, women remain excluded from decision-making processes in most cases.

Since fishing is the primary source of livelihood, any decline in fisheries resources directly affects the entire family, with women and children bearing the brunt of economic hardships. In times of financial crisis, families struggle to afford medical treatment and education, with

women suffering the most due to their limited access to resources and economic opportunities.³⁹

4.7. HCV 6 – Cultural Significance and Community Livelihoods

Mangrove forests in Balochistan are deeply embedded in the cultural and traditional practices of local communities. The communities along the coast of Lasbela and Gwadar districts of Balochistan (with significant presence on the Sindh coast) form a distinct yet heterogeneous group. Their habitat, livelihood, culture, traditions, aspirations, and challenges are largely the same.³⁹

The Miani Hor mangrove ecosystem, in particular, holds a unique cultural identity as it has been continuously utilized by fishing communities for centuries. The customary rights of local fishermen and their reliance on mangroves for sustaining traditional practices have made the mangrove ecosystem an integral part of their daily life. The elders of the coastal villages pass down generational knowledge on fishing techniques, boat-building, and sustainable resource use, all of which are intertwined with the existence of mangrove forests. Fishing communities follow the patti system, a share-based fishing arrangement that has been practiced for generations, ensuring equitable distribution of resources and income.²⁹

The wood from mangroves such as *Rhizophora* and *Ceriops* has long been a critical material in the construction of dwellings, especially in coastal areas where wooden structures are common. Mangrove wood is prized for its durability and resistance to rot, making it suitable for building stilt houses and other structures in the coastal regions of Pakistan. Lowers of mangrove species like *Ceriops* and *Avicennia*. Local communities harvest the wild honey produced by bees that frequent the mangrove flowers. This wild honey has been an important food resource for coastal populations, and its production is tied to the health of the mangrove ecosystems.⁴⁰

The flowers of *Rhizophora mucronata* produce honey, which is traditionally collected by local communities. However, the paper notes that the honey from *R. mucronata* flowers can be toxic and is considered poisonous in some regions, though it has been used historically.³⁰

Avicennia marina has been traditionally used to treat skin diseases. This species is known for its medicinal properties, particularly in traditional herbal medicine for treating a variety of

³⁹ Shahrukh, N., Hussain, S., Azeem, T. and Khan, S., 2020. Coastal communities of Balochistan vis-à-vis CPEC: Mapping perceptions and socioeconomic issues. *Policy Perspectives*, 17(1), pp.53-72.

⁴⁰ Bandaranayake, W.M., 1998. Traditional and medicinal uses of mangroves. *Mangroves and Salt Marshes*, 2(3), pp.133-148. <https://doi.org/10.1023/A:1009988607044>.

ailments. *Avicennia marina* contains terpenoids, steroids, and naphthalene derivatives. These compounds contribute to its medicinal properties and may also have antimicrobial and anti-inflammatory effects.⁴¹

Kalimat Khor remains an isolated and remote area where the local communities are largely disconnected from the outside world, living in a self-sustained manner. With minimal external interaction, they have adapted to their environment, relying on fisheries and mangrove resources for their livelihood. The local communities play a vital role in conserving fish resources by adhering to indigenous fishing methods and avoiding harmful nets, which may provide short-term earnings but ultimately harm fish populations. They also refrain from overfishing or continuous fishing and follow traditional fishing timetables that vary by season and fishing grounds. In addition, they informally monitor the fishing activities of outsider trawlers in their waters and drive them away when found. However, during nighttime, their small boats limit their ability to enforce these measures, leading to conflicts with outsiders. Some quarrels have occurred over this issue, highlighting the need for government intervention to prohibit trawlers from fishing in communal waters. Being dependent on the region's mangrove resources, the local communities also take steps to manage and protect them. Influential community members control patches of mangrove forests and oversee their protection through watch and ward systems, preventing outsiders from exploiting these areas. They have actively challenged commercial interests and external threats to their resources, thereby reducing external pressure on the mangrove ecosystem.⁴²

5. CONSERVATION PROJECTS IN HIGH CONSERVATION VALUE AREAS

Several conservation projects have been implemented focusing on mangrove restoration, biodiversity conservation, and sustainable resource management. These projects aim to enhance coastal resilience, mitigate climate change impacts, and support local communities that depend on these ecosystems. Below is an overview of key conservation initiatives.

