CHAPTER 1
INTRODUCTION

1.1 Background

Mangrove forests are unique plant communities restricted to biotopes with harsh conditions i.e., intertidal areas of lagoons, estuaries and sheltered bays in tropical and sub-tropical areas worldwide (Polidoro et al.2010; Spalding et al.2010; Mukherjee et al.2015). Mangroves are known for stabilizing coastlines by controlling erosion and facilitating sediment deposition (Das, 2020). They are capable of growing under extreme environmental conditions such as high and changing salinity, frequent tidal in undation with associated sediment hypoxia, low air humidity, and high temperatures as well as strong variations there in. Despite all the ecological services and economic benefits associated with mangrove ecosystems, global mangrove cover continues to decline (Lee et al. 2014; Richards & Friess.2016). These forests are the source of living for a large number of human beings around the world by providing wood for fuel, charcoal and timber as well as area of fishing. They act as nurseries for the marina fauna, protect and stabilize shoreline and perform protective mechanism against tsunamis, erosion and flooding and storm surges in the coastal zones (Ismail et al., 2014).

For convenience global mangroves distribution is distinguished into zones (Badola, R. & HussainS.A. (2003) 1. West zone 2. East zone. West zone embodies African coast of Atlantic, North and South American portions, which also comprises Galapagos islands and the East zone embodies eastern part of African coast, South Asian countries via…India and Pakistan, South east Asian countries like Indonesian archipelago and Australia and New Zealand. East zone found to embodies higher species richness (Badola & Hussain (2003). With respect tocoordination extent's location of mangroves limited to 32oN and 38oS, sprawling in 112 countries coastlines of tropical and subtropical regions for an area between 167000 and 181000 km2 (Miththapala, 2008). Bangladesh reported to possess world's single largest mangrove area stretching over 600000ha2. 35% of global mangroves have lost in last two decades (Mathew et.al, 2010)

Mangroves forest in South Asia occurs on the sea shoreline of Bangladesh, India, Pakistan and Sri Lanka which covers 7% of the world mangroves (Giri et al.,2011).

The largest adjoining mangroves forests in the world 'Sundar-bans' which is situated at the border of Bangladesh and India. The diversity of mangrove species in these regions ranges from 12-13 in Bangladesh, 30-35 in India, 4-8 in Pakistan and 18-20 in Sri Lanka (Polidoro et al., 2010).

Mangroves forests are the major constituents which play a key role in sustaining ecosystem into the harsh environment these forests providing shoreline stabilization, maintain water quality, storm protection, flood control, protect habitat and biodiversity, providing shelter and breeding grounds to marine life plus migratory birds sediments and nutrient retention, protect seaport and coastline erosion owing to waves action and siltation, provide fodder for domestic livestock, fuel wood hunting and fishing for local communities, give rise to cultural and recreational tourism (Duke et al.,2007).

Mangroves forest have offered a crucial role in the growth of economics of the tropical and subtropical people from last few decades plus provide a vast habitat of land and aquatic plants and animals. In Pakistan this forest once covered 250,000 hectares and ranked as fifth largest mangrove ecosystem in the world according to (Dawn report. 2017) the mangroves of Indus delta decrease 98,014 hectares and is ranked as lower than 15th at the global level.

Pakistan's coastal area is an arid sub-tropical desert with 1,050 kilometers long coastline of which one-third is in Sindh and the rest in Baluchistan. The average rainfall is 100-200mm per year, and that too, sporadic. The Indus Delta is spread over 600,000 hectares along the southern Arabian Sea Coast in Sindh. Out of these, 260,000 hectares are covered with mangroves mainly in the Indus Delta swamps. Pakistan is divided into 18 habitat types, among them mangrove forests, which occur Existing estimates show that mangroves cover approximately 129,000ha in the Indus Delta and about 3,000ha on the Baluchistan Coast in the Miani Hor,Kalmat Khor, and Gawatar Bay areas. The Indus Delta therefore supports 97 percent of the total mangrove forest (37 percent of the Delta area) while the three pockets on the Baluchistan Coast support the remaining 3 percent (varying from 8 percent of the total area in Gawatar Bay to 21 percent in KalmatKhor and 25 percentin Miani Hor). mainly in the Indus Delta and in a few patches westward along the Baluchistan Coast (Government of Pakistan,1996).

