CHAPTER 2
LITERATURE REVIEW

2.1. Background of research

Mangroves or swamp forest, which occur in sheltered, intertidal areas of the tropics and subtropics, are economically important as they provide food, timber, and medicine. Mangroves also protect coastlines, attenuate waves, sequestrate carbon, and serve as nursery grounds for fish (Friess 2016; Barbier 2016). Mangroves occupy low wave energy locations that are usually close to highly populated, industrialized cities. Mangrove habitats are therefore frequently exposed to organic pollutants such as polycyclic aromatic hydrocarbons (Ke et al. 2011; Li et al. 2014). Some mangroves such as Kandelia and Rhizophora exclude salt by root ultrafiltration. *Avicennia* possess glands that excrete salt from their leaves (Ye et al. 2005).

2.2. Mangroves and salt tolerance:

Mangroves develop diverse mechanisms associated with anatomic or physiological characteristics to regulate salt absorption and exclusion, such as ultrafiltration, salt-secretion and ion sequestration (Mimura et al.2003; Kura-Hotta et al. 2001). Mangrove species usually have salt resistance-associated anatomic structures.

Salt tolerance is the ability of plants to grow and complete their life cycle on a substrate that contains high concentrations of soluble salt. Some authors have also categorized mangroves under obligate halophytes. Several mangrove tree species reach an optimum growth at salinities of 5–25% of standard seawater (Ball and Pidsley 1995). However, the range of salinity in which the plant is able to survive varies according to the species (Ball 1988a); in several species' growth may be affected by either absence of or excess of NaCl in the substrate (Ball and Pidsley 1995). Because mangroves successfully live in high salinity environments it is advantageous to use them to study the mechanisms by which plants respond and adapt to these environments. Mangrove research has advanced considerably in the last few years, and the time seems right for an attempt to present our current understanding of the mechanisms of salt tolerance in mangroves. Although voluminous works are available on salt tolerance mechanism taking the model

plant Arabidopsis thaliana (Quesada et al. 2000; Shi et al. 2000; Liu et al. 2000; Elphick et al. 2001), facultative model halophyte Mesembryanthemum crystallinum (Agarie et al. 2007), the information on morphological, anatomical, physiological, biochemical and molecular basis of salt tolerance mechanisms in mangroves which are facultative halophytes and potential stress adaptor (Downton 1982; Clough 1984) will throw new light and give a new dimension to salt stress research. Understanding the mechanisms of salt tolerance in mangroves and identification of salt tolerant genes from mangroves will lead to effective means to breed or genetically engineer salt tolerant crops.

2.3. Economic Value of Mangrove:

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 covered250,000 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. The mangrove foreststhave enormous economic potentiality and utilitarian value at the ecosystem as well as at the component levels (UNEPWCMC 2006). Mangroves have been playing a significant role in the economy of tropical societies for thousands of years, providing a wide variety of goods and services including wood production, support for commercial and subsistence fisheries, salt production and shoreline protection and coastal erosion control (Krauss *et al*. 2008).

Mangroves exhibit a high degree of ecological stability and community persistence in the face of environmental inconstancy. Their survival is due to a variety of key features that in toto result in ecosystems having properties of both terrestrial and marine biomes plus a few uniquely their own, such as large below-ground storage and transformation rates of carbon and nutrients; simple architecture and self-design; highly efficient but complex biotic controls; species redundancy; and multiple feedbacks which serve to either facilitate and augment recovery from, or resilience to, natural and anthropogenic disturbances Alongi, D.2002; (Daniel M & Alongi 2008)

2.4. Mangroves Growth:

Mangroves grow in sheltered tropical and subtropical coastal areas across the globe. In general, this is an area between latitudes of 25 degrees north and 25 degrees south, however, geographical limits are highly variable depending upon the area of the world and local climates. In Eastern Australia, the mangrove *Avicennia marina* can grow as far south as 38 degreesand *Avicennia germinans* can grow as far north as 32 degrees in the Atlantic. A major restriction for where mangroves can live is temperature. The cooler temperatures of northern temperate regions prove too much for the mangroves. Afluctuation of ten degrees in a short period of time is enough stress to damage the plant and freezing temperatures for even a few hours can kill some mangrove species. However, rising temperatures and sea level due to climate change are allowing mangroves to expand their ranges farther away from the equator and encroach on temperate wetlands, like salt marshes. (Deltares, 2014)

Mangroves grow in a soil that is more or less waterlogged and in water whose salinity fluctuates and may be as high as that of the open sea (Naidoo *et al*. 1997). Mangrove trees adapt to survive such uncompromising surroundings with several morphological features such as salt-excreting leaves, and viviparous water dispersed propagules. In response to salinity where water economy is stringent, leaves tend to be smaller and thicker in mangroves (Ball 1988a).

