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Taxonomic Status of Halophytes in Coastal Kachchh District, Gujarat

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Abstract

District Kachchh, despite having arid climate and long coastline, can be considered as biologically rich region. For the present study the floristic surveys of both inland and coastal plants were carried out during July 2011 to October 2012, which resulted in record of total of 203 angiosperm taxa. They fall under 145 genera and 57 families. Out of that 102 halophytic species were recorded during rapid survey that belongs to 53 genera and 37 families. The dominant families were Poaceae (16 taxa), Asteraceae, Cyperaceae, and Chenopodiaceae present with seven taxa. Kachchh represents mainly one worst invasive exotic species namely *Prosopis jullflora*, which may pose survival threat to the indigenous flora. Out of these, 74 species distributed predominantly among xerohalophytic communities naturally and 28 hydrohalophytic have been listed by present survey with special reference to their life form and main localities of their distribution.

Keywords: Vegetation; Flora; Halophyte; Kachchh; Coastal

Introduction

Halophytes are defined as plants that naturally inhabit saline environments and benefit from having substantial amounts of salt in the growth media. Salt tolerating plants represent only 2% of terrestrial plant species but they represent a wide diversity of plant forms [1]. About half of the higher plant families consist of halophytes and they have a polyphyletic origin [1]. It is estimated that about 3.6 billion of the world's 5.2 billion ha of dryland used for agriculture suffers from erosion, soil degradation and salinization [2]. Salt-affected soils impact upon nearly 10% of the land surface (950 Mha) and 50% of all irrigated land (230 Mha) in the world.

Classification of halophytes

Halophytes are classified in a variety of ways such as classification based on general ecological behavior and distribution, response of plant growth to salinity and quantity of salt intake etc [3]. As per the stocker, 1928 definition of halophytes is "Plant which can tolerate salt concentrations over 0.5% at any stage of life" after that the definition given by Flowers, *et al.* 1986 "An ability" to complete the life cycle in a salt concentration of at least 200 mM NaCl under conditions similar to those that might be encountered in the natural environment [4]. On the basis of habitat, Halophytes can be divided into two main types based on their geographical distribution or habitat [5].

These two types are as follow:

Hydro-halophytes: These are the plants which can grow in aquatic soil or in wet conditions. Most of the mangroves and salt marsh species along costal lines are hydro-halophytes [5].

Xero-halophytes: They may grow in environment, where the soil is saline but the water content of the soil is less due to evaporation and many of them are succulents [5].

Halophytes grow in a wide variety of saline habitats, from coastal regions, salt marshes and mudflats, to inland deserts, salt flats and steppes. Salinity causes certain structural changes in halophytes. They have thicker leaves, smaller and fewer stomata, larger cells and well developed water storing tissues. The succulence has larger cells on the spongy mesophyll and multilayer palisade tissue. Halophyte occurs across a wide range of plant families, with the Chenopodiaceae being dominant and it consists of about

550 halophyte species [6,7]. The other families that include halophytes are Poaceae, Fabeaceae and Asteraceae however less than 5% of the species in these families are halophytes [7]. Moreover, some halophyte species do not show significant yield reduction even when irrigated with seawater e.g. *Suaeda maritime* [8]. The latest scientific research study indicates that vast saline areas could be adequately used for salt tolerant grasses *Aeluropus* and *Sporobolus* for fodder production as well as for crops and vegetables i.e. Barley, Been, Sorghum and Beet, Broccoli, Cauliflower, Pomegranate, Cucumber etc. to meet the food demand of society. The primary objective of this paper is to present the current existing species status (number of halophytes reported) from present study and understanding the distribution of halophytes in arid region like Kachchh. Moreover this study is highlighting about this small but diverse group of plants and its fulfill almost every requirement of human beings especially those related to food, fodder, fuel, medicines, agricultural and so on in arid region of Kachchh but species specific traditional ethnic use of plants as well as phytochemical study will be recommended for future work.

