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Saltmarsh Halophytes in Mannar Landscape, Sri Lanka

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Abstract: **The coastal ecosystem diversity in Sri Lanka is a combination of several ecosystems which are estuaries, lagoons, beaches, rocky shores, sand dunes, salt marshes and mangroves. Saltmarsh vegetation is mainly found in Northwestern and Southeastern regions in Sri Lanka. This ecosystem in the Northern region of Sri Lanka have not received any attention from ecologists for a long period of time. This review studying the saltmarsh vegetation, mainly halophyte species in Mannar landscape, Sri Lanka. The unique features of salt marsh vegetation, previous and current classifications of Sri Lankan saltmarsh vegetation and the physical morphological characteristics of saltmarsh halophytes in Mannar with the observations are focusing to communicating by this paper.**

The saltmarsh halophytes are unique vegetation including a conservational importance, the coastal studies are currently discussed as the issues of sea level rising with the global warming. Sri Lankan saltmarsh halophytes, *Sesuvium portulacastrum, Salicornia branchiata, Suaeda maritima, Suaeda monoica, Suaeda vermiculata*, *Tecticornia indica (Halosarcia indica)* and *Cressa cretica* are assessed unique physical characteristics, qualitative morphological features such as colour variations of plants with their age and other environmental factors.

Since this coastal wetland has numerous ecological, economical and other variety of values, conserving these habitats are very important. Saltmarsh halophytes consist with important physical and chemical properties are also adding a greater importance to the coastal wetlands. Since restoring or rehabilitation of a coastal habitat is a costly and time-taking process compare to the terrestrial habitats the scope of this review is highlighting the uniqueness and conserving importance to the society.

Keywords: **Coastal ecosystem, Conservation, Halophytes, Saltmarsh vegetation, Species, Morphological characteristics.**

I. INTRODUCTION

Salt marshes are a type of wetland ecosystem spread over the coastal intertidal zone in-between the land and salt or brackish water. These coastal wetlands are found worldwide in coastal intertidal zones particularly in middle to high latitudes. Saltmarshes are widely distributed in temperate region which is in higher latitudes while in tropical and sub-tropical region they are found in coastal areas behind the mangroves [1,2]. McOwen. *et al.,* (2017) has described the occurrence and extent of saltmarsh vegetation at a global scale covering 99 countries in the world (Figure 1). They have included saltmarshes in North and Central America, South America, Africa and the Middle East, Europe, Russian Federation, Oceania and Asia in their study including 10 points of saltmarsh locations in Sri Lanka. ten Brink *et al.,* (2011) and Murrey *et al.,* (2011) also have considered the global distribution of saltmarsh ecosystem in their studies.

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The coastal ecosystem diversity in Sri Lanka is a combination of several ecosystems which include estuaries, lagoons, beaches, rocky shores, sand dunes, salt marshes and mangroves. Saltmarsh ecosystems in Sri Lanka are found mainly in arid north western, north, and south eastern coast on sandy and muddy flats that are periodically inundated with seawater [3]. According to Sri Lankan Coastal Zone and Coastal Resource Management plan (CZCRMP) 2018, estimated extent of salt marshes in Sri Lanka is about 27,520 ha. with the largest area found between Manthai and Vankalai coastal belt. The other areas where salt marshes are found include Hambanthota, Puttalam, Kalpitiya and Mundel coastal areas [30]. Very few studies have been carried on saltmarshes in Mannar coastal region in Sri Lanka. (Premadasa *et al*.,1979 and Ranawana *et al*.,2020.) A recent study by Ranawana *et al*., (2020) reported seven true saltmarsh species namely *Sesuvium portulacastrum*, *Halosarcia indica*, *Salicornia branchiata*, *Suaeda maritima*, *Suaeda monoica*, *Suaeda vermiculata* and *Cressa cretica* from Mannar coastal area in Sri Lanka.

