INTRODUCTION
CHAPTER – 1

INTRODUCTION

1.1 COASTAL ECOLOGY

Coastal ecology is a wide and multidisciplinary subject which is linked with biology, geology, and earth sciences. These three are a part of each ecosystem including the coastal, where they generate biotic and abiotic components and their communication (Ahmad, 1982). Coastal ecosystem is vital, not only for a wide range of biodiversity, but also for the food chain, livelihoods, and climate regulation for the human population (Gardner et al., 2015). The coastal resources have an immense ecological and economic importance to the coastal environment and the coastal communities. However, globally, it gets destroyed and exists under the condition of threat due to disturbances in nature and anthropogenic pressure (UNEP, 2016; Parthasarathy & Gupta 2014). According to IUCN data, the rate of coastal ecosystem losses is the highest in the world (IUCN, 2016). Since the advent of civilization, the use, overuse, and misuse have led to depletion of various natural resources. The improper utilization and management practices have caused a major disturbance in the coastal ecosystem. The “Sumatra” tsunami on 26 December, 2004 in the Indian Ocean was the best example of it and has brought more attention towards coastal ecological conservation for scientists across the world.

1.1.1 Coastal Ecosystem Services

The coastal components are associated with numerous environmental functions. Their ecological services have a role in water, food chains of nutrients, carbon capture, biological diversity, releasing of raw materials like minerals, sand, quartz, and mica and so forth. The interaction of these components provides regulating and cultural benefits such as flood control, coastal erosion control, tidal effect control, shoreline protection, protection from cyclones, climate regulation, tourism and support functions
Furthermore, they provide recycling of nutrients, purification of water, remediation of contaminants, recharging of groundwater aquifers, and an important habitat for wildlife and vegetation, especially for rare, endangered and threatened species of flora and fauna (Ma et al., 2012; GEC 2012; TIII, 2014). The coastal economic services are found due to fisheries and varying products from vegetation sources. According to ‘The State of World Fisheries and Aquaculture’ report, the aquaculture raises the economy by mounting annual fish production rate, which is increasing at an average rate of 3.2% (FAO, 2014). Some worldwide assessments have considered the coastal vegetation products such as coal, food, fuel, honey, natural gum and natural medicines are contributing economic evaluation of ecosystem services (Cabrera et al., 1998; Mukherjee et al., 2014; Rameshkumar & Eswaran, 2013). Additionally, the coastal vegetation plays a vital role in various environmental functions like protection and management (Gedan et al., 2011). They have been providing beneficial services to the coastal community and the wetland territory (GEC, 2012). Commonly, the coastal vegetation is found on marshy lands, sandy beaches, mudflats and rocky areas. According to the species and their habitat structures, coastal vegetation is categorized under Strand vegetation, Eu-estuarine and Pro-estuarine vegetation which is a part of coastal mangroves (Ingole, 2005; Rao & Sastry, 1974; Sridhar & Bhagya, 2007). According to UNEP (2006), more than one-third (40%) of the global population lives near the coastal area and utilizes the sources for their livelihoods. However, the utilization rate of coastal vegetation is on a hike because of intensive and rapid human development (Bhavsar et al., 2014; Nayak & Bahuguna, 2001). Some environmental factors and natural disturbance have put pressure on their survival which catches attention of the environmentalists (Gaur et al., 2007; Rath & Rousk, 2015; Zia & Khan, 2004).