Materials and Methods

Kachchh is the second largest district in the country, covering a total area of 45,652 km^2 and located on the western-most tip of India. Rann of Kachchh is a seasonal marshy region surrounding Kachchh. It is salty lowland, rich in natural gas and a resting site for migratory Siberian birds. Administratively, this district encompasses 10 talukas and 950 villages. Kachchh district covering the coastal area is 6749.77 km^2 and Six talukas are coastal i.e. Lakhpat, Abdasa, Mandvi, Anjar, Gandhidham, Mundra and some part of Bhachau (Figure 1). For this study all these talukas are selected. Kachchh coast is one of the rare ecological zones in the world having rich biodiversity. It comprises mangroves, halophytes, mudflats, seaweeds, commercial fishes, and several rare marine species. The mangroves of Kachchh are the largest entity in the west coast of mainland India. In Kachchh distribution of halophytes is considerable because of desert, hills, ranns and long coast line. However, there is a total lack of study on Kachchh halophytes.

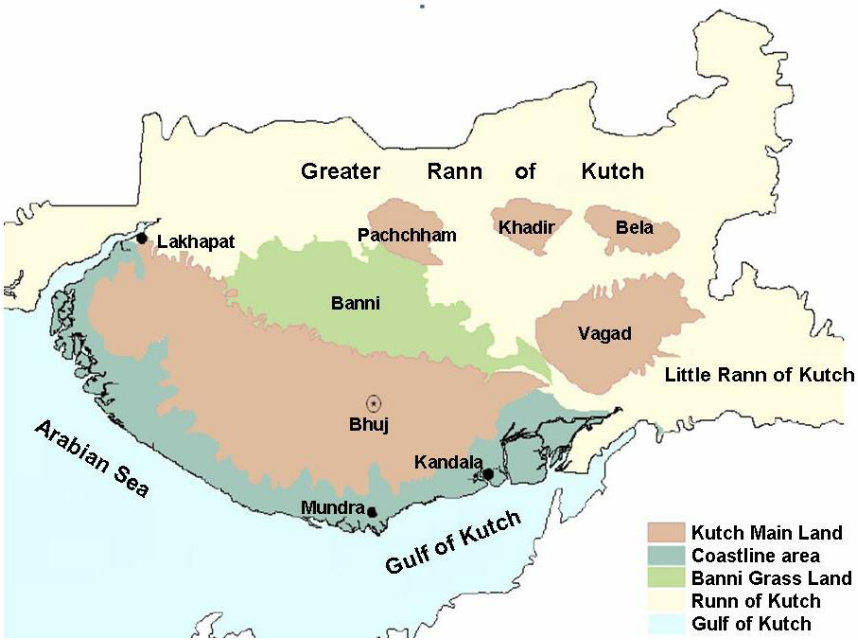

Figure 1: Location Map of Study area

Vegetation sampling is one of the important tasks undertaken to assess the status of halophytic species in the natural habitat and to examine their conservation status in terms of distribution, population, and threats they are facing due to several anthropogenic activities.

From the GIS base map, rich vegetation areas across the coast line and site approachability were identified from the Survey of India toposheets. However, while selecting areas, care was taken to represent variations in the types, landscape type (terrain) and land use type (forest, non-forest and agriculture lands) and to capture the plant diversity of entire study area. GPS coordinates for the geographical location of each transect was recorded.

Halophytes survey was conducted annually using Transect and Quadrate Method of Mueller-Dombois, 1974; Mueller-Dombois and Ellenberg, 1967; Kershaw, 1973 and Mishra, 1968 [9-12]. The survey was carried out in all the coastal areas using quadrate in transects of 1.25km long and 25mt circular plots depending upon the area. Along the transect, at every 200 mt a circular plot of 10 mt radius was laid for shrub cover, 25mt radius for tree layer and 1 quadrates of 1m x 1m within the circular plots for quantification of herb and grass layer (plate 1). At each plot for tree layer, data was collected on the substratum nature, soil type, number of individuals of different species, girth at breast height (GBH), height of tree, canopy cover and species wise number of individuals in regeneration and recruitment category. For shrub layer species wise number of individuals was counted, cutting and browsing/ grazing signs and number of regeneration and recruitments. For herb layer, numbers of individuals of each species falling within

the sampling area were counted besides collection of information on the phonological stages of each species. For anthropogenic pressure assessment, besides recording cutting and grazing/browsing signs, the number of dung pallets was also counted within 1 m quadrate laid for herb layer assessment.

Plate 1: Photographs showing the quadrate survey techniques in Coastal Talukas

The identification of plant species was done with the help of existing published work in the form of flora, research articles and reports [13-17].