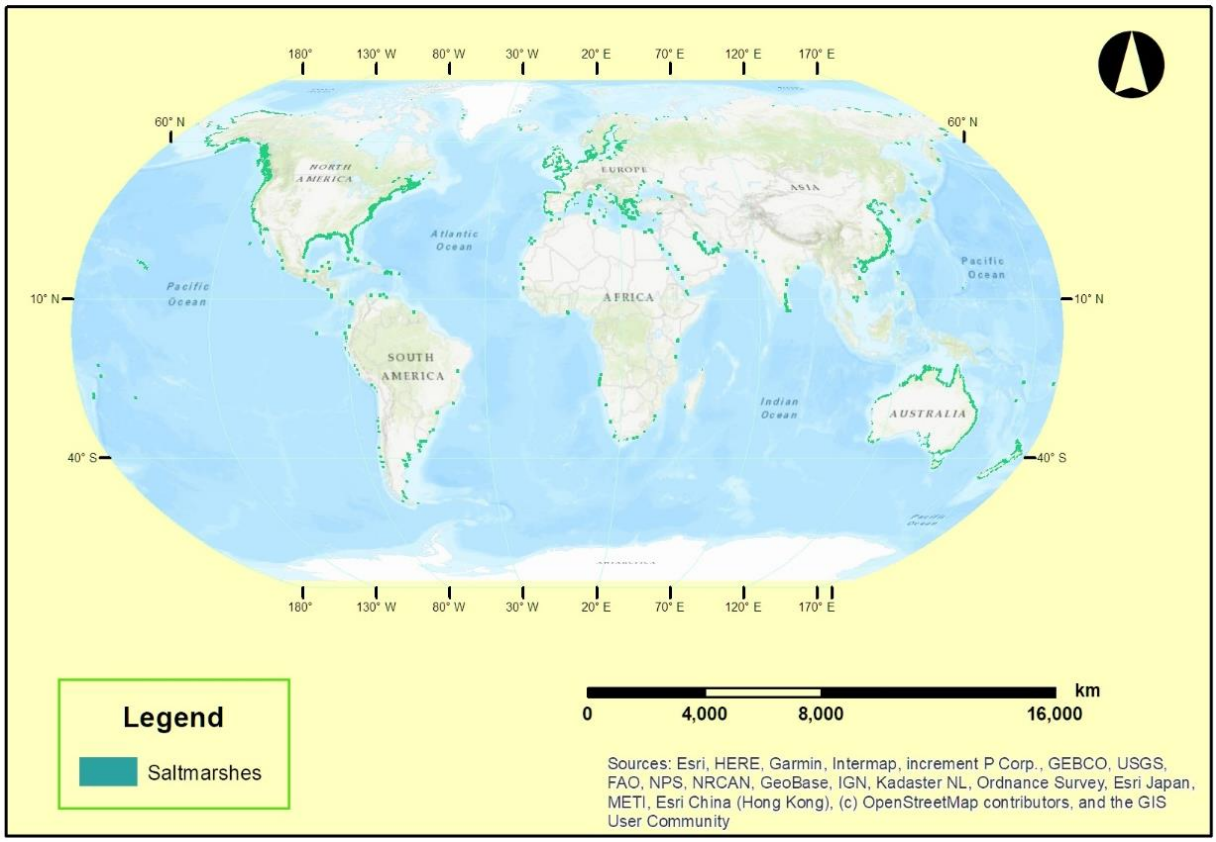

Fig. 1. Global distribution of saltmarshes.

Coastal ecosystems have very important ecological and economical values. Saltmarsh ecosystem generally supports a collection of different plant communities of small shrubs and perennial herbs [3,4]. This ecosystem is known as the most productive coastal ecosystem which provides a range of benefits such as providing food source and habitat to both estuarine and coastal fauna, protection of shoreline, water quality improvement etc. [5,6].

II. BODY OF ARTICLE

Saltmarshes in the northern region of Sri Lanka have not received any attention from ecologists for a long period of time. This review focus on ecological and morphological characteristics of saltmarsh halophytes in Mannar coastal region in Sri Lanka (Figure 2).