1.2 INTERACTION OF COASTAL COMPONENTS

Coastal marine organisms are found at a high rate of influence by the abiotic components. The varying types of coastal vegetation and associated ecosystems support the proliferation of unique diversified soil macro
and microorganisms. Their interaction plays a pivotal role in the degradation of contaminants, purification of water, carbon sequestration, benthic organisms, nutrient recycling process, the release of substances for plant nutrients and so forth (Rath & Rousk, 2015; Sierszen et al., 2004; Sims et al., 2013). Thus, the coastal ecosystem is known as the “Kidney of Earth” (Ma et al., 2012). Under this harsh environment, some extremophiles, halophiles, eubacteria, chemolithotrophs and other adapted communities are found and involved in the recycling process (Yousuf, et al., 2012; Zahran, 1997). These microbes and coastal plants also release enzymes in a soil environment which catalyze reactions involved in energy transfer, crop productivity, environmental quality, and nutrient recycling processes. They also depict the functional diversity, healthy vegetation and the soil status of the coastal wetland ecosystems (Gianfreda & Ruggiero, 2006). Under unfavorable conditions such as salinity, metal contaminants, drought, the presence of contaminants and seasonal variations can show major effects in habitats particularly on soil enzyme activities which reflect the present ecosystem conditions. Indian coastal study, in Sundarban region, showed seasonal variation effects on soil microbial biomass and enzyme activities (Tripathi et al., 2007). Similarly, soil moisture, pH, organic carbon, metal concentrations have been noted for degradation of a living organism in the coastal (Ji et al., 2009). However, soil salinity, one of the common and major responsible factor for the decline soil enzyme activities in the coastal and the nearest agricultural soil (Acosta-Martinez & Tabatabai, 2000; Miller et al., 2010). Likewise, another study was discovered that the soil enzymes functional diversity showed counter effects owing to pesticides near Gujarat coastal (Zaveri et al., 2016). These studies are advised to make attention to evaluate environmental parameters and enzymes diversity of study sites.

1.3 MENACE CONDITION(S) TO COASTAL ECOLOGY

The World Bank Group (WBG) helps the countries to improve the coastal resources and their sustainable development. Because coastal ecology is highly influenced by the impact of climate change, environmental conditions, disturbance of nature and man-made activities (UNEP, 2016; Parthasarathy & Gupta, 2014). Rapidly growing human population, and
associated development activities such as urbanization, agriculture practices, consumption of coastal vegetation source as fiber, food, and fuel, transport system development etc. are causing the destruction of coastal ecology (Ronnbaack, 1999; TEEB, 2014). The state economic development activities such as the establishment of petroleum, cement, pharmaceuticals, chemical, and salt industries, as well as port development activities, have tremendous pressure on the coastal ecology (SAC, 2012; GEC, 2012). Moreover, some natural calamities such as cyclone, flood, tsunami, sea level rise, and cyclone are being one of the most hostile and unpredictable activities which degrade the coastal resources (Chang et al., 2006; Marois & Mitsch, 2017). In recognition of the influence of these activities are widely destruct living and nonliving components of the ecosystem. Numerous studies have been found that coastal vegetation’ and coral reefs are highly affected by these activities (Nayak & Bahuguna, 2001; Prerna et al., 2012; Singh et al., 2014). Mainly, coastal vegetation’ and coral reefs are the most productive and fragile components of coastal ecology which provide the highest ecological and economic importance to the coast (Barbier et al., 2011; Mukherjee et al., 2014; Vo et al., 2012). Currently, multidisciplinary research addressing various issues related the impact of the anthropogenic pressure and natural disasters on coastal ecological components has come to limelight. Because, a minor change in the coastal ecosystem may lead a radical change in microbe and vegetation diversity driving certain life forms to extinction (Singh et al., 2014; Tripathi et al., 2007). Hence, the coastal ecological components have become the focus of research for investigators over the world.

Mainly, the coastal different vegetation and coral reefs are the most dynamic and brittle components of coastal ecology which provide the uppermost benefits to the environment and coastal communities. Coastal ecology has impressive biodiversity and it associates itself with crucial environmental functions; still, it is scientifically less understood (UNEP; Boaden & Seed, 1988). This study focuses on the plants associated with diverse habitats of the coast and it serves as one of the most important living components of the coastal ecology. Because, the coastal vegetation is continuously degraded under the unfavorable environmental conditions such as
the stress of saline, acidic pH of the soil, less availability of nutrients, soil moisture content and the structure of the soil (Ji et al., 2009; Kim & Yu, 2009; Miller et al., 2009; Vallés et al., 2011). In addition, some natural imbalanced activities like a cyclone, tsunami, flood, and coastal erosion are the key factors for the degradation of coastal vegetation (Polidoro et al., 2010; Rameshkumar & Eswaran, 2013; Srivastava et al., 2014; Thampanya et al., 2006). These situations may cause loss of some crucial species which is vulnerable and draw attention for further studies.