Analysis

- Shannon-Weiner Diversity Index is calculated by using following formula
- $\Sigma pi \ (\text{Log } pi) = H'$ where
- $pi = \frac{\text{Total number of individuals of the species}}{\text{Total number of individuals of all the species}}$
- Density is calculated by using following formula.
- $\text{Density} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrates studied}}$

Results and Discussion

Base map was prepared from the satellite image of 2009 (LISS III). Landuse-Landcover and Enhanced vegetation index map were prepared for the study area using Erdas Imagine (9.3) remote sensing software. These maps and survey of India toposheets were used for the identified locations with rich vegetation and approachability. Following figure showing dark green color is having rich vegetation and light green color shows less vegetation in study area (Figure 2).

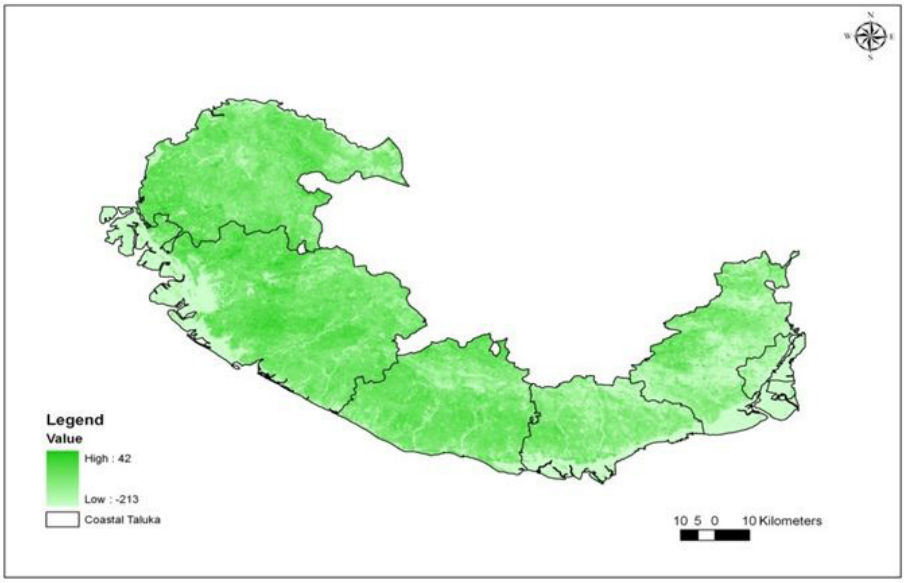

Figure 2: Vegetation index map of the study area based on satellite image of LISS III

Floral Study: The survey was conducted between July 2011 to October 2012 in six coastal talukas of Kachchh District and in different habitats such as Intertidal - Creek, Wetland, Sand dunes (Dhuva), Reserved Forest, Riverside, Agriculture, Waste land and open scrub patch within 20 km near coastal sites. A total of 250 circular plots and 51 transect for tree, shrub and herb layers were sampled for detailed vegetation analysis (Figure 3).