Avicennia marina commonly known as Timer which is a leading specie of mangrove in the coastal area of Pakistan. Timer's leaves and fruits are used as fodder for cattle and wood is used as a source of fuel as an alternate of kerosene oil or natural gas, are either not available or too expensive for the local communities. However, the wood of Avicennia marina (timer) is not much desirable as compared to Rhizophora mucronata because of low tendency of smoke and lower calorific value but still used at large scale for domestic purposes by coastal community. The survey conducted by (Amjad et al., 2007) shows 25% by local communities used wood for fuel consumption. The increasing ratio of trees cutting reduced adult tree population, canopy height and canopy closure (Walters, 2005b; Lopez-Hoffman, et al., 2006).

Avicennia marina is the most dominant and widespread species. Other species have been reduced considerably if not lost completely. Rhizophora mucronata occupies a large area in Miani Hor, Balochistan. Bruguiera Gymnorhiza and Ceriops tagal, which once occurred in the Hub River delta (Champion et al,1965) can no longer be found and even Avicennia marina has been disappeared.

Table 1. List of Species and Distribution of Mangroves in Pakistan

Species	Distribution
RHIZOPHORACEAE	
Bruguieragymnorhiza (L) Lamk.	Karachi and Indus delta (Hassan) Estuary of Indus (Murray); no specimen in Kew, Edinburghand Pakistan
Ceriops tagal (Perr.) C.B. Robin	Karachi and Coast of Sindh (stocks) Mouth ofIndus and"Salt water creek" (Murray)
Ceriops decandra (G.) Ding Hou	Sindh tidal zone; existenceconsidered doubtful
Rhizophora apiculataBlume	Tidal marshes at the mouth of Indus: Miani Hor, Las Bella(T & S)
Rhizophora mucronata Lamk.	Mouth of Indus on muddy shores and tidal creeks (Henslow; Las Bella and Makran Coast (Burkill)
MYRSINACEAE	
Aegiceras corniculatum (L.) Blco.	Mangrove swamps at mouth of the Indus (Stocks, Ritchie)Karachi (Jafri): Miani Hor
AVICENNIACEAE	
Avicennia marina (Forsk.) Vierh.	Tidal mangrove swamps;Sand spit (stern) China creek,etc. (Jafri), Kalmat Hor
SONNERATIACEAE	
Sonneratiacaseolaris (L.) Engler	Mouth of Indus and Tidal Zone (Common, fide Murray);Indus delta no specimen seen.

Rising Sea Level and effect of Salinity of *Avicennia marina* and *Rhizophora mucronata*

Mangrove trees constitute a delicate ecology that is being endangered by rising sea levels (Cheng et al., 2015; Woodroffe et al., 2016), extreme climate disasters, increased UV radiation (Fei et al., 2015), and human activities, (i.e., oil spills, contamination, and deforestation) (Pan et al., 2019).

Global warming is one of the many factors that threaten the mangroves ecosystem in all over the world. Currently Sea level rise is a universal phenomenon that is owing to global warming and Pakistan is on 10^{th} in the list of most vulnerable impacts of sea level rise. The mangroves of Indus delta is one of the largest arid mangrove of the world that covers proximate 250,000-283,000 hectares till early 1980s but it decreases 160,000 hectares in 1990. According to (WWF- Pakistan, 2006) estimated that mangrove of Indus delta covers around 73,000 hectares, another study estimates that the loss of Indus delta around1,700km^2 owing to sea encroachment (Qureshi, 1993). Rising sea levels may causethe problem of coastal erosion because of higher wave actions, strong tides and possibility of greater flow, all of these may lead the depletion of mangroves forestand damaged physical structures. These critical hazards reduced silts deposition and may contribute the destruction of mangrove ecosystem.