Saltmarsh vegetation and their unique features

A unique feature of the salt marsh vegetation as well as mangrove vegetation is the zonation of plant species distribution and composition with the elevation gradient. This is usually the arrangement of species in belts parallel to the shore line which depends on the local variation in microtopography [7]. Saltmarsh vegetation has unique properties and characteristics to survive in saline environment. Saltmarsh vegetation dynamics depends on physical, chemical and abiotic factors affecting

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plant physiology [8]. Salinity and tidal activities are key factors for plants in coastal wet lands. This vegetation is tolerating the environmental stress of the ecosystem. Therefore, the zonation can be observed in coastal wetland in relation to the competitiveness of plants and tidal cycles.

The zonation of estuarine saltmarsh vegetation is mainly found in temperate region which has regular tidal influence. The tropical and sub-tropical regions, the irregular tidal influences and environmental conditions allow saltmarsh plants to occur as larger zones which comprises of small infrequent patches of plants [9].

Figure 2. Saltmarsh distribution in North Western Coast in Sri Lanka. (Source: Ranawana *et al.*, 2020)

There are no descriptive studies on the zonation pattern of tropical and subtropical saltmarshes. Premadasa *et al*., (1979) has described well marked vegetational zonation in studied islet in Mannar area which is mainly related to topography and lesser extent to the soil condition and the exposure to wind. According to the field observations in North-Western coastline there cannot be observed a distinguishable zonation pattern in saltmarsh vegetation. The reason might be low tidal activity (tidal amplitude < 0.75m) around Sri Lanka compared to the other regions. However, a recent study by Ranawana *et al*., (2020) has identified different saltmarsh vegetation communities in Mannar landscape. *Suaeda monoica* and *Suaeda maritima* mixed with the land vegetation species mainly as *Senna auriculata, Salvadora persica, Phoenix pusilla and Thespesia populnea* can be observed in the interior margin of a salt marsh.

Saltmarsh flora species are characteristically inhabited by halophytes including herbaceous forbs, graminoids, and dwarf or subshrubs [3]. Global saltmarsh plant species distribution is summarized based on previous saltmarsh research study data (Table 1)

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Table 1. Global saltmarsh species distribution.

Regions and countries of saltmarsh distribution (Mcowen *et al*., 2017)	Climatic region Sayre *et al*., (2020)	Saltmarsh plant species recorded	Sources
North and Central America			
Canada, United States, Greenland, Mexico	Temperate region	*Spartina spartinae, Spartina patenes, Spartina alterniflora, Distichlis spicata, Salicornia - Batis- Monanthochoie*	Kennish (2001)
Nicaragua, Costa Rica, Panama, Antigua and Barbuda	Tropical region		
South America			
Chile	Temperate region	*Spartina alterniflora, Spartina densiflora, Sarcocornia perennis, Juncus acutus, Juncuss kraussii, Scirpus maritimus, Scirpus americanus, Phragmites australis*	Isacch *et al*., (2006)
Uruguay, Argentina	Sub-tropical region		
Brazil, Peru, Ecuador, Venezuela	Tropical region		
Africa and the Middle East			
Algeria, Angola, Djibouti, Egypt, Gambia, Ghana, Iran, Iraq, Kenya, Kuwait, Mauritania, Morocco, Namibia, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, South Africa, Sudan, Tanzania, Tunisia, United Arab Emirates, Western Sahara	Tropical region	*Bassia diffusa (Thunb.), Sarcocornia mossambicensis, Sarcocornia natalensis, Suaeda spp., Sporobolus virginicus., Salicornia spp., Sesuvium portulacastrum and Juncus kraussi), Cotula coronopifolia L, Limonium linifolium (L.f.) Kuntze, Juncus kraussii Hochst., Juncus kraussii Hochst.*	Adams (2020)
Europe			
Albania, Azerbaijan, Bulgaria, Croatia, Estonia, Georgia, Greece, Iceland, Latvia, Lithuania, Norway, Poland, Slovenia, Spain, Sweden, Ukraine	Temperate region	*Spartina anglica, Suaeda maritima, Puccinellia maritima, Aster tripolium, Atriplex portulacoides, Elytrigia aetherica, Festuca rubra, Triglochin maritima, Juncus gerardii, Limonium vulgare, Armeria maritima, Elytrigia spp., Suaeda vera, Frankenia laevis, Plantago maritima, Seriphidium maritimum, Lotus corniculatus, Leontodon autumnalis*	Lefeuvre *et al*.,(2013); Boorman (2003)