5.1. Sonmiani Mangrove Restoration Project

Located in the Sonmiani Marsh Dam area of Balochistan, this project is led by the South China Sea Institute of Oceanology (SCSIO) of the Chinese Academy of Sciences, in collaboration with the Lasbela University of Agriculture, Water & Marine Sciences (LUAWMS), Pakistan.

⁴¹ Vinoth, R., Kumaravel, S. and Ranganathan, R., 2019. Therapeutic and traditional uses of mangrove plants.

⁴² WWF-Pakistan (c. 2007) 'Participatory Learning and Action (PLA) Report: Kalimat Khor'. Available at: https://www.wwf.org.pk/pdf/tp_kap_kalimat.pdf

The project focuses on the restoration of 16 acres of mangrove forests using advanced anti-pollution ecological restoration afforestation technology developed by the Chinese Academy of Sciences. The initiative aims to rehabilitate degraded coastal wetlands by applying innovative restoration techniques. Additionally, the project actively involves local fishing communities in conservation efforts, ensuring that they play a role in safeguarding their natural resources while benefiting from sustainable livelihoods.⁴³

5.2. Balochistan Integrated Water Resources Management and Development Project (BIWRMDP)

The BIWRMDP, implemented by the Government of Balochistan's Irrigation Department with support from the World Bank, is a large-scale mangrove conservation project aimed at restoring and protecting coastal ecosystems. In collaboration with IUCN Pakistan, this initiative seeks to plant 3,518,840 mangrove plants across 2,020 acres along the Balochistan coastline. This extensive restoration effort is designed to improve water resource management, coastal stability, and ecosystem health while also providing long-term benefits to local communities dependent on mangroves for fuelwood, fodder, and fisheries.⁴⁴

5.3. WWF-Pakistan & JS Bank Mangrove Plantation Campaign

To address climate change and promote ecological sustainability, WWF-Pakistan and JS Bank launched a campaign to plant 100,000 mangrove saplings along the coastal belt of Balochistan, specifically in Miani Hor, an area known for its rich biodiversity, including marine dolphins and coastal birds. The project aims to enhance carbon sequestration, regulate water cycles, and increase green cover in Pakistan's coastal regions. By integrating local communities into conservation efforts, the campaign not only restores critical ecosystems but also raises awareness about the importance of mangroves in mitigating climate change.⁴⁵

5.4. Pakistan Navy – Mangrove Plantation Campaign

The Pakistan Navy, in collaboration with IUCN Pakistan and the Gwadar Development Authority (GDA), initiated the Mangrove Plantation Campaign 2018, a large-scale project aiming to plant two million mangroves across the coastal regions of Sindh and Balochistan. As part of this initiative, additional plantation efforts were carried out in Shabbi Creek, Gwadar, covering an 8-kilometer stretch. While this campaign has significantly contributed to

⁴³ The Nation (2023) '16 acres of mangrove forest successfully restored in Balochistan', *The Nation*, 15 March. Available at: <https://www.nation.com.pk/15-Mar-2023/16-acres-of-mangrove-forest-successfully-restored-in-balochistan>

⁴⁴ Balochistan Integrated Water Resources Management and Development Project (BIWRMDP), 2023. *BIWRMDP and IUCN Pakistan lead grand celebration of International Day for the Conservation of the Mangrove Ecosystem in Sonmiani, Lasbela*. Available at: <https://www.biwrmdp.org.pk/balochistan-integrated-water-resources-management-and-development-project-and-iucn-pakistan-lead-grand-celebration-of-international-day-for-the-conservation-of-the-mangrove-ecosystem-in-sonmiani-lasbela/>

⁴⁵ WWF-Pakistan (2019) 'WWF-Pakistan and JS Bank initiate 100,000 mangroves plantation drive', *WWF-Pakistan*, 14 August. Available at: <https://www.wfpak.org/?353455%2FWWF-Pakistan-and-JS-Bank-initiate-100000-mangroves-plantation-drive>

mangrove restoration, IUCN recommends further plantation efforts to ensure long-term sustainability and maintain ecosystem functionality.⁴⁶

6. CONCLUSION

The mangrove forests of Balochistan, particularly those in Miani Hor, Kalamat Khor, and Gwatar Bay, play an essential role in the region's ecological and socio-economic landscape. These coastal ecosystems serve as critical breeding grounds for marine life, provide livelihoods for local fishing communities, and act as natural buffers against coastal erosion and extreme weather events. The High Conservation Value (HCV) assessment highlights the urgent need to protect these forests, given their biodiversity significance, ecosystem services, and cultural importance.