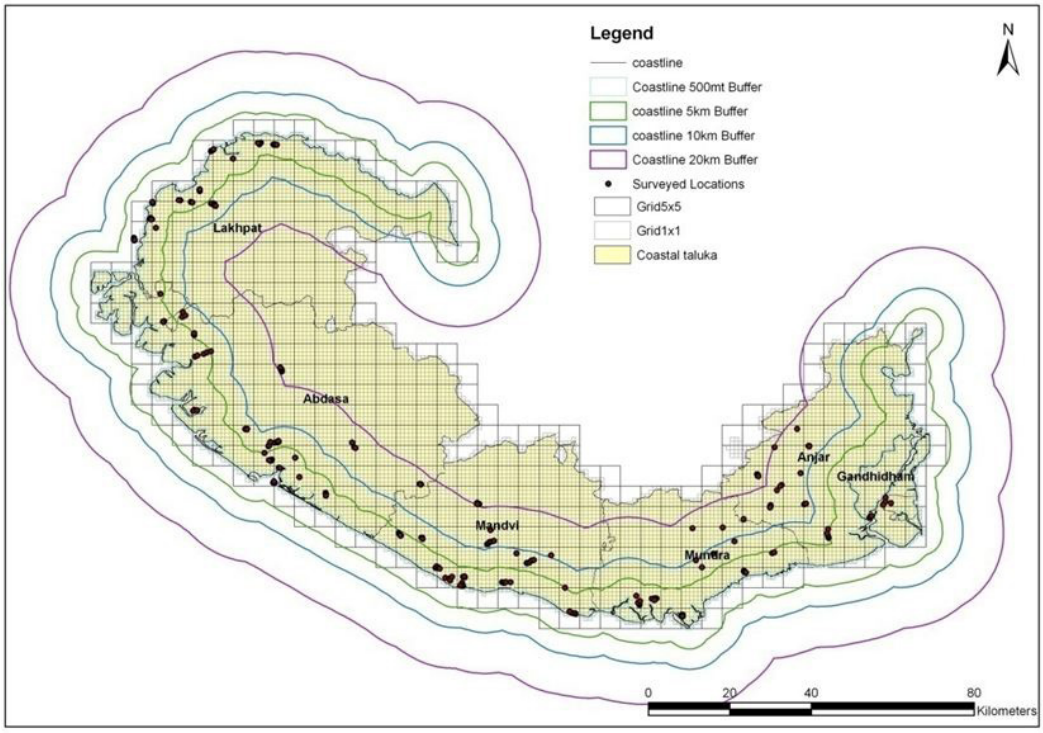

Figure 3: Surveyed Locations across study area from coastline to various distances

Taxonomical diversity of plant species recorded from the sampling sites showed that a total of 200 plants belonging to 145 genera and 57 families. Totally 102 halophytic species were recorded during rapid survey that belong to 53 genera and 37 families (Table 1).

Life form	Species	Genera	Family	Diversity	Density/ha or Density /M^{2*}
Tree/small tree	19	11	10	1.44	6.77
Shrub/Under shrub	35	21	17	2.34	2172
Herb	30	28	21	2.42	12*
Grass/Sedge	18	15	2	1.84	46.21*
Overall	102	70	38	3.12	

Table 1: Life Form Status of Halophytic Plants in Coastalkachchh

Halophytes are grouped according to their distribution into two categories: inland halophytes and coastal halophytes. Inland halophytes inhabit wetland or salt flat, agriculture hedge and on low salt marsh areas. Inland common halophytes are *Aeluropus lagopoides, Chloris virgata, Cressa cretica, Fagonia schweinfurthii, Zygophyllum simplex*, etc. present in wetlands. Some of the mesophyte such as *Azadirachta indica* was reported at normal as well as saline soil. This plant grows under both type of soil, therefore the plant considers as a halophytes [18]. Inland salt flat halophytes are *Suaeda fruticosa, Cyperus conglomeratus, Tamarix dioica, Salsola baryosma, Urochondra setulosa, Salvadora persica, Aristida funiculata*, etc.

Coastal vegetation is patchy and comprised of mostly dwarf shrubby halophytes, with a few halophytic annuals and a mangrove tree species. Coastal mangrove halophytes are *Avicennia marina, Salicornia brachiata and* low marsh halophytes *Zaleya govindia, Arthrocnemum indicum, Asparagus racemosus, Limonium stocksii*, etc. Sand dune vegetation covers mostly sustain plant species of *Cyperus arenarius Retz. Ipomoea pescaprae* (L.) R. Br. and *Spinifex littoreus* (Burm.f.) Merr. same species reported from Kachchh on sand dunes. The dominant coastal sand dune vegetation belongs to the Asteraceae, Cyperaceae, Fabaceae and Poaceae [19,20].

Out of 102 halophytic species recorded 74 was xero halophytes and 28 hydro halophytes. The coastal communities vary from stand to stand depending on local soil type, moisture and elevation. Among the species reported from this survey *Acacia planiforns, Pluchea arguta, Phoenix sylvestris* were rare and present in very few locations. The dominant halophytic vegetation belongs to the Poaceae (16 species), Asteraceae, Cyperaceae, and Chenopodiaceae (7 species) families. Present study also some of the species i.e. *Balanites aegyptiaca* (L).Del, *Eucalyptus globulus Labill., Aloe vera* (L.), *Cassia auriculata L., Datura metal auct.* and *Grewia tenax*

(Forsk.) Fiori etc. have ambiguous position for consideration as halophytes or not but based on Kachchh soil chemical property results plants considered under halophyte group [18].