Table cont.:

Globally saltmarsh distributed regions and countries (Mcowen et al (2017))	Climatic region Sayre R. et al (2020)	Saltmarsh plant species records from previous studies	References
Russian Federation			
Russia	Temperate region	*Puccinellia phryganodes, Carex subspathacea, Stellaria humifusa, Potentilla egedei, Bolboschoenus maritimus, Zostera marina, Eleocharis uniglumis, Carex subspathacea, Carex ursina, Triglochin maritima, Tripolium vulgare, Plantago maritima, Calamagrostis deschampsioides, Plantago schrenkii, Salix ovalifolia, Carex lyngbyei, Rhodiola integrifolia*	Sergienko (2013)
Asia			
Japan, Korea	Temperate region		Patro *et al*., (2017)

Bahrain, Cambodia, India, Philippines, Sri Lanka, Taiwan, Vietnam	Tropical region	*Arthrocnemum indicum, Atriplex stocksii, Cressa cretica, Eriochloa procera, Fimbristylis ferruginea, Heliotropium curassavicum, Imperata cylindrica, Myriostachya wightiana, Porteresia coarctata, Phragmites karka, Salicornia brachiata, Scirpus littoralis, Sesuvium portulacastrum, Suaeda maritima, Suaeda nudiflora, Suaeda monoica, Suaeda fruticosa, Urochondra setulosa*	
Australia	Tropical region	*Batis argillicola, Sarcocornia quinqueflora, Tecticornia halocnemoides, Tecticornia indica, Tecticornia pergranulata, Tecticornia australasia, Carpobrotus glaucescens, Portulaca bicolor, Portulaca oleracea, Portulaca pilosa, Salsola kali, Dysphania littoralis, Enchylaena tomentosa var. glora, Suaeda arbusculoides, Suaeda australis, Sesuvium portulacastrum, Dissocarpus biflorus*	Johns (2006); Saintilan (2009)
Current Study - Sri Lanka (Figure 2)			
Norh Western Reigon Vankalei, Mannar, Vidaththalathive	Tropical region	*Sesuvium portulacastrum, Salicornia brachiata, Suaeda maritima., Suaeda monoica, Suaeda vermiculata, Tecticornia indica,*	Premadasa *et al.*, (1979); Ranawana *et al.*, (2020); The National red list 2020-Conservation status of the flora of Sri Lanka (2020). Sri Lanka

SALTMARSH VEGETATION IN SRI LANKA

Premadasa *et al.*, (1979) has proposed a simple classification of saltmarsh vegetation in Sri Lanka. (Figure 3).