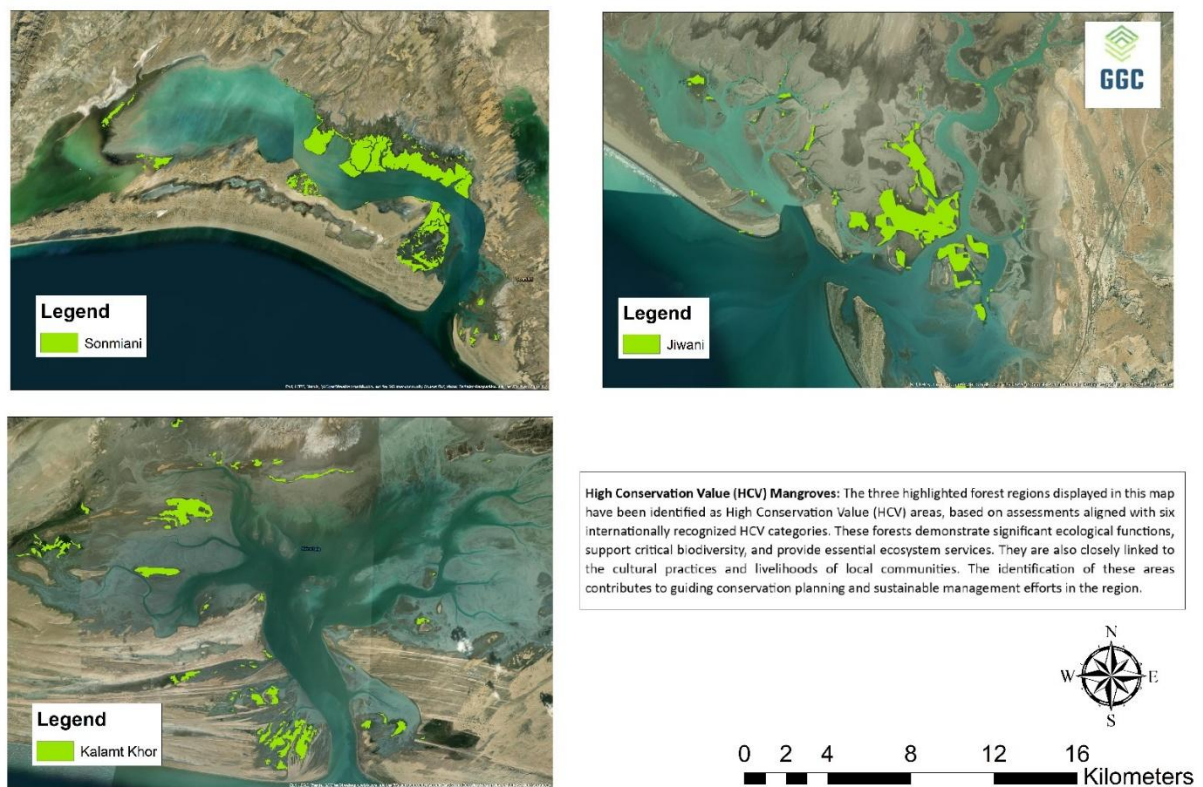


Figure 2 HCV Areas

⁴⁶ Arshad, Z. (2018) 'Restoring mangroves in Balochistan', *Voice of Balochistan*, 9 October. Available at: <https://voiceofbalochistan.pk/opinions-and-articles/social-development/restoring-mangroves-in-balochistan/>

Despite their resilience, Balochistan's mangroves face significant threats, including deforestation, reduced freshwater inflows, and unsustainable resource exploitation. Anthropogenic pressures, such as overharvesting for fuelwood, habitat degradation due to land encroachment, and climate change impacts like rising sea levels, further endanger these forests. Conservation efforts, including afforestation projects, community-led sustainable management initiatives, and international recognition under the Ramsar Convention, have helped mitigate some of these challenges. However, more comprehensive and integrated conservation strategies are necessary to ensure the long-term sustainability of these vital ecosystems.

