# CHAPTER 2
# LITERATURE REVIEW

## 2.1 Background

Mangroves are one of the few plant species in the world that have evolved to survive in the challenging environments encountered in coastal and estuary settings. Pakistan is lucky to have mangrove forests along its coastline since they are a valuable natural resource for supporting coastal populations' lives and protecting the shoreline. In Pakistan, mangrove forests are mostly found in the estuary regions of the Indus Delta along the Arabian Sea coast in Sindh Province's south. One of the world's largest arid land mangrove forests may be found in the Indus Delta. Due to several stressors, the real area covered by thick mangrove vegetation has drastically decreased. Eight species of mangroves have been identified along the Sindh coast by Nasir and Ali (1972; cited by IUCN Pakistan, 2005): Avicennia marina, Rhizophora mucronata, Ceriops tagal, Ceriops roxburgiana, Rhizophora apiculata, Aegiceras corniculatum, Sonneratia caseolaris, and Bruguiera conjugata. The most prevalent mangrove species in Pakistan is A. marina. R. mucronata and C. tagal are found in Miani Hor, as well as Daboo and Khai creeks in the Indus Delta.



A. corniculatum can be found in Pakar and Daboo streams close to Shah Bunder, but it has nearly vanished from other parts of the delta. As a result of habitat loss, three species—Bruguiera gymnorrhiza, C. tagal, and A. marina—have gradually vanished from the Hub River Delta (Champion et al., 1965; cited by IUCN Pakistan, 2005); additionally, species like Ceriops decandra, R. apiculata, and S. caseolaris can no longer be confirmed (Nasir and Ali, 1972; cited by IUCN Pakistan, 2005). Due to its strong tolerance for salt and capacity for survival under challenging circumstances, A. marina, the dominant species, makes up approximately 99.9% of the mangrove forest cover along the shoreline. In the deltaic wetlands of seasonal rivers like the Hub, Porali, Hingol, and Dasht, which empty into the Arabian Sea at Kalmat Khor, Miani Hor, and Gwater Bay, Baluchistan is home to a few isolated patches of mangroves. In Baluchistan Province, the mangrove forest that is dominated by A. marina.

## 2.2 Growth of Mangroves

In the area where the land and the sea meet, mangroves develop. They experience salinity fluctuations and frequent tidal flooding, which causes waterlogging (Naidoo et al. 2002; Sengupta and Chaudhuri 2002; Paliyavuth et al. 2004; Jagtap and Nagle 2007). They are exposed to the air like other marine creatures, putting them at danger for desiccation and overheating; however, they also have to deal with salt and waterlogging (Naidoo et al. 2002; Sengupta and Chaudhuri 2002; Paliyavuth et al. 2004; Jagtap and Nagle 2007). The aforementioned issues deteriorate in tropical climates with high temperatures. First off, desiccation and overheating are worse at low tide, and secondly, any water that is left behind might evaporatively saline than the open sea. The warmth of the sea during high tide reduces the oxygen content of the water (Hogarth 1999). Even though the soils on which mangroves grow are often saturated with water, high salinity makes it more difficult for mangroves to draw water from the soil. Many mangrove species, as a result, exhibit morphological traits and high water-useefficiency typical of terrestrial xerophytes (Clough et al. 1982; Ball 1988a; Clough and Sim 1989).

## 2.3 Effects of Environmental Conditions

Many diverse human activities are now threatening mangroves. Exploitation frequently goes beyond natural replacement. Mangroves are harmed by the increased salinity that results when irrigation plans for the interior divert river water from coastal areas. Pollution has a cost. Without taking into account what could be lost, deliberate clearing is done to expand aquaculture. Due to their location at the meeting point of land and sea, mangroves are probably one of the first ecosystems to be impacted by climatic changes. According to predictions (Pernetta 1993; Field 1995; Ellison et al. 1997; Das et al. 2002; Kim et al. 2005; Jagtap et al. 2007; Gilman et al. 2008), mangroves tend to move inland when sea levels rise along with the fast climatic changes. In addition, any considerable sea level rise brought on by global warming would inevitably result in an expansion of the very small area where mangroves are able to develop (Pernetta 1993; Das et al.