2.5. Viviparous Propagules:

The seedling develops without dormancy largely by elongation of the hypocotyl to produce a cigar-shaped seedling known as propagules, which remains conspicuously pendulous on the mother tree for several months (Tomlinson and Cox 2000). The viviparous condition is so strongly associated with mangroves that it is suggested to have adaptive significance in the intertidal environment. It was assumed that vivipara in mangroves may be an adaptive characteristic permitting avoidance of high salinity at germination (Henkel 1979). Some evidence has proved that developing viviparous propagules (i.e., hypocotyls) in Rhizophoraceae retain lower salt concentrations than in other organs of mother trees especially the leaves, but it increases gradually during the process of Propagules maturation (Wang *et al*. 2002).

2.6. Salinity Mechanism:

Mangroves experience hyper saline conditions as a result of evaporation (which raises the salinity level) and fluctuation of salinity caused by tide (Lovelock and Feller 2003). High salinity and salinity variation pose a problem for mangroves (Lovelock and Feller 2003). Another typical characteristic of mangrove is the induction of leaf succulence by thickening of leaves with increasing water content (Suarez and Sobrado 2000). For example, *Laguncularia racemosa* can increase leaf thickness and water content when stressed with high salinity (Sobrado 2005), by which absorbed salt was diluted and salt-induced damage was reduced to some extent. Mangroves are salt-tolerant trees, also called halophytes, and are adapted to live in harsh coastal conditions. They containa complex salt filtration system and a complex root system to cope with saltwaterimmersion and wave action. They are adapted to the low-oxygen conditions of waterlogged mud, (Flowers & Colmer,2015) but are most likely to thrive in the upper half of the intertidal zone. (Zimmer & Katarina,2021)

2.7. Raising awareness among local communities about the importance of mangrove forests can be achieved through various methods.

Here are a few commonly used approaches:

Raising awareness among local communities about the importance of mangrove forests is a crucial aspect of their conservation and sustainable management. It can foster a sense of ownership, empower communities to take action, and ensure the long-term protection of these valuable ecosystems. In this article, we will explore several significant methods that have proven effective in increasing awareness about mangrove forests among local communities, supported by relevant references.

- Community Engagement and Participation: Engaging local communities directly in the conservation and management of mangrove forests is a powerful approach. Community-based organizations, workshops, training programs, and participatory decision-making processes can be employed to actively involve community members. Through such involvement, their awareness and understanding of the value of mangrove forests can be enhanced, leading to greater commitment to their preservation.

- According to Dahdouh-Guebas et al. (2005), community engagement played a vital role in the aftermath of the tsunami in creating awareness about the
  - protective role of mangrove forests. The involvement of local communities in restoration efforts helped highlight the significance of mangroves as naturalbarriers against coastal hazards.
- Environmental Education and Outreach: Education plays a crucial role in increasing awareness about mangrove forests. Conducting educational campaigns, workshops, and awareness-raising programs in schools, community centers, and local events can be effective. These initiatives can include interactive activities, presentations, field trips to mangrove forests, and the distribution of educational materials.
- Lewis and Marshall (1998) emphasized the importance of environmental education in promoting mangrove conservation. Their research demonstrated that educational programs that provide scientific information about mangroves and their ecological functions can significantly enhance awareness and appreciation among local communities.
- Demonstration Projects and Ecotourism: Demonstration projects within or near mangrove forests can serve as living examples of their ecological and economic benefits. Such projects provide opportunities for local communities to witness firsthand the importance of mangrove ecosystems. Ecotourism initiatives that promote sustainable practices and educate visitors about the value of mangroves can indirectly contribute to community awareness.

- Spalding, Kainuma, and Collins (2010) highlighted the role of demonstration projects in raising awareness about mangroves. They stressed the need to establish pilot projects that showcase the potential benefits of mangrove conservation and sustainable use, particularly inareas where local communities rely on the resources provided by these ecosystems.
- Traditional Knowledge and Cultural Practices: Recognizing and valuing the traditional knowledge and cultural practices associated with mangrove ecosystems can enhance community awareness and pride. Cultural events,

storytelling, and incorporating traditional ecological knowledge into conservation efforts can be effective in fostering a deeper connection between communities and mangrove forests.

It was revealed the importance of indigenous knowledge and cultural practices in mangrove conservation among Filipino communities. By integrating traditional practices into conservation programs, communities developed a stronger sense of ownership and were motivated to protect their mangrove forests (Quarto, 2005).

In conclusion, raising awareness among local communities about the importance of mangrove forests is a multifaceted task that requires employing various methods. Community engagement, environmental education, demonstration projects, and recognition of traditional knowledge and cultural practices are significant approaches in increasing awareness and promoting active participation. By implementing these methods, local communities can become empowered stewards of mangrove forests, contributing to their long-term conservation and sustainable management.