The species of Mangroves Forest such as *Avicennia marina* and *Rhizophora mucronata* helps to cover the shoreline edges and thus useful to protect the land and ecology against natural disasters e.g., strong wave actions, stormy winds cyclones and tsunamis (Cornforth *et al*., 2013; Giri *et al*., 2007a; Porwal *et al*., 2012; Satyanarayana *et al*., 2011). But the rapid cutting of these treesby local communities may results in soil erosion which is another important source of siltation in the area of mangroves. Moreover, the construction of barrages and dams onto the Indus delta filled with fresh water during flood season and that freshwater have been used for the consumption of humans and cattle. But after flood season these series of dams and barrages are filled with seawater for rest of the year. Changes in precipitations patterns, or a sea-level rise, will alter the salinity in mangrove ecosystems. The intrusion of seawater in the upstream zones of estuaries due to sea level rise increases salinity in these areas while a higher amount of precipitation reduces salinity. Arise in sea-level has been observed for

over 100 years approximated by 19 cm in 2010 compared to 1900. An additional rise of approximately 40 to 70 cm over the next 100 years is expected, stressing the importance of sea-level rise and the concomitant rise in salinity for certain areas. (Mitra., 2013) stated that mangrove ecosystems cannot keep pace with the rate of sea-level rise. This raises questions about the possibility of assisted migration of mangrove forests. Assisted migration must be considered in order to preserve these ecosystems.

Role of littoral or swamp forests

For thousands of years mangrove forests have provided natural buffer against cyclones and other storms that often hit the shores of southern India. The role of mangroves in protection of the life and property along the coast is being strongly realized today after the 1999 super cyclone of Orissa and the tsunami of 2004. In October 1999, a super cyclone, with wind speed of 160 miles per hour struck Orissa and killed at least 10,000 people and rendered homeless 7.5 million. However, those human settlements located behind the mangrove swamps suffered little loss. The villages in and around Bhitarkanika were spared much of the cyclone's fury because of the vast mangrove forest. Bhitarkanika is the second largest mangrove formation in India, next only to the Sunder bans (Venkataraman,2004).

Natural Disturbance in Mangroves

A variety of natural disturbance regimes affect mangrove forests. These may be relatively local-scale events such as breakage of branches during windstorms, lightning strikes, frost damage (in more northern areas), and whole-scale destruction of the forest by hurricanes. Gradients in the types and frequency of disturbance are also present across the geographic range of mangrove forests. (Odum*et al.* 1982).

A positive relationship between large-scale disturbance (cyclones) and species richness in the mangrove forests of northeastern Queensland, Australia, has been reported. Forests that were impacted, on average, by one cyclone every 5 years had more species than forests affected by fewer storms. Species in the Rhizophoraceae often dominate these forests. In the Sunder bans mangroves of Bangladesh, the Rhizophoraceae is a minor component of the forest community.

The Sunder bans are struck by to 40 cyclones a year. The Rhizophoraceae's inability to coppice, in comparison to other groups may account for their vulnerary ability to cyclones.

Salinity is a critical abiotic factor that affects plant growth, productivity, and dispersion in tropical and semitropical intertidal areas because excessive Na+ causes an osmotic imbalance in organisms (Zhu, 2001; Krauss et al., 2008; Munns and Tester, 2008). Salinity affects approximately 20% of the world's cultivable land and 50% of its irrigated land (Tuteja, 2007).