When compared to richness of other vegetation vs. *P. juliflora*, 55% of the *P. juliflora* was reported from coastal talukas of Kachchh District. Highest GBH (girth) was recorded as 79 cm at Agricultural hedge and a maximum height of 16 feet was recorded at a near coast *P. juliflora* dominant patch. Overall, it was found that *P. juliflora* is an abundant tree species compared to other tree species in coastal talukas of Kachchh district (Figure 4).

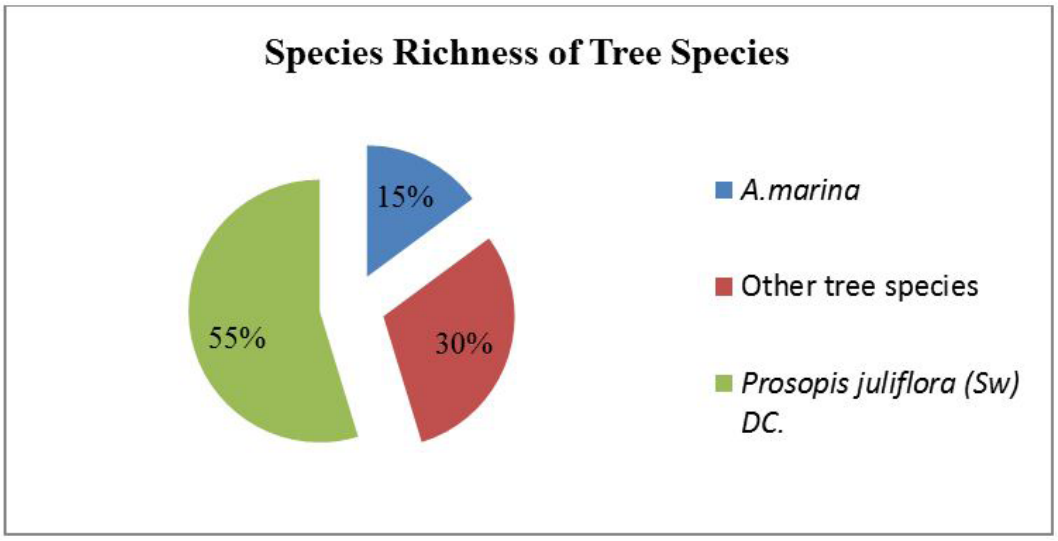

Figure 4: Species Richness of Tree Species across study area

Most of the tree GBH fall under the 1 to 20 cm class showing younger nature of plants and large cutting pressure recorded in the coastal talukas. There are very few trees having >120cm GBH (Figure 5). There were 13 dominant tree species distribution across study area as shown in the map (Figure 6). Table 2 gives the details of rare and endangered plant species recorded during the study period.