2002; Kim et al. 2005; Jagtap et al. 2007; Gilman et al. 2008).

**2.4 Mechanism of salinity Tolerance:**

Salt stress research will gain fresh insight and a new dimension thanks to the knowledge on the morphological, anatomical, physiological, biochemical, and molecular foundation of salt tolerance mechanisms in mangroves, which are facultative halophytes and prospective stress adaptors (Downton 1982; Clough1984). Since most mangroves may flourish in freshwater, salt is often not necessary for development (Tomlinson 1986; Ball 1988). However, because to competition from freshwater species, they do not thrive in areas that are purely freshwater. Therefore, salinity is crucial in removing other vascular plant species that are not suited to growing in a saline environment. According to several studies, the main reasons why mangrove restoration efforts failed included a lack of knowledge about the key ecological factors that influence mangrove health, including the ecological requirements for salinity, suitable hydrology and topography, and an appropriate species composition (Elster 2000; Primavera & Esteban 2008; Ahmad 2012; Kodikara et al. 2017). One of the key elements affecting mangroves' development, dispersion, and productivity is salinity (Ball 2002).



Studies of mangrove restoration projects at various sites have shown that it affects the survival and growth of planted mangrove seedlings, and it frequently exhibits high spatial and temporal fluctuations, driven by inputs of fresh water and sea water, inundation, ground water seepage, and evaporation (Bosire et al. 2008; Kirui et al. 2008; Krauss et al. 2008; Hoppe-Speer et al. 2011).Therefore, a key issue in mangrove planting initiatives is identifying species-specific reactions to salinity (Ye et al. 2005; Krauss et al. 2008).

According to certain research, seedlings of at least some species exhibit their best development performance when exposed to moderate salinity, such as 17.5 psu (Aziz & Khan 2001a; Jayatissa et al. 2008; Flowers &Colmer 2015). In contrast, according to other research, water with a significantly reduced salinity boosts productivity, growth, and survival (Yakir et al. 1995). According to the species and their capacity to maintain high water usage efficiency, mangrove plants' tolerable salinity ranges in the wild vary (Reef & Lovelock 2015). For instance, *Avicennia marina* (Kirui et al. 2008) has great salt tolerance, *Rhizophora mucronata*

(Kirui et al. 2008) exhibits moderately high salt tolerance, and species like *Bruguiera sexangula* (Kirui et al. 2008), *Sonneratia caseolaris*, and *Aegiceras corniculatum* (Kirui et al. 2008), (Hogarth 2007; Jayatissa et al. 2008). The effects of salinity on tissue water potential, physiological characteristics like stomatal conductance, and the role of inorganic ions in influencing mangrove seedling response to various salinity levels have all been reported (Smith & Snedaker 1995; Aziz & Khan 2001a; b; Reef & Lovelock 2015), in addition to effects on survival and growth.

Kamali and Hashim (2011) described a novel approach which facilitated restoration and organic recovery of the mangrove ecosystem. With this technique, a seaward detached breakwater was built along the coastline to protect the restoration area from wave action, preventing further erosion and promoting sediment deposition, substrate elevation, and sapling recruitment. Mangroves have supported coastal populations in underdeveloped nations for many generations in addition to being a dynamic ecosystem and a source of resources. A significant area of research is the socio-ecology and socio-economics of the mangrove ecosystem, and during the past several decades, numerous studies have been conducted in various nations with abundant mangroves. Fouda and Al-Muharrami (1995) conducted a thorough examination into the mangrove ecology of Mahout Island of Omen, including the mangrove structure, community animals, socioeconomic factors, and affects of humans.



Abuodha and Kairo (2001) studied the human-induced stressors on the mangrove swamps of the Kanyan coast with reference to deforestation, conversion, and pollution with a focus on sustainable usage and suitable government regulations. Allen et al. (2001) looked at patterns of natural and anthropogenic disturbance of the mangroves on the Pacific Island of Kosrae and found that the most common anthropogenic disturbance is the cutting down of trees for poles and fuel, which leaves small, dispersed gaps in the forest structure. Glaser (2003) lookedat the socio-economic priorities of mangrove communities and the interactions between the local economy, mangrove ecology, and social sustainability in the Caete estuary in northern Brazil.