The findings of this report underscore the importance of adopting a multi-faceted approach to mangrove conservation in Balochistan. Strengthening legal frameworks, enforcing environmental regulations, promoting alternative livelihood options for coastal communities, and enhancing research and monitoring efforts are essential steps in safeguarding these ecosystems. Furthermore, the application of the HCV framework can guide targeted conservation policies, balancing ecological preservation with the socio-economic needs of local populations.

Investing in sustainable coastal management practices and fostering community involvement in conservation activities will not only preserve biodiversity but also support climate resilience and economic stability in the region. By recognizing the intrinsic value of mangroves and implementing proactive conservation strategies, Pakistan can ensure that these irreplaceable coastal ecosystems continue to thrive for future generations.

Annex A: Land Use Assessment of 06 Sites

I. Sonmiani Khor

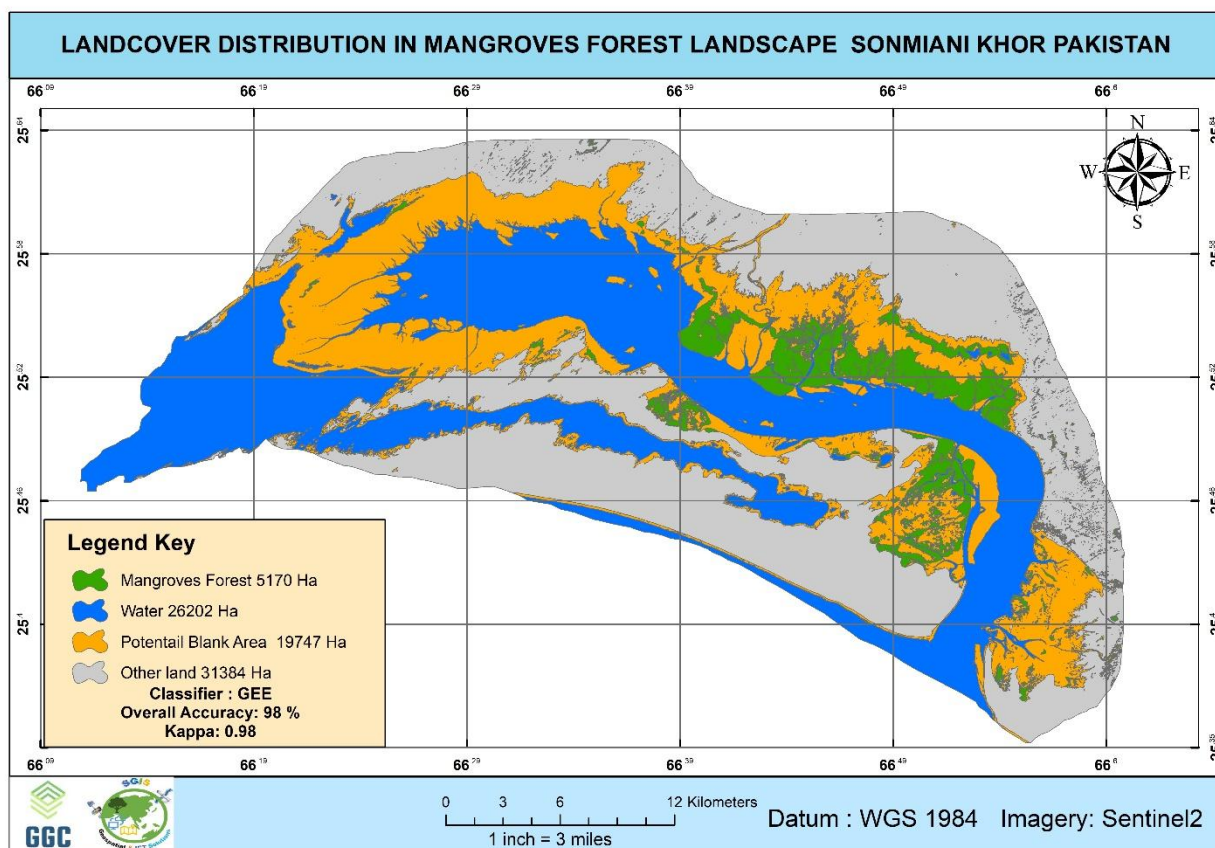


Figure 3 Landcover Distribution

Table 5 LULC Standard Classes

Land Cover Type	Area (ha)	Percentage of Total (%)
Mangrove Forest	5,170	6.26%
Water Bodies	26,202	31.75%
Potential Blank Area	19,747	23.93%
Other Land	31,384	38.03%
Total Area	82,503	100%