1.4 COASTAL VEGETATION

The coastal vegetation is widely dispersed and grow under a peculiar environment (Rao & Sastry, 1974). It is found in littoral and swamp forest (Type 4B) and near the coastal and intertidal zone of coast. In 1976, Chapman divided coastal vegetation into marine algae of littoral and sub-littoral forests, phanerogamic and algal vegetation of salt and brackish marshes, sand dune plants, drift-line vegetation, shingle vegetation, and mangroves. The vegetation is closely related to the habitat structure, soil conditions, and geomorphic factors which creates varying patterns of vegetation (Kim & Yu, 2009). Seagrass and macroalgae are found in the subtidal area which is submerged while macroalgae proliferate on rocky shores or in coral reefs. The intertidal zone which is influenced by the daily tides has limited growth of plant species because of saline soil and water. The intertidal coast has mudflats where salinity is relatively high and supports the growth of mangroves. Only salt marsh and mangrove species can bloom in such areas. At the landward side in cliff and dune vegetation, where the soil salinity is gradually decreased is comprised of the herbs, shrubs, and creepers diversity. Among all, these two landforms have more floral species diversity and are conducive for some rare and threatened species (Castillo et al., 1991; Zalba & Nebbia, 1999).

However, these varying vegetation continue to decline under unfavorable edaphic factors, environmental conditions, natural tragedies, and the developmental activities. Majorly soil salinity is being identified as the limiting factor for proliferation of vegetation followed by soil moisture, soil pH, soil structures, carbon, nitrogen and phosphorous availabilities, and the nutrient
toxicity (Basha et al., 2010; Fenu et al., 2013; Ji et al., 2009; van Wijnen & Bakker, 1999). The geographical location and climate conditions influence coastal vegetation (Farooqui, Gaur, & Prasad, 2013; Kim & Yu, 2009). Besides these, living factors like plant-plant inter and intra interactions are found to create disturbance in the vegetative communities (Oberndorfer & Lundholm, 2009; Vallés et al., 2011). These influences affect vegetation distribution patterns by controlling plant species survival rates. A high influence of an edaphic factor leads the species to risk category (Oberndorfer & Lundholm, 2009).

Overall, the coastal vegetation contains a large number of floral species in specific environmental conditions. It receives an annual rainfall in a ranging from 250 mm to 3000 mm and temperature from 25 to 35 °C (Gnanappazham & Selvam, 2014; Heumann, 2011). They have unique adaptation survival traits under saline conditions, varying temperatures, a high and low concentration of moisture, high and low tides of water and abundant living microorganisms and insects (Hameed et al., 2015; Shah, 2017). These unique floral species are used to give emphasis to a specialized group of plants which can breed in the coastal areas. The present study considers mangrove associates, salt marsh, and sand marsh vegetation because of their higher species diversity. The plants have unique adaptation features like specialized seed germination mechanism, increased thickness of leaves, development of specialized root system, rolled leaves in response to heat, salt and lack of water, hairy leaves to avoid heat stress and produced large seeds to increase viability and vigour of seedlings (Flowers & Colmer, 2015; Massó i Alemán et al., 2010). The mangroves, associate mangroves, species of sandy and salt marshes have few to more above mentioned features to survive under high saline conditions and are known as “Halophytes” (Bandaranayake, 2002).

These halophytes are associated with the coastal mangroves and their habitats serve as a bridging ecosystem between freshwater and marine systems. They occupy 1% of the world’s surface and 4,740 sq km in India accounting for 0.14% of the total geographical area (DasGupta & Shaw, 2013). This study was conducted to assess the medicinal flora, which can grow in different coastal habitats and their ecological dynamics from the selected sites.
of Gujarat. Singh et al., (2012) reported that Gujarat has second largest areas of mangroves, covering 23% of India’s appraised mangroves. Along with that, Gujarat coast and associated diverse habitats have been studied for important plant species (Bhatt et al., 2009; Ishnava et al., 2011; Pardeshi et al., 2010; Rodrigues et al., 2011). The Forest Survey of India reported that from 2013 to 2015, 112 sq km, area under vegetation has expanded. Although, Gujarat is a largest maritime state of India and comprise a higher number of diverse vegetation but has not been much explored for their ecological study. Thus, the present study focuses on the medicinal importance of halophytes (reported under GMPB and IMPB database) near the land areas of a high water line was considered for the targeted study.