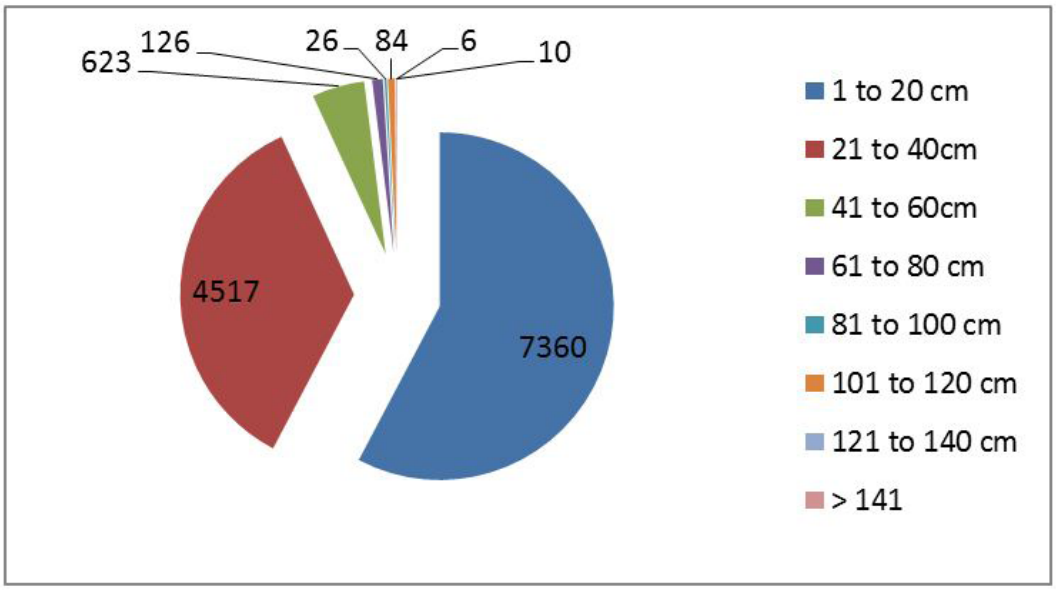

Figure 5: GBH Categories of Tree Species across study area

There is 28 plant species whose distribution has not been reported from Gujarat or Kachchh coast. Even the exhaustive report of Banerji, *et. al.*, has not mentioned the distribution of these plant species (Table 3). These species could be added to the already described list of Banerji, *et. al.* [13]

Utilization of the halophytic species was reported in Pakistan flora by Khan MA, *et. al.*, but for Indian flora concern species wise very less information reported by Hari Bhagwan *et. al.*[21]

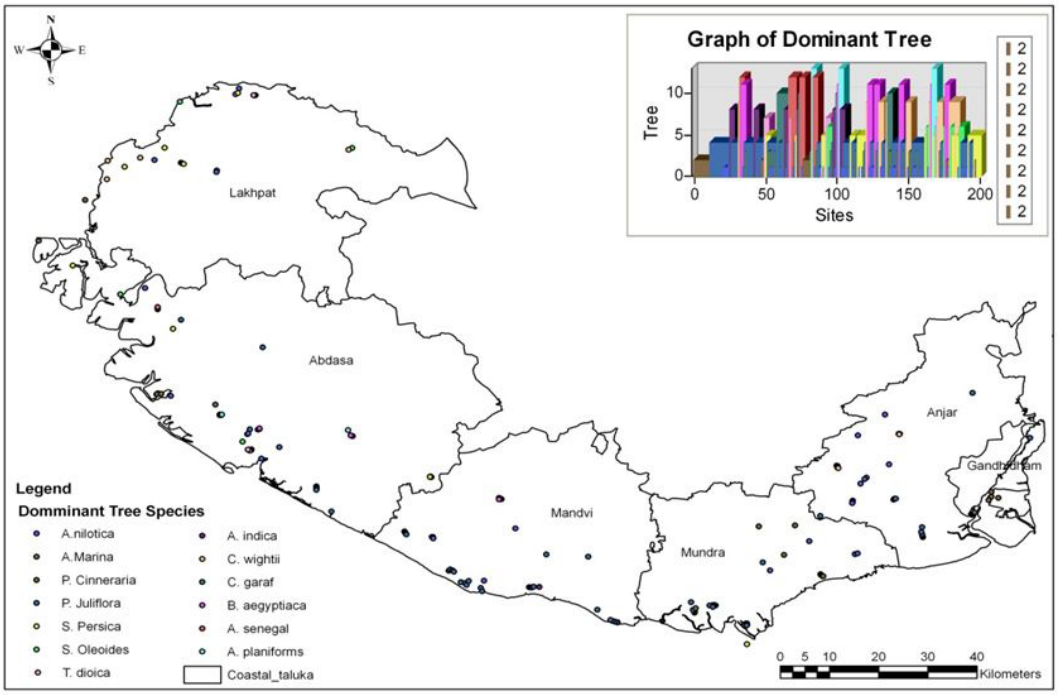

Figure 6: Dominant Tree species distribution across study area

Plant Species	Life form	Status	No. of Individuals recorded
Asperagus dumosus Baker	Under shrub	Rare	84
Azadirachta indica A. Juss.	Tree	Rare & Planted	342
Commiphora wightii (Arn.) Bhandari	Small tree	Rare & Endemic	111
Corchorus capsularis L.	Under Shrub	Rare	8
Indigofera caerulea Roxb. Var. *occidentalis*	Shrub	Rare	1
Leptadenia pyrotechnica (Forsk.) Decne.	Under Shrub	Rare	5
Limonium stocksii (Boiss.)	Herb	Rare	25
Senra incana Cav.	Herb	Rare	4
Sonchus asper (L.) Hill.	Herb	Rare	103
Tamarix dioica Roxb.	Tree	Rare	126
Urochondra setulosus (Trin.) Hubb	Grass	Rare & Endemic	330
Zygophyllum simplex L.	Herb	Rare	8