2. Jiwani Khor

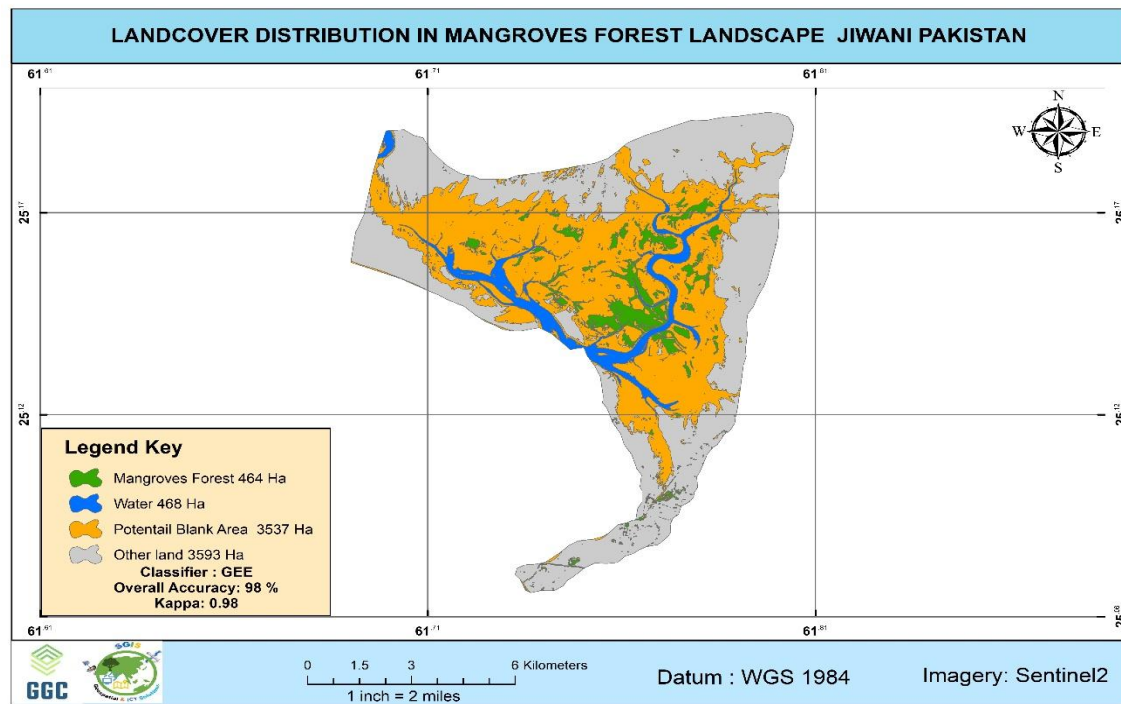


Figure 3 Landcover Distribution

Table 6 LULC Standard Classes

Class	Area (ha)	Percentage (%)
Mangrove Forest	464	5.75%
Water Bodies	468	5.80%
Potential Blank Area	3,537	43.87%
Other Land	3,593	44.56%
Total Area	8,062	100%