1.4.1 Importance of Coastal Flora

Coastal halophytes have vital ecological functions in wetland habitats. According to Ingone, (2005), the Indian coastal region has varying kind of halophytes including in coastal, island, and deltaic areas. Deltaic areas are found in both the Gulfs of Gujarat as well as at the openings of different estuaries on the east coast of India. Coastal vegetation develops on intertidal coastlines, slightly at the entry of rivers, backwater areas of the west coast and sheltered bay areas. The island areas exist near shallow but protected intertidal zones of bay islands (Saravanakumar et al., 2009). These coastal halophytes are categorized into different types, namely succulent, non-succulent, facultative, shingle, grassweed and obligate halophytes. The individual type of vegetation grows under specific environmental conditions which lead to varying types of vegetation (Dagar, 2005). The environmental variables such as soil structure, aeration, drainage, nutrient availability, toxicity, and salinity are also responsible for it (Yu et al., 2012). In the present conditions, consideration is being paid worldwide to conserve the halophytes supportive niche including marshlands. These halophyte species have been traditionally used for different purposes like fuel, fodder, boat building, development of natural products, firewood, stakes for fishing, shelter and traditional medicinal practices (Singh et al. 2012; Singh et al., 2014). The coastal communities are highly dependent on the coastal sources and vegetative products for their economy and livelihood.
(Ronnbaack, 1999). The study contributes the halophytes ecological services in a complementary medicine field by evaluating medicinal flora on the basis of higher antioxidant potential from coastal regions of Gujarat.

**Research Priority to Coastal Flora: An Essential Natural Medicinal Source**

One more well-founded reason is products from seacoast vegetative components have been utilized for the development of alternate drug sources in the current scenario. This is because drug demand rate continues to increase due to rising population of drug users a worldwide. The data of World Drug Report noted around 255 million drug users up to 2015 (UNODC, 2017). To overcome the problem, traditional medicines are beginning to be sought after for the support of health care delivery as a prominent, safe, and easily available source (WHO, 2013). From ancient times, India is well known for its traditional medicinal practice and holds the second position in the world in it (Gurib-Fakim, 2006). At present, India is also facing drug demand, safety and efficacy problems (UNODC, 2017). In order to meet this new demand and in response to a resolution, the Ministry of Ayush and the Ministry of Earth Science have proposed a project on “Drug from Sea” under Ocean Science research. Seacoasts and associated environments are world’s most productive habitats (MoES). Varying coastal vegetation is mainly explored for their ethnopharmacological importance because the species produce effective molecules during their lifespans to protect themselves and survive under extreme conditions (Saranraj & Sujitha, 2015). They have a unique adaptation in morphology, anatomy, and physiology (Flowers & Colmer, 2015). Generally, they produce polyphenol group of compounds considered as effective natural substances and further utilized for the development of an eminent alternative drug source (Ksouri et al., 2012). At present, it is a new arena for to utilize extracts and evaluating components for the development of natural medicines from coastal biotic components. Hence, the study ideates itself on medicinal halophytes assessment, their phytoconstituents, and antioxidant potential as a prominent medicinal property.
1.4.2 Halophytes a Potent Source of Natural Antioxidants