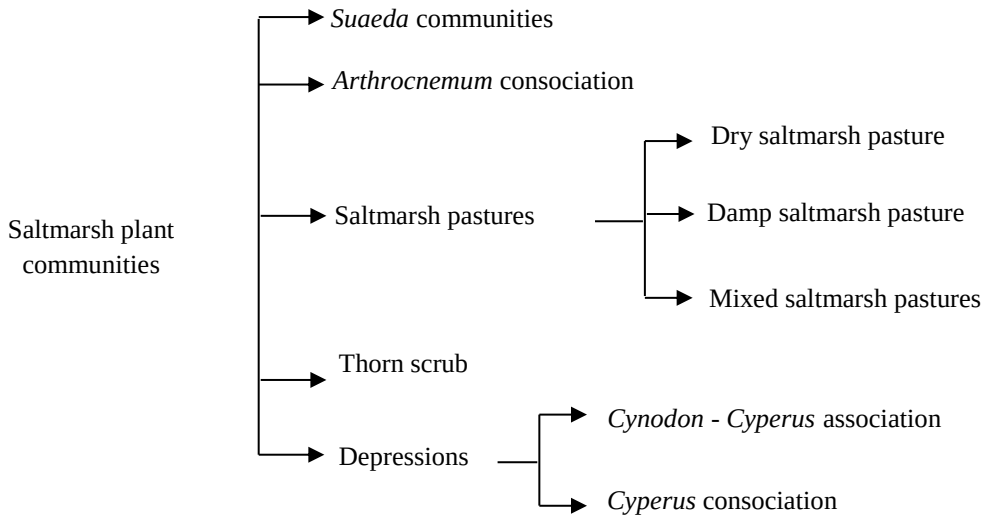

Fig. 3. A summary saltmarsh plant community categorization. (Source; Premadasa *et.al.*, 1979)

Recently, Ranawana *et al*., (2020) has clearly classified the saltmarsh vegetation in North Western Coastal line. Their classification was based on the visual observations on physiognomy and species composition of saltmarsh flora which resulted five major categories of floristic assemblages in saltmarsh. Those saltmarsh categories are Chenopod succulent dominant saltmarsh communities, Sedge dominant saltmarsh communities, Grass dominant saltmarsh communities, Forb dominant saltmarsh communities, Mixed saltmarsh communities.

Chenopodiaceae is a flora family of 113 genera and 1300 species which includes many halophyte and weeds which occur mainly in desserts and semideserts. Among them six genera are found in Sri Lanka and *Salocornia*, *Halosarsia* and *Suaeda* are known as true salt marsh plant genera [11]. *Halosarcia indica*, *Salicornia branchiata*, *Suaeda maritima*, *Suaeda monoica* and *Suaeda vermiculata* are the true saltmarsh species which represent the family Chenopodiaceae in Sri Lanka. Some saltmarshes dominated by an assemblage of these chenopod succulents are categorized as Chenopod succulent dominant saltmarsh communities by Ranawana *et al*., (2020).

The other major plant communities found in North Western Coastal marshes are sedge species and graminoid species of family Cyperaceae which represents Perennial or annual herbs. [3,4,11]. *Eleocharis geniculata*, *Cyperus arenarius*, *Cyperus rotundus* are major sedges and *Leersia hexandra*, *Panicum repens*, *Panicum sumatrense* and *Sporobolus diander* are major graminoid species found dominantly in these saltmarsh areas. These Cyperaceae species dominant saltmarsh vegetation has been classified as Sedge dominant saltmarsh communities by Ranawana *et al*., (2020). This vegetation is used for grazing by domestic livestock during the intensive livestock management and also feral species in the area such as donkeys and horses.

Premadasa (1990) described grasslands found in Mannar area are as low-land arid pastures (10) with abundant short grass cover dominated by *Cynodon dsctylon*, *Eragrostis tenella*, *Aeluropus lagopoides*, *Cyperus rotundus*, *Fimbristylis pubisquama*, *Panicum repens* and *Zoisia matrella*. These grass-dominated habitats are also known as saltmarsh pastures [3] and salt marsh plant species such as *Suaeda maritima*, *Suaeda vermiculata* are present in this habitat occasionally. These salt-tolerant turf grass dominated pastures are classified as Grass dominant saltmarsh communities by Ranawana *et al*., (2020). The vegetation cover and the structure of this turf grass dominant saltmarsh communities work against the soil erosion and in filtering suspended sediment from runoff [4]. These grass dominant saltmarsh pastures are also used by grazing animals such as cattle and feral donkeys.

Forbs are broad-leafed, non-woody herbaceous flowering plants which are not graminoids (grasses, sedge). Salt tolerant forb species such as *Atriplex repens*, *Enicostema axillare*, *Epaltes divaricata*, *Euphorbia indica*, *Heliotropium curassavicum* and *Indigofera oblongifolia* found in dominant patches mixed with grasses and salt marsh plants in saltmarsh margins are named as forbs dominant saltmarsh communities by Ranawana *et al*., (2020).