3. Sahidi Forest

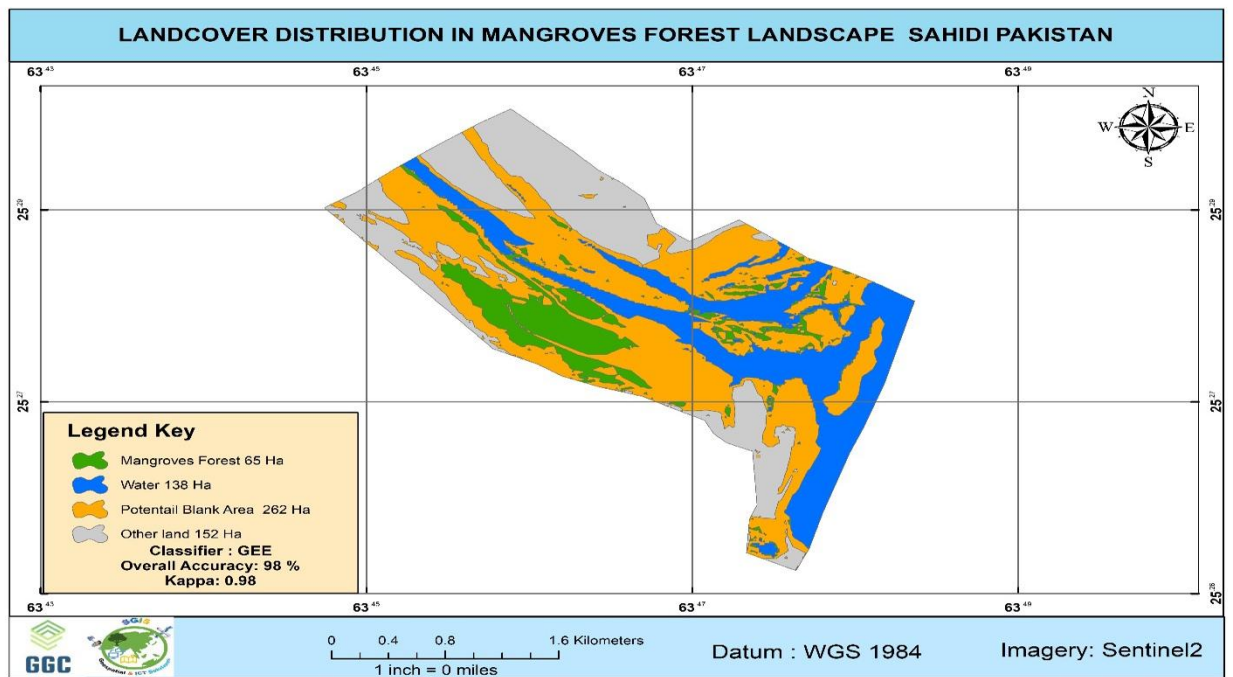


Figure 4 Landcover Distribution

Table 7 LULC Standard Classes

Land Cover Type	Area (ha)	Percentage of Total (%)
Mangrove Forest	65	10.53%
Water Bodies	138	22.36%
Potential Blank Area	282	42.46%
Other Land	152	24.63%
Total Area	617	100%