Different halophyte diversity has been studied since long and the knowledge and information of its importance are now understood far and wide. Because of their unique properties for the adaptation, varying species are used in traditional medicines. For survival under stressful conditions, halophytes cope with oxidative stress by producing enzymatic and non-enzymatic antioxidants. Some enzymes such as catalase, superoxide dismutase, glutathione reductase, ascorbate peroxidase, and dehydrogenase act as primary antioxidants which terminate the free-radical chain reactions by donating electrons or hydrogen and convert into stable compounds. The plant’s secondary metabolites include total phenol, flavonoids, tannin, alkaloids, steroids and so forth which are known as secondary antioxidants (Oueslati et al., 2012; Panda, 2012; Roy et al., 2011). These natural antioxidants show strong defense against cellular damage, DNA damage and reduce oxidative damage to biomolecules. The plant extracts have active phytoconstituents which contain radical scavenging and chelating activity on reactive oxygen species (ROS) and reactive nitrogen species (RNS). Thus, the natural products are used for the prevention of different oxidative stress and related diseases such as cancer, anti-inflammatory, diabetes, cardiovascular and neurological disorders (Rodrigues et al., 2015). India’s west coast have highest halophytes diversity in comparing with the east coast. Species diversity of the Gujarat mangrove halophyte is actually low and limited 13 number of species with seeming dominance of Avicennia marina (Singh, 2002). But, the coast dune flora of Gujarat region was found around 66 floral species from 56 genera (Rodrigues et al., 2011). The region comprises of maximum herbs and shrub halophytes and moderate grassweeds as well as tree species. And the evaluation of species status is mandatory due to stand in critical habitats living conditions. Nowadays, these species are exploring in herbal medicinal practices. Because, in the 21st century, natural medicines are getting significant attention in global health debates. They are also called green medicine, a traditional medicine which is derived from plants - one of the cheapest sources, and require least or no industrial process (Tilburt & Kaptchuk, 2008). More attention is being paid to natural drug development from halophyte species because they thrive in a peculiar
environment. Also provides a niche for some threatened and rare wild species and possess an uncommon morphology and physiology. They have different photosynthesis path from other glycophytes, for a reason itself develop chemical constituents which secure them from the stress. And further, their extracts and inherent compounds can be utilized in a folklore medicine (Saranraj & Sujitha, 2015). The Indian government also takes initiatives to use natural resources of the coast and associated habitats in developing traditional medicines. To date, the Indian government’s project, “Drug from Sea” screened 2000 extracts for varying medicinal activities and more than 100 commercially viable products have been recognized (MoES). The concerned project presents more opportunities for the development of natural medicine from halophyte species to overwhelming availability, economy, and generic drug demand sources. Therefore, the study projected to assess halophytes medicinal importance by executing varying antioxidant assay for the collected species by random sampling at sites.

### 1.5 STATUS OF INDIA’S COAST

The Indian sea coast, 7516.6 km long, is covered by the Arabian Sea on the west, the Bay of Bengal on the east, Lakshadweep islands towards the southwest and the Indian Ocean towards the south. A total of nine states cover the Indian coast which includes Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, and West Bengal. In addition, some islands of West Bengal and Andaman & Nicobar are also a part of the Indian coastland (SAC, 2012). The Indian coast is endowed with an extensive variety of environments i.e. coral reefs, mangroves, ocean grasses, sand rises, vegetated shingle, mudflats, salt swamps, estuaries, tidal ponds and lagoons, which are categorized by different living and nonliving forms (Ingole, 2005). The variety of marine environment is credited to geomorphological and climatic variables along the sea coast. The atmosphere along the sea coast fluctuates from the tropical areas in the south to that of the subtropical and drying conditions in Kachchh in the northwest. The annual rainfall differs from 300 mm in the arid region of Kachchh to 3200 mm at Andaman-Nicobar in the south. The varying rainfall pattern, environmental conditions, and geographical
locations are the key factors for diverse vegetation (SAC, 2010; GEC, 2012). The coral reefs and diverse coastal wetland mangrove forests are the most productive components of the Indian coast (SAC, 2012). The natural sources serve as a major income source for the coastal communities’ (Joseph & Balchand, 2000). Coral reefs, a dynamic ecosystem provides a shelter and nutrition to different marine flora and fauna. In India, coral reefs occur in the Gulf of Kachchh, the Gulf of Manar, the Andaman and Nicobar and the Lakshadweep islands. Coastal vegetation confine unique ecological formations arising almost exclusively in the tropics (SAC, 2012; GEC, 2012). The effects of natural disasters such as storm, cyclone, tsunami etc. are mitigated by the dense vegetation of the coastal known as mangroves (Alongi, 2002; Lugo & Snedaker, 1974). India's east coast has the world’s largest mangrove forests while the west coast contains diverse mangrove vegetation. Seagrass vegetation is found in the mid-tidal zones of shallow sheltered localities of seas, gulfs, lagoons and backwaters (Nayak & Bahuguna, 2001). They are submerged plants and habituated to the marine environment for the completion of lifecycle under water. The seaweeds are commonly found on flat and rocky coastal wetlands that progressively slope towards the sea with marked high to low tidal effects (Venkataraman, 2008). The coastal communities utilize these sources for basic livelihood. A recent study has found that the Indian coastal region persists under threatened conditions owing to increasing anthropogenic and natural pressure (Bassi et al., 2014). The economic activities like ship breaking, port development, aquaculture, offshore drilling may lead to important habitat destruction. Increasing population, their needs, industrialization and other development processes also cause an adverse effect on the coastal ecosystem (Prasad et al., 2002). Previously, Indian coasts were studied for the degradation of wetlands, erosion of shorelines, degradation of mangroves, destruction of habitat and natural disturbances by onsite variable analysis and remote sensing techniques (Gnanappazham & Selvam, 2014; Nayak, 2002; Nayak et al., 1989; Kumar et al., 2006; Selvam, 2003). Among all maritime states of India, Gujarat covers one-third portion of the Indian coastline including some productive and enriched habitats. Singh (2002) was reported that Gujarat exhibits higher development owing to the large coastal zone. It also covers the largest area of the coastal wetlands. The Gujarat Ecological Commision data under the ICZM
project found that economic activities continue to rise near the coastal districts of Gujarat (NCSCM and GEC, 2014; GEC, 2009). Rapid urbanization, industrialization, increasing population and their needs may lead to the destruction of the coastal ecosystem. Therefore, the coastal habitat and biodiversity protection have caught the attention of the conservationists of Gujarat.