Dahdouh-Guebas et al. (2006) used local usage patterns and residents' perceptions of the mangrove ecosystem to indicate mangrove deterioration caused by overexploitation, aquaculture, and urbanisation in the Godavari mangroves forest of India. Research on the ethnobiology, socioeconomics, and management of

mangrove forests has been thoroughly reviewed and synthesised, and there have also been comments on the geospatial monitoring techniques that are used toinvestigate mangroves.es for poles and fuel wood, which leaves a few tiny, scatteredholes in the forest's structure. Glaser (2003) looked at the socio-economic priorities of mangrove communities and the interactions between the local economy, mangrove ecology, and social sustainability in the Caete estuary in northern Brazil. In an ideal setting, mangroves may develop in a large tidal range from one Mean High Water Spring (MHWS) tide down to mean sea level (MSL) (Swales et al. 2007). They feature a number of unique adaptations, such as waxy leaves and aerialroots, that allow them to thrive in conditions that would be too severe for the majority of other plant species (Swales et al. 2009).

In calm coastal regions and estuaries, mangroves are often found in the top half of the intertidal zone, where they are most prevalent closer to the high-tide line. They grow off of seed propagules, which colonise appropriate soils with a lot of muck (Park 2004). Mangroves develop extensive root systems as a means of adaptation to the anoxic conditions present in muddy substrates, which are rich in nutrients but poor in oxygen. With breathing roots called pneumatophores above the ground's surface, this root system acts as a raft for the tree, allowing air to be transported into the root system. In salty conditions, mangroves' waxy leaf surfaces and specialised breathing holes (stomata) reduce water loss. With prolific growth observed in many regions, these adaptations enable mangroves to be exceedingly productive (Morrisey et al. 2007). Mangroves are mostly found in subtropical areas with mean water and air temperatures of around 20 °C. However, the incidence of ground frost often restricts the real geographical spread. Physical damage to plants and propagules brought on by overnight temperatures below 4oC lowers photosynthetic rates (Morrisey et al. 2007). According to Beard (2006) and Walbert (2002), freeze-injury reduces the chances of effective seedling development, sapling establishment, and long-term survival. By changing water flow (attenuatingwaves and currents), mangroves increase Sediment Accumulation Rates (SAR) (Morrisey 2007). Fine sediments including silt, clay, and organic matter are encouraged to settle due to the physiological characteristics of mangrove aerial root (pneumatophore) systems. The majority of the sediment buildup occurs on the seaward margin or along tidal channels (Dingwall 1984, Clarke 1993, Furukawa et al. 1997), with sediment being delivered into mangrove ecosystems via rivers and streams (Nicolls et al. 2002).

In the Firth of Thames, Swales et al. (2007) discovered that following mangrove colonisation, sedimentation accretion rates rose from 20 mm/yr to over 100 mm/yr, causing tidal mudflat elevation to rise quickly and additional mangrove colonisation. According to local factors including geomorphology, coastal hydrology/oceanography, and sediment inputs, sediment accumulation rates vary significantly amongst mangrove forests (Jennerjahn and Ittelkott 2002). 1 With their enormous root systems, mangroves reduce water velocity and dampen waves, keeping them from breaking on exposed shorelines (Swales et al. 2009). Mangroves can therefore help prevent coastal erosion by protecting the beach in some places (Jennerjahn & Ittekkot 2002). Sedimentation, increased nutrient inputs, climate warming, or a combination of the above are the main factors that contribute to the expansion of mangroves (Young and Harvey 1996, Schwarz 2002, Swales et al. 2007, Morrisey et al. 2007, 2010, Lovelock et al. 2010, and Lundquist et al. 2014). Due to rising average temperatures, increased rates of sedimentation, and increased levels of carbon dioxide in the atmosphere, climate change has an impact on the growth and spread of mangroves (McLeod &Salm 2006). Increased SAR in estuaries will allow for enhanced mangrove colonisation as a result of the anticipated increased intensity and frequency of rainfall events (Ellison 1994; Field 1995). Mangroves are also expected to move to higher latitudes as a result of less frequent temperature extremes (freezes), which improve seedling survival rates (McLeod &Salm 2006, Alongi 2008, Lundquist et al. 2011, Cavanaugh et al. 2014).