Saltmarsh areas occupied by sedge communities in depressions, salt tolerant grasses or broad leaf plants in higher ground and woody cover with mangroves and Chenopod succulents are described as Mixed saltmarsh communities in Ranawana *et al*., (2020). These mixed saltmarsh communities form a are observed a heterogeneous horizontal and vertical structure depending on the microtopography, ground water regimes and salinity levels [4].

Saltmarsh halophytes in North Western coastline in Sri Lanka and their morphological characteristics

There seven saltmarsh species have been recorded in Sri Lankan saltmarshes (Table 2). All these saltmarsh species are succulent herb or shrub species found in abundance in saltmarsh habitats along the Mannar coastal region. According to the field observations, growth pattern of these species varies with respect to each other and their height also differs from one species to another (Table 3).

Table 2. Six true saltmarsh species recorded Mannar coastal plane, Sri Lanka.

Family/Scientific Name	Common Name	NCS
Family: Aizoaceae		
Sesuvium portulacastrum (L.) L.	S: Maha-sarana; T: Vankiruvilai	LC
Family: Amaranthaceae		
Salicornia brachiata Roxb.		VU
Suaeda maritima (L.) Dumort.	T: Umiri, Umuddi, Umunddi	NT
Suaeda monoica Forssk. ex J.F.Gmel.		NT

Suaeda vermiculata Forssk. ex J.F.Gmel.	T: Umiri, Umuddi, Umundd	NT
Tecticornia indica (Willd.) K.A.Sheph. & Paul G.Wilson	T: Kotanai	EN
Family: Convolvulaceae		
Cressa cretica L.	T: Panittanki	LC

NCS – National Conservation Status (The National red list 2020-Conservation status of the flora of Sri Lanka (2020). Sri Lanka: Biodiversity Secretariat, Ministry of Environment and National Herbarium, Department of National Botanic Gardens.)

EN – Endangered, VU – Vulnerable, NT – Near threatened, LC – Least concerned

Table 3. Height comparison of saltmarsh species recorded in the present study.

Family	Species	Height indicated in Flora of Ceylon	Average height recorded in this study
Aizoaceae	*Sesuvium portulacastrum*	-	10 – 20 cm
Amaranthaceae	*Salicornia brachiata*	15- 40 cm	15 – 40 cm
Amaranthaceae	*Suaeda maritima*	15 – 80 cm	15 – 80 cm
Amaranthaceae	*Suaeda monoica*	300 cm	300 cm
Amaranthaceae	*Suaeda vermiculata*	20 – 60 cm	15 – 30 cm
Amaranthaceae	*Tecticornia indica (H.indica)*	-	15 – 30 cm
Convolvulaceae	*Cressa cretica* L.	-	5 – 15 cm

Suaeda monoica showed the maximum height which is about 300cm and this is the one that grows as a tall saltmarsh species in Sri Lanka (Table 3). *Suaeda maritima* also grows as a woody herb which is nearly one-meter in height in some habitats. *Salicornia brachiata* and *Tecticornia indica* grows as small shrubs reaching the maximum height about 40 cm. *Suaeda vermiculata* and *Sesuvium portulacastrum* are mat forming herbs (creepers).

The halophyte genus *Sesuvium* consist of several species with a worldwide tropical, Mediterranean and warm-temperate distribution which often grow in coastal saline soil and inland habitats [11,12,13]. *Sesuvium portulacatrum* is one of the pantropical species found in Sri Lankan salt marsh ecosystem. This species is commonly known as "Seapurslane" and also has various common names based on its distribution [12,13,14]. In Sri Lanka, this species is known as "Maha sarana" in Sinhala and "Vankiruvilai" in Tamil [11,15].

Sesuvium portulacastrum is a perennial herb grows up to 10-20cm (Table 4). This plant is a prostrate or creeping succulent forming mats about 2m diameter with reddish green stem. Leaves of this species is fleshy, oblong shaped with flat top and convex beneath. At early growing stages the plant grows prostrate with green color leaves with a pink color margined which is not much fleshy. Then plant transform in to mat form with some prostrate stems and leaves becoming fleshier by and reddish-purple color with aging (Plate 1).