1.6 GUJARAT’S COASTAL REGIONS AND ASSOCIATED ECOLOGICAL COMPONENTS

Gujarat coast consists of 1600 sq km coastline by the Gulf of Kachchh (GK), the Gulf of Kambhat (GKh), the Saurashtra coastland (SC) and the Diu & Daman union territories. The Gulf of Kachchh region has mangroves, coral reefs, and seagrass as biotic components as well as salt pans, mud flats, sandy beaches, creeks and salt marsh as abiotic components (Fig 1.1). It has extensive mudflats and is extremely indented with a number of cliffty rocky islands. Forest Survey of India reported that the highest mangrove halophytes are covered by the Kachchh district (786 sq km) (Fig 1.2) while Jamnagar contains a diversity of coral reefs. India’s first marine national park is developed in the Gulf of Kachchh region. The region also reported the largest halophytes area on the west coast of India accounting for 22.69% of the total mangroves. Around 77% of Gujarat’s halophytes (mangroves and associated mangrove species) occur in the Gulf of Kachchh (DasGupta & Shaw, 2013; Rodrigues et al., 2011). The Gulf of Kambhat region has seven estuaries, sediments, grass beds, mud flats, lagoons and mangrove habitats. The Saurashtra coast is moderately straight directly facing the Arabian sea and comprises varying habitat diversity like marshlands, rocky beaches, sand beaches, estuaries, bays, wetlands, and mudflat areas. The Indian territory of Diu has numerous cliffs, embayments, beaches, estuaries, and mudflats, while the site of Daman contains heavy minerals, mica, and quartz sand beaches along with the Damanganga mudflat area. The Gujarat coast provides an extensive variety of coastal life owing to its varied geomorphology, physiology and coastal process. Moreover, the individual habitats also create varying marine biodiversity but the
development, natural disasters and human activities affect it adversely (NCSCM and GEC, 2014; SAC, 2012; GEC, 2012; SAC, 2010; Singh 2000).

Coral Reefs, Jamnagar, Gulf of Kachchh, Gujarat (Source – Gujarat Ecological Commission)

Fig. 1.1 Ecological Components of Gujarat Coastal Regions from Gulf of Kachchh and Saurashtra coast region.
Fig. 1.2 Mangrove Areas of Different Districts of Gujarat according to the India State Forest Report, 2015 (FSI, 2015).