Table 2: Rare and Endangered Species of Halophytic Plants

S. No.	Scientific Name	Status	Banerji - 2002 (BSI publication)
1	*Aeluropus lagopoides* (L.) Trin. ex Thw.	Common	Not mentioned this species in Gujarat coast
2	*Bergia ammannioides* Roxb. ex Roth	Common	Not mentioned this species in Gujarat coast
3	*Chenopodium album* L.	Common	Not mentioned this species in Gujarat coast
4	*Eleusine indica* (L.) Gaertn.	Common	Not mentioned this species in this book
5	*Eleocharis dulcis* (Burm.f.) Henschel		Not mentioned this species in this book
6	*Enicostema axillare* (Lamk.) Roynal	Common	Not mentioned this species in Gujarat coast
7	*Evolvulus alsinoides* (L.) L. var. alsinoides	Common	Not mentioned this species in Gujarat coast

S. No.	Scientific Name	Status	Banerji - 2002 (BSI publication)
8	*Heliotropium bacciferum* Forsk. var. *suberosum* (Clarke) Bhandari	Common	Not mentioned this species in this book
9	*Indigofera caerulea* Roxb. Var. *occidentalis*	Rare	Not mentioned this species in this book
10	*Najas graminea* Del.	Throughout	Not mentioned this species in Kachchh coast
11	*Solanum incanum* L.	Not Common	Not mentioned this species in Gujarat coast
12	*Sonchus asper* (L.) Hill.	Rare	Not mentioned this species in this book
13	*Zizyphus nummularia* (Burm. F.) W. & A.	Common	Not mentioned this species in Gujarat coast
14	*Pergularia daemia* (Forsk.) Chiov.	Common	Not mentioned this species in this book
15	*Commiphora wightii* (Arn.) Bhandari	Rare & Endemic	Not mentioned this species in Gujarat coast
16	*Pheonix dactylifera* L.	Throughout	Not mentioned this species in this book
17	*Crotalaia linifolia* L.	Not Common	Not mentioned this species in Gujarat coast
18	*Aerva javanica* (Burm.f.) Juss.	Common	Not mentioned this species in Kachchh coast
19	*Heliotropium supinum* L.	Throughout	Not mentioned this species in Gujarat coast
20	*Heliotropium rariflorum* Stocks	Not Common	Not mentioned this species in this book
21	*Euphorbia tirucalli* L.	Frequent	Not mentioned this species in Gujarat coast
22	*Vigna radiata* (L.)	Cultivated	Not mentioned this species in this book
23	*Halopyrum mucronatum* (Linn.)	Common	Not mentioned this species in Gujarat coast
24	*Tamarix troupii* Hole	Common	Not mentioned this species in this book
25	*Dactyloctenium sindicum* Boiss.	Common	Not mentioned this species in this book
26	*Gossypium stocksii* Mast.	Cultivated	Not mentioned this species in this book
27	*Periploca aphylla* Decne.		Not mentioned this species in this book
28	*Pluchea lanceolata* (DC.)		Not mentioned this species in this book

Table 3: Current Status of Halophytic Plant Species

Conclusion

Halophytes have evolved a range of adaptations to tolerate seawater and higher concentrations of salts such as in an inland saline land. The present investigation establishes that the current halophytic plant status of the coastal and near coastal areas of Kachchh. There is no information available on utilization of halophytic plants in Kachchh district. Local people are using their traditional system for different purposes. There is a need to document the traditional knowledge for utilization of halophytic plants. Present work of coastal and near coastal region also reported there is a pressure on plants because of high industrialization in coastal talukas. Major find out of this work is some common as well as rare plants reported in Kachchh coast, but they were not mentioned in Kachchh or Gujarat coast by Botanical Survey of India book '*Diversity of Coastal Plant Communities in India*'. Therefore, this paper will help to compile and update the knowledge of country's present plant wealth with emphasis on distribution and status.

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