Stage 1 – Green leaves with pink margins

Stage 2 – Reddish purple fleshy leaves

Plate 1. Color changes of leaves of *Sesuvium portulacastrum* with the age.

Sesuvuim usually inhabitat sandy beaches in backshore which is inundated by high tides, tidal flats, on the margins of hurricane wash over channels. In tropics, this species usually recorded on estuarine mudflats, adjacent to mangrove swamps, in salt marshes and on calcareous shorelines, on the margins of lagoons, on coral sand and rubble shorelines also along coasts and river mouths and in lower mountains [12,14,16].

The family Amaranthaceae represents five true saltmarsh species of the study area which are *Salicornia brachiata*, *Suaeda maritima*, *Suaeda monoica*, *Suaeda vermiculata* and *Tecticornia indica*.

Salicornia brachiata is an erect woody herb, usually grows up to 15cm - 45 cm (Table 4). This species grows with segmented greenish stem [11] (Plate 2). *Salicornia brachiata* shows two color variations during life cycle with its age and sometimes this shows color variation with environmental conditions. This species starts with very little green color fleshy prostrate nods (Plate 2) and then becomes branched small shrub which is about 15-45cm in height. With age it turns to yellow color stems with some brown fade in the areas where the branches connect to the main stem of the plant (Plate 3). Sometimes this color changes can be observed after flooding the plant with salt water for few days after a heavy rain (Plate 4).

Plate 2. Early growing stage of Salicornia brachiata.

Stage 1. Green color branches

Stage 2. Yellow color branches

Plate 3. Color variations in *Salicornia brachiata*.

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a. b.

Plate 4. Color variations in *Salicornia brachiata* after flooding the area.

Suaeda maritima is annual or probably short-lived perennial and widely distributed coastal species found from all continents [7, 31]. Four distinct color variations of *Suaeda maritima* were observed during the field studies which were green, yellowish green, reddish green and red (Plate 5). These colors were highly noticed in their leaves and less in stem and other vegetative parts. (Plate 5). Several researchers have confirmed that these color morphs of *Suaeda.maritima* is a response to changing environmental conditions [17]. Therefore, this color changes may have resulted during their life cycle (Plate 6) with the changes of temperature, water level, salinity differences of soil, climatic variations and other ecological factors of the environment.

Stage 1 – Green color

Stage 2 – Yellowish green color

Stage 3 – Reddish green color

Stage 4 – Red color

Plate 5. Color variations in *Suaeda maritima*.

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Plate 6. Color changes in *Suaeda maritima* in same habitat .

Suaeda monoica is a saltmarsh succulent which grows as a small tree or a shrub about 3m in height. This is the tallest salt marsh halophyte in the study area. The *Suaeda monoica* also shows two color morphs during its life cycle which is green and yellowish green even though not prominent as in *Suaeda maritima* (Plate 7)

a. Stage 1- Green

b. Stage 2- Yellowish green

Plate 7. Colour variations in *Suaeda monoica*.

Suaeda vermiculata is a succulent found in salt marsh pastures which belongs to family Amaranthaceae. *Suaeda vermiculata* is a small shrub with woody stem at the base, much branched at upper and obovate-oblong shaped leaves curved and flattened one side only [11,31]. *Suaeda vermiculata* is a partially succulent halophyte, to cope with salinity and drought stresses with its tolerance mechanisms. These characteristics include succulence, leaf burns, leaf shedding, stunted growth habit, change in color of the leaves, thick cuticular layers etc. [18]. *Tecticornia indica* is perennial herb, woody at the base, stems prostrate; branches ascending or erect; internodes cylindrical to barrel-shaped, becoming corky with age [11,31]. Three major colour morphs were observed during the study period which is green color at the early stage and reddish green and red color with the age (Plate 8). This might also be caused by different ecological factors.

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Stage 1- Green

Stage 2- Reddish green

Stage 3- Purplish-red

Plate 8. Color variations of *Tecticornia indica*.