1.7 THREAT TO GUJARAT’S COASTAL ECOLOGY

Gujarat has been found a high rate of development (50%) near the coastal area (NCSCM and GEC, 2014). The Gulf of Kachchh region has large industries in cement, salt, coal, chemicals, and energy production fields. Cement production industrial activities create water pollution by increasing the turbidity and toxicity of coastal water. It also gets polluted by pharmaceutical, CETP, chemical and other industrial effluents (Nayak & Bahuguna, 2001; Nayak et al., 1989; Srivastava et al., 2014). The National Census of 2011 presented that the urban population increased in the coastal districts by 66.4, 53 and 50 percent in Valsad, Kachchh and Bharuch respectively. Urbanization creates exploitation of renewable and non-renewable natural resources and discharge of waste effluents and sewage materials in the coastal region (GEC, 2012). The Gulf of Khambhat region has oil and gas reserves, and their leaching process increases water turbidity and destructs habitats. Some mining activities are also responsible for habitat destruction. Port development, ship-breaking,
recycling activities also create pressure on the coastal habitats (GEC, 2012; Kumar et al., 2006). In India, around 70% of the salt is developed by Gujarat and major salt pans area is reported from the Gulf of Kachchh. This action creates an increase in salinity of coastal water and it also disturbs the water table level of the surrounding areas (Balamurugan & Aravind, 2015; Pasha et al., 2016). The Saurashtra coast directly faces the Arabian Sea and is the most exposed to activities of natural imbalance. Some natural disturbances have tremendous pressure on the natural resources and lead to the degradation of the coastal environment (Jaiswal et al., 2009; Kumar et al., 2006). These variations can directly adapt to chemical and physiological properties such as salinity, soil pH, nutrient availability and sediment properties. These environment alterations provide favorable conditions for the biotic components of coastal habitat. At the point when hydrologic conditions in wetlands change even marginally, the biota may react with massive changes in species creation, richness and ecosystem efficiency (Prasad et al., 2002). Overall, these activities lead to the destruction of coral reefs, mangroves, coastal vegetation, and other coastal biodiversity hotspots. Thus, the scientists, researchers and some government organizations have paid attention to protect, maintain and develop this productive environment. Especially, there is more concern for the Gulf of Kachchh (GoK) and the Saurashtra coastal regions because the former has a fragile and productive habitat and the SC region is associated with habitat diversity (Singh, 2002; Prusty, 2009; Ingole, 2005; Saravanakumar et al., 2009).

Major Concern To Coastal Vegetation

The mentioned development activities and periodic natural calamities have taken place most serious and worrisome destruction in the different coastal vegetation. However, earlier in the 1970s, this destruction was found to be the lowest. But nowadays, improper utilization, influences of abiotic factors, and other state development activities are causing risk on vegetation. Worldwide research has proven that there is extensive coastal deforestation which is causing a decline in the number of species also, extinction in some cases (Newbold et al., 2015). The rate of global coastal vegetation has decreased by 35% in the last decade and in certain Asian countries, it has been
reduced by half. The annual coastal deforestation global rate is approximately 2% and human activities have been proven as the primary culprits in most countries for this (GEC, 2012a). Hence, the study contributes to ecological importance of selected species of coastal Gujarat (availability found at the specific area in particular site) by finding their medicinal importance.

1.8 NEED TO CONSERVATION

Realising the importance of coastal hotspots, the Ministry of Environment and Forests (MoEF, 1991) announced a project on Indian Coastal Zone Management (ICZM) and the mangrove restoration and management activities increased during the period from 1983 to 2008. The Gujarat Ecological Commission (GEC) plays a leading role in mangroves reclamation and conservation on mudflat areas of the Gujarat coast (Fig 1.3). Mudflat contains uncommon types of vegetation along with macro and microorganisms (Bassi et al., Kumar, 2014). Under the actions of coastal zone management, remote sensing and geographical information system (GIS) are widely used. A large number of the studies have been conducted on Gujarat coastal region viz. shoreline change detection, land use land cover mapping, assessment of area and diversity of vegetation, influences of abiotic factors, adverse effect(s) of natural disasters, and so forth (Balamurugan & Aravind, 2015; Mahapatra et al., 2015; Misra & Balaji, 2015; Nayak & Bahuguna, 2001; Saravanakumar et al., 2009; Shah & Thivakaran, 2014). It seems that the species level conservation and management are essential to ensure the protection of the coastal ecosystem services. Therefore, RS and GIS techniques are beneficial as they offer ex-situ conservation of medicinal species at its growth proliferative sites.