Salinity causes two forms of stress in plants: osmotic pressure (due to increased osmotic pressure) and ionic stress (due to increased amounts of harmful ions, such as Na+ and Cl−, resulting in ionic imbalance) (Flowers and Colmer, 2008). In this context, mangrove trees are essential halophytes that can develop in an increasingly saline environment Several mangrove plants grow well at salinities ranging from 5% to 25% of normal seawater (Parida and Jha, 2010;Krishnamurthy et al., 2017).

1.2 Research Problems

Based on the above introductory discussion following questions are possible.

1. Does synthesis of silver nanoparticle from leaves of the plant extract *C. diurnum* have potentiality to degrade Azo- dyes?
2. Are silver nanoparticles synthesized from plant extract *C. diurnum eco*-friendly?
3. Does silver nanoparticle's synthesized form *C. diurnum* have bio-activity?

1.3 Novelty and Originality of the Research

The green synthesis of silver nanoparticles has been done by different researchers 'recent years, *T. foenum-graecum* seeds extract along with silver Nitrate salt to prepare silver nanoparticles for degradation of methyl orange, methylene blue, and eosin Y by $NaBH_4$. In a reduction reaction involving the chemical dyes methyl orange, methylene blue, and eosin Y, the silver nanoparticles that had undergone bio reduction displayed extraordinary size-dependent catalytic characteristics. Utilizing a biosynthetic process creates new opportunities for creating the optimal catalyst with the highest activity and stability (Vidhu & Philip, 2014).

For the creation of nanoparticle s, in a study *Centella asiatica* extract was combined with a concentration of silver nitrate and cupric sulphate. After the addition of plant extract, copper nanoparticle synthesis was shown by a shift in color from colorless to bluish green and the development of yellowish-brown silver nanoparticle s. By using a UV-Visible spectrophotometer, the synthesized nanoparticles were further confirmed. For both nanoparticle s, distilled water was used as a blank. Copper nanoparticles and silver nanoparticles were both characterized at wavelengths between 200 and 700 nm. Along with silver nanoparticle, methyl orange (MO), methyl red (MR), phenol red (PR), and eosin Y (EY) were employed. In a similar manner, copper nanoparticles were introduced to Methyl orange (MO), Methyl red (MR), Phenol red (PR), and Eosin Y (EY). Decolorization of the solution served as a sign of degradation, which was detected using a UV-visible absorption spectrophotometer (Raina, Roy, & Bharadvaja,2020).

In another article, mature fruit extract of *C. diurnum L.* (family: Solanaceae) was used as a reducing agent to synthesize silver nanoparticles (AgNP). By means of time-dependent UV-Vis Spectrophotometric measurement, the stabilized AgNP's were identified. The Transmission Electron Microscopy study of the nanoparticle, with an average particle size of roughly 50 nm, validated the nanoparticles spherical/oval shape. In a laboratory bioassay, AgNP's demonstrated effective larvicidal effects against *Anopheles stephensi* and *Culex quinquefasciatus* mosquito larvae (Ghosh, Rawani, Mondal, & Chandra, 2022). Theplant used in this research is species of *Cestrum* family called *C. diurnum* which isindigenous to Pakistan and the West Indies as well as other parts of world. Day- blooming cestrum and day-blooming jasmine are examples of common names. In Urdu language named as "راجہ دن کا" (king of the day). This fast growing, evergreen, woody shrub, which is frequently used for borders and screens, releases its perfumeduring the day.

The leaves of Day-Blooming Jessamine *(C. diurnum)* are good source of many minerals, especially vitamin D_3. In terms of proximate composition, *C. diurnum* leaves are comparable to regularly consumed green vegetables. *C. diurnum* leaves are a particularly high source of lutein, a xanthophyll, and beta- carotene, a precursor of vitamin A. Calcium and vitamin D_3 are both abundant in the leaves of *C. diurnum.* The leaves of *C. diurnum* could eventually be used as a food source for people with more toxicological testing. This study will use a locally accessible plant *C. diurnum* leaf extract for nanoparticle production. The novelty of

this research is no work on leaves and flowers of *C. diurnum* has been done regarding synthesis of nanoparticles (Chennaiah, Bhaskarachary, Rao, & Raghuramulu, 2009).