4. Kalamat Khor

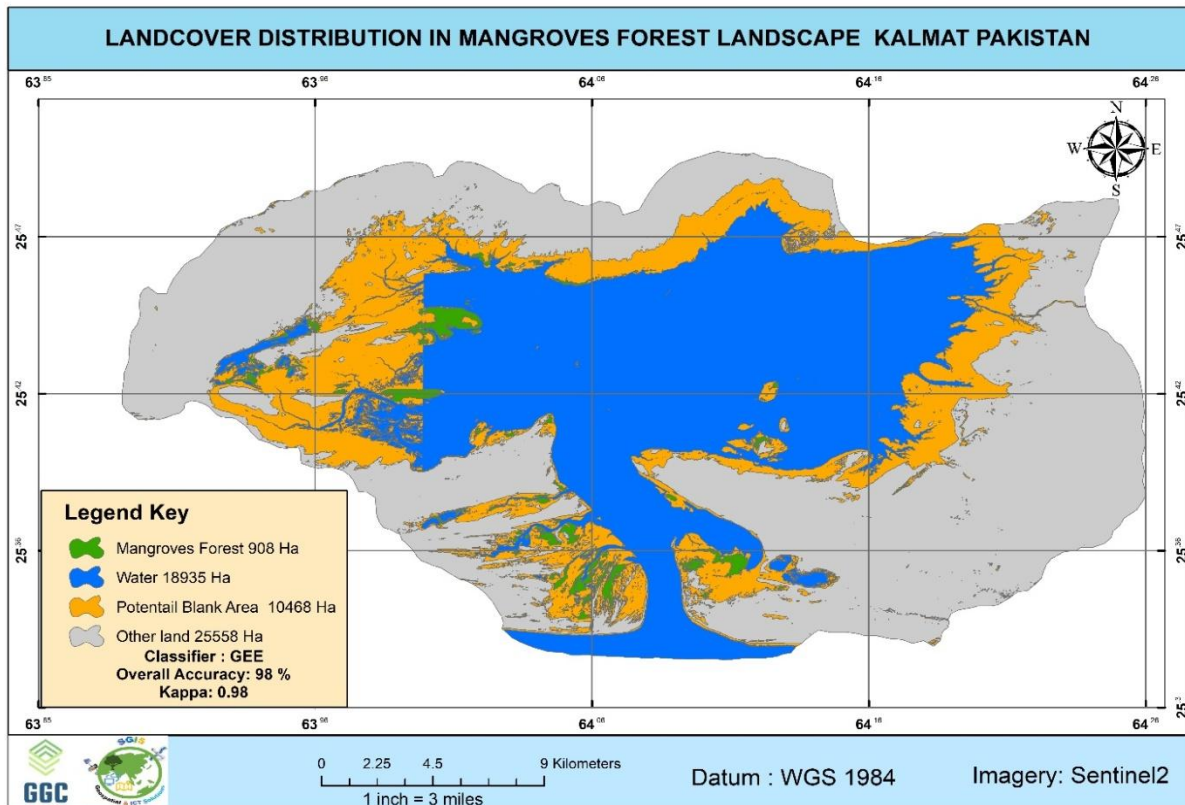


Table 8 LULC Standard Classes

Land Cover Type	Area (ha)	Percentage of Total (%)
Mangrove Forest	908	1.625%
Water Bodies	18935	33.89%
Potential Blank Area	10468	18.73%
Other Land	25558	45.74%
Total area	55869	100%

5. Shabi and Ankara Creeks

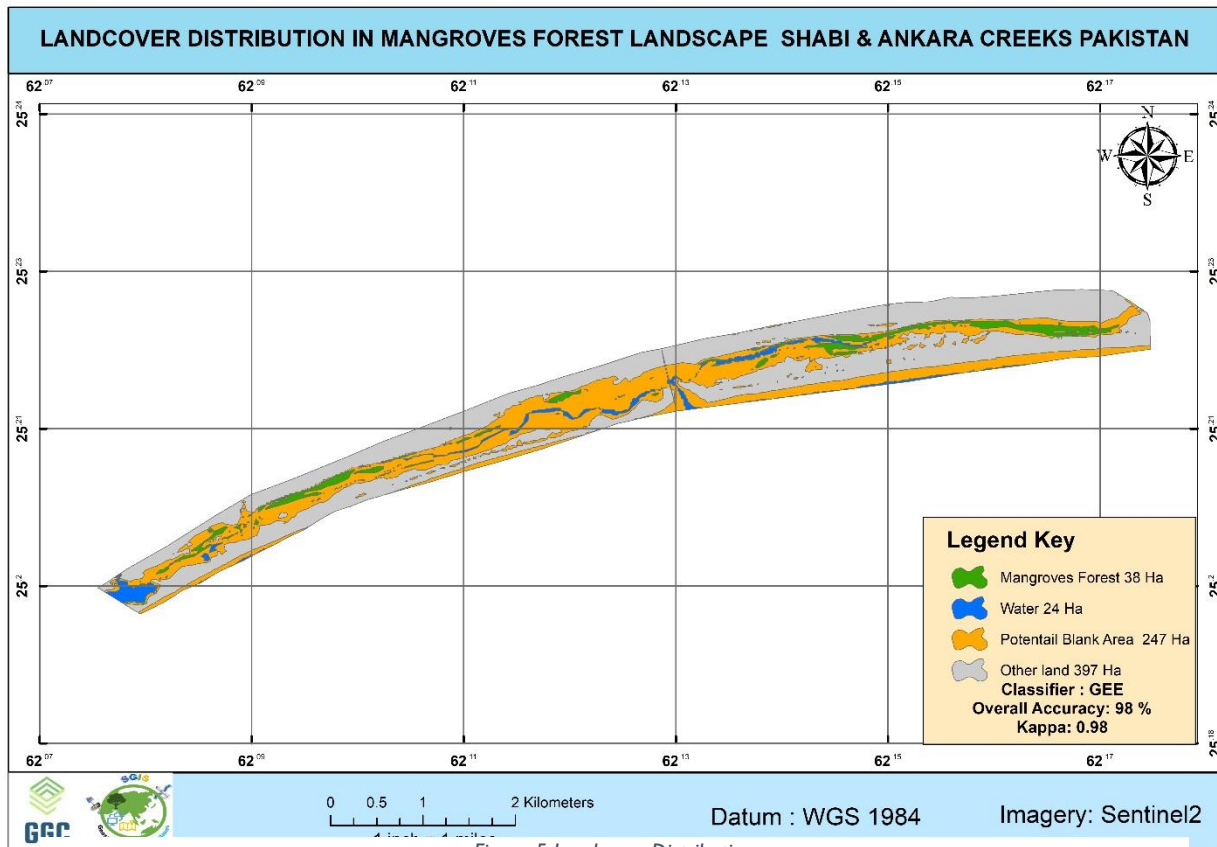


Figure 5 Landcover Distribution

Table 9 LULC Standard Classes

Land Cover Type	Area (ha)	Percentage of Total (%)
Mangrove Forest	38	5.37%
Water Bodies	25	3.53%
Potential Blank Area	247	34.93%
Other Land	397	56.15%
Total Area	707	100%