Fig. 1.3 Mangrove Restoration Process at Gujarat Coast (Source – Gujarat Ecological commission information brochure)
1.9 PURPOSE OF THE STUDY

There is a recent trend of obtaining natural medicines from a plant source. Because plants contain secondary metabolites, widely used as a source of potential chemotherapeutic agents. Due to their high potential, wide applicability and efficacy, they are often used for the treatment of diseases and disorders. India has a rich heritage of knowledge on plant-based drugs. Presently, many pharmaceutical industries have utilized these sources for the development of natural medicines. It provides inexpensive and easily available alternate drug source. Moreover, these natural medicines contain least side effects, more durability and are safer than the synthetic drugs. Owing to the awareness about drug usage and their sufficient knowledge behind utilization, wider population are using natural medicines in their common medicinal practices. In India, Gujarat has the highest number of pharmaceutical industries and is known as ‘pharmaceutical hub’. In the present scenario, these industries are engaged to find out the best alternate drug source from plant material. To date, the tropical forest species are widely studied and utilized for the medicinal purpose. But, nowadays, the coastal vegetation have found more attention for the medicinal purpose utilization aspects. For the present study, Gujarat coast and associated different habitats were assessed for their high species diversity. Commonly these species are halophytes and are developed under harsh conditions as well as find a high influence of abiotic factors. During their lifespan, they are producing most diverse and crucial compounds due to their survival under harsh environment. This key factor pulls attention to identify crucial halophyte species for the best source of green medicines.

Along with species, their habitats and environmental conditions are also considered for the study. These interlinked factors are essential to study for the Gujarat coastal region. Since it finds a high rate of development near coastal region. The growing population, urbanization, and industrialization are causing tremendous pressure on coastal habitats. Apart from these, the Gulf of Kachchh and the Saurashtra coast regions are highly affected by natural disasters. Tropical cyclones, heavy winds and rainfall cause major damage in the Gulf area while Saurashtra coast is majorly impacted by coastal erosion.
Gujarat has the longest coastline in the country and has been its lifeline, drawing prosperity from faraway lands. But under various pressures, this shore and associated living and nonliving components are being chewed away across the large swaths by the Arabian Sea. These conditions are making communities and coastal ecology and ecosystems more vulnerable. The natural and anthropogenic pressure which cause habitat destruction as well as loss of biodiversity. Consequently, the actions cause more threat to coastal vegetation and soil microbes where some common, rare and threatened species are also present.

Owing to the constant decline of these essential sources of coastal ecology from Gujarat region, the species, and surrounding environmental variables are also considered for the study. The nutritional status of the soil, soil structure, soil pH, electroconductivity and microbial diversity reveals the conditions of the soil. Additionally, microbes and associated enzyme activities health status and functional diversity of the soil. The coastal vegetation is highly dependent on the soil physicochemical and microbial parameters. Under favorable conditions, species diversity and density are which helps to maintain coastal ecology. The conservation and management of these sources are also essential to protect the coastal environment. Recently remote sensing and GIS tools are widely used in monitoring, protection and management actions near the coastal region. To date, Gujarat coast has been widely explored for their scientific studies by these tools. Here, as a part of conservation and management of medicinal species, the most suitable and fragile regions were assessed for monitoring and change detection for two and half decades interval. These species are sensitive to the environment and thus, are essential to conserve at the growth proliferation location itself.

Overall, based on the ecological status of Gujarat coastal, vegetation of diverse habitats are considered as a priority. The sites comprise medicinal species from the Gulf of Kachchh and Saurashtra coast are consider for their ecological study. By considering the issues associated with the targeted sites and to acquire better outcome for the study sites, accompanying aim and objectives have been chosen to conduct the investigation.
Aim of The Study

“Ecological study of selected medicinal plant in coastal wetland of Gujarat”

Objectives

1. Screening of medicinal plants in the coastal wetlands of Gujarat
2. Analysis of soil’s physicochemical and microbial diversity in a coastal wetland
3. Study of phytochemicals of selected medicinal plant species
4. Enzymatic activity and their correlation with plant soil environment
5. Study of land-use pattern change in Coastal wetland (Fragile region) using GIS & Remote Sensing