Based on these problems, it can be concluded several formulations.The Problems that will be discussed further are:

- How to compare *Avicenna marina* and *Rhizophora mucronata* using salinity in Mangroves?
- How to improve mangroves forests using awareness and surveying method in local communities?

1.4. Aim and Objectives of the Research

- To identify the comparison between *Avicenna marina* and *Rhizophora mucronata.*
- To identify the productivity of Avicenna marina andRhizophora mucronata.
- To approach the local communities for the survey and awareness about mangroves forest in Pakistan.
- To detect that which species, have a significant role in biodiversity conservation.

Research benefits:

- Mangrove forests play a significant role in development of the fish that is caught near the Sindh coast.
- It is hoped that it can contribute ideas to local communities and the policy makers in managing mangrove forests in the future will be better.
- Saltwater can kill plants, so mangroves must extract freshwater from the seawater that surrounds them.
- Many mangrove species survive by filtering out as much as 90 percent of the salt found in seawater as it enters their roots.

Research Hypothesis

H1: *Avicenna marina* has a higher salinity tolerance than *Rhizophoramucronata* on the Karachi Coast, Pakistan.

H2: The salinity tolerance of Avicenna marina and *Rhizophora mucronata* on the Karachi Coast, Pakistan is affected by factors such as tidal inundation and soil characteristics.

H3: The distribution and abundance of Avicenna marina and *Rhizophora mucronata* on the Karachi Coast, Pakistan is influenced by their differential

salinity tolerance.

1.5. Significance of the research

1. Ecological significance: The Karachi Coast is a vital coastal ecosystem that provides habitat for a diverse range of marine and coastal plant and animal species. Understanding the salinity tolerance of Avicenna marina and Rhizophora mucronata is crucial to assess their ecological roles and how they are impacted by salinity stress.
2. Conservation and management: The Karachi Coast is under constant threat from various human activities such as pollution, urbanization, and overfishing, which can affect the salinity of the surrounding water. The research can provide valuable insights into the conservation and management of these two mangrove species, and how they can be conserved in the face of changing environmental conditions.
3. Economic significance: The Karachi Coast mangrove forests play a significant role in the local economy by providing various ecosystem services, including timber, fisheries, and ecotourism. Understanding the salinity tolerance of these two mangrove species can help to manage and sustain these ecosystem services.
4. Scientific significance: The research can contribute to the overall understanding of the plant's ability to adapt to salinity stress, which can have implications for agriculture and horticulture in areas with high salinity soils.
5. Scope and limitations of the study: The research on the comparison of salinity tolerance between Avicenna marina and Rhizophora mucronata on

the Karachi Coast, Pakistan has a broad scope, covering several aspects related to the two mangrove species. The study will focus on assessing the salinity tolerance of the two species and the factors that affect it. The scope also includes determining the distribution and abundance of the two species on the Karachi Coast and how salinity stress affects their ecology and survival. The study will use a combination of laboratory and field-based techniques to collect data on various parameters related to the two species' salinity tolerance.

Limitations:

1. The research on the comparison of salinity tolerance between Avicenna marina and Rhizophora mucronata on the Karachi Coast, Pakistan may have some limitations. These include:
2. **Limited sample size:** The study may have a limited sample size due to logistical constraints and the availability of the two mangrove species in the study area.
3. **Seasonal variability:** The study may be limited by the seasonal variability in the salinity levels of the surrounding water, which may affect the results' accuracy.
4. **Cost and time constraints:** The study may be limited by cost and time constraints, which may affect the ability to collect data on all relevant parameters related to the two-mangrove species' salinity tolerance.
5. **Generalize ability:**The study's findings may be limited to the specific geographic area of the Karachi Coast and may not be generalizable to other regions with different environmental conditions and mangrove species.