Cressa cretica is a small herb (10cm-15cm height) like true saltmarsh species which is basally woody small herb that is much branched above with closely condensed ovate leaves [11]. This plant much differ from other saltmarsh succulents having the same color (gray-green) during the all stages of the plant and also non- fleshy as other true saltmarsh plants. *Cressa cretica* can be observed in higher saltmarsh areas which are in dried muddy flats not in sandy areas.

Except *Sesuvuim portulacastrum* other five species (*Salicornia brachiata, Suaeda maritima, Suaeda monoica, Suaeda vermiculata and Tecticornia indica*) can be seen co-occurring in the same habitat (Plate 9). *Suaeda maritima* and *Suaeda monoica* show the colonization in every habitat and they were observed a prominent mutual distribution all over the year. During the wet season, the depressions are getting filled with rain water and salt water from tidal creeks which are narrow inlets of ocean water. Then the saltmarsh species restrict to the margins of those mud flats and tidal flats.

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Plate 9. Distribution of salt mash species in-space. (01. Suaeda monoica 02. Salicornia. brachiata 03. Tecticornia indica 04. Suaeda maritima)

CONSERVATION IMPORTANCE OF SALTMARSH ECOSYSTEM AND ITS BENEFITS

Saltmarsh is a very important ecosystem in the coastal habitats which has a conservational importance. Saltmarsh ecosystem provides habitats for wide variety of flora and fauna by forming a rich coastal productivity area through outwelling and exporting of nutrient and organic matter [20,21,22]. Hence these coastal marshes provide a greater nursery and breeding ground for some juvenile fish species and crustaceans [19,20] and also feeding and resting place for marine fish species, crustaceans and migratory birds [20]. Shoreline protection is a highly challenge topic for coastal communities worldwide. Saltmarshes and mangroves provide the natural contribution to reduce the coastal erosion and protect the shorelines from storms [23].

Saltmarsh halophytes consist with important physical and chemical properties. *Suaeda* plants can biosynthesize natural substances with powerful antioxidant activity and are considered as a renewable source of energy, food, and edible oil for a larger number of populations living in the harsh environment with high salinity and drought conditions [18,24]. The importance of medicinal value of halophytic plants have discussed by many researches [25,26,27]. The halophytic species are rich in bioactive compounds (primary and secondary metabolites) such as polyunsaturated fatty acids, carotenoids, vitamins, sterols, essential oils (terpenes), polysaccharides, glycosides, and phenolic compounds [25,27] which results antioxidant, antimicrobial, anti-inflammatory, and anti-tumoral activities in preventing various diseases (e.g. cancer, chronic inflammation, atherosclerosis and cardiovascular disorder) and ageing processes [25].

Since these plants are rich in nutrients such as antioxidants, fatty acids and amino acids, many halophytes have traditionally used as food other than herbs and fodder [27,28]. Currently this halophytic based food has becoming a trend which also gives a solution for the future food crisis. There is a program known as “The Halophytic Kitchen Lab” conducting by Emirates soil museum funded by International Center for Biosaline Agriculture [32]. Ranawana *et al.*,(2020) has conducted a community program during their study by introducing the edible value of *Suaeda maritima*.

III. CONCLUSION

Since this coastal wetland has numerous ecological, economical and other variety of values, conserving these habitats are very important. Currently major issues that causes declining the global saltmarsh ecosystem are climate-change effect due to global warming, pollution, land use change and invasive species [29]. Sea level rises occur with the climate changes and this causes draining and flooding the healthy soil in saltmarsh ecosystem. Pollution due the human activity intensifies the anaerobic conditions of the soil and affects to the marine life heath. Converting saltmarshes into aquaculture ponds is the major threat to saltmarshes in Mannar area. Further, *Prosopis juliflora* is also causing decline of saltmarsh extent in Mannar

area. Garbage dumping in the saltmarshes and encroachments are also major threats. Restoring or rehabilitation of a coastal habitat is a costly and time-taking process compare to the terrestrial habitats. Therefore, conserving these coastal habitats is very important.

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