6. Sawar Forest

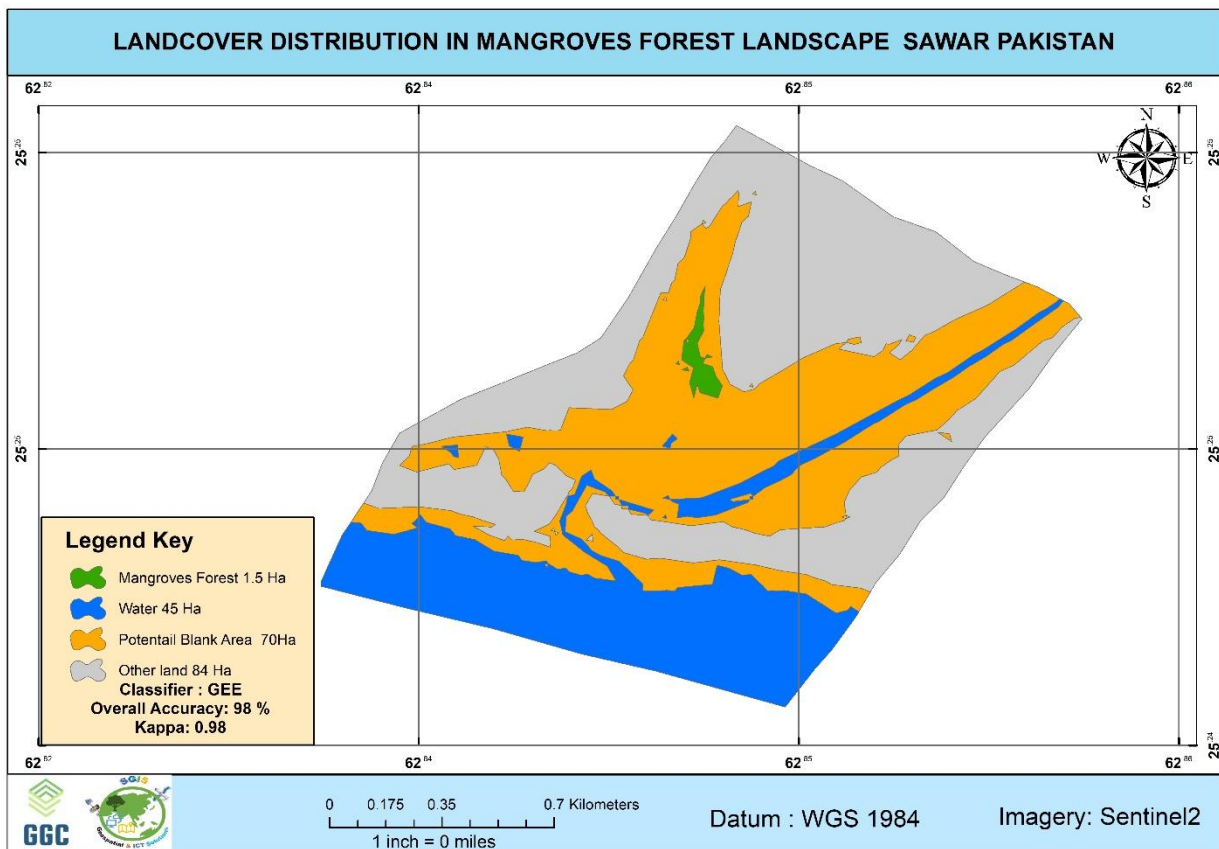


Figure 6 Landcover Distribution

Table 10 LULC Standard Classes

Land Cover Type	Area (ha)	Percentage of Total (%)
Mangrove Forest	1.5	0.75%
Water Bodies	45	22.44%
Potential Blank Area	70	34.91%
Other Land	84	41.89%
Total Area	200.5	100%