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Kerala Mangroves– Pastures of Estuaries – Their Present Status and Challenges

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Abstract: ***Mangroves form most valuable biomass and act as a living buffer/ bioshield/ biowall preventing coastal erosion and damage to infrastructure and loss of life by reducing the destructive force of nature. Mangroves are the most carbon rich forest in the tropics and soils are high in carbon. In the tropics, along the coastline mangroves live where many people want to live and hence the amount of land they grow on has declined by 30 to 50 % over the past 50 years. In most forests, sediment and litter decay rather quickly, but in mangrove forest there is not enough oxygen to break down the litter so the breakdown of material is much slower and this means more CO_2 storage. Daniel Donato (US Agriculture Department) reported that tropical mangroves are better at storing CO_2 from atmosphere two to four times more than tropical rain forest store and its storage is mostly on that thick organic muck layer in the soil. In India, mangroves account for about 5 percent of the world's mangrove vegetation and are spread over an area of about 4,500 km^2 along the coastal States. Mangroves are highly localized in Kerala, but the species diversity and their associates are comparatively rich. Mangroves are confined to estuaries, lagoons, backwaters and creeks. In Kerala mangroves are distributed in all districts except Idukki, Pathanamthitta, Palakkad and Wayanad and the maximum extent is reported from Kannur district (1100 ha.), Ernakulam (600 ha.) and Kasaragod (315 ha.) and the minimum extend was represented by three districts, Malappuram (26 ha.), Thiruvanthapuram (28 ha.) and Thrissur (30 ha.) (Vidyasagaran and Madhusoodaran, 2014). During the survey, a total of 24 pure mangroves were recorded belonging to 15 genera and 9 families. Rhizophoraceae represented by 8 species, Acanthaceae 4 species, 1 species each representing Myrsinaceae (Primulaceae), Malvaceae, Combretaceae and Pteridaceae, two species from Euphorbiacea, three each from families Lythraceae and Arecaceae. Present survey revealed that Lumnitzera racemosa, Nypa fruticans, Phoenix sylvestris, Phoenix humilis var. pedunculata and Ceriops tagal are the most threatened species in the west coast of India, similarly Bruguiera sexangula is also confined in few places wherein their populations is facing further decline. Unmindful of the vital role they have in maintaining aquatic as well as avian fauna, mangroves are being destroyed at an alarming rate in India. For instance, mangrove forests that once adorned Kerala's entire coastal area are now reduced to just 17 sq km, of which only 2 sq km comes under the government. The Kerala Forest Ministry identifies human encroachment as the major reason for depletion of mangrove. The popular misconception that plant species in mangrove forests are of no use has added to its slow death. Mangroves of Kerala are considered as the relics of the past. Land reclamation, industrialization and invasion made extensive clearing and degradation of many areas. Hence there is an urgent need to protect the remaining mangrove areas and a massive afforestation campaign is to be initiated with the full hearted support of the local governess.***

Keywords: Kerala Mangroves, Pastures of Estuaries , bioshield, Carbon sequestration

1. Introduction

Mangroves are various types of trees up to medium height and shrubs that grow in saline coastal habitats in the tropics and subtropics – mainly between latitudes 25° N and 25° S. Mangroves in India account for about 5 percent of the world's mangrove vegetation and are spread over an area of about 4,500 km^2 along the coastal States/UTs of the country. Kerala was once blessed with this amazing ecosystems about 700 sq.km mangroves were present till 1957 but it is now in a declined state. It has reduced to less than 17.0 sq. km. Kannore and Kasargod districts are having the maximum number of mangroves and Trivandrum, Kollam, Allapuzha, Kottayam, Ernakulam, Thrissur, Kozhicode and Malappuram are the other districts along with the three identified Ramsar sites namely Ashtamudi, Sathamkotta and Vembanad. More than 80% of the mangroves are under the custody of private owners; therefore, they are under serious threat of destruction. Rhizophoraceae, Avicenniaceae and Sonneratiaceae are the three families represented in Kerala. There are 59 species of mangroves are represented in India out of that 14 of them are represented in Kerala (Source: Malayala Manorama Daily, 26th Friday, 2006)

2. Literature Survey

Tomlinson (1986) has recognized only 40 true mangrove species from the Old World (Indo-West-Pacific) and only 8 true mangrove species from the New World (Atlantic-East Pacific). Recent reports state that there are in total 101 global mangrove species, of which 11 species are from the New World, and 91 species are from the Old World. Mangroves do not come from a single genetic group but they represent a large variety of plant families that are adapted to tropical intertidal environment. For example, there are 19 plant families with mangrove representatives, but only 4 families are exclusively mangroves. There are no orders that are exclusively mangroves. The plant family Rhizophraceae has only 4 of its 16 genera that exist in mangrove habitat.

Blasco (1975) reported 60 species of mangroves belonging to 41 genera and 29 families. Untawale (1985) and Banerjee *et al.*, reported 59 species, 41 genera and 20 families; of these. 34 species are present on the East Coast; 25 species on the West Coast, and 45 species on the Andaman and Nicobar Islands. Singh *et al.*, (1990) reported that of 32 principal mangrove species, 13 are present on the West Coast, 23 species on the East Coast and 27 on the Andamans. The East

Coast of India is richer in mangroves (65 spp: 83.4%) and lastly the West Coast (36 spp: 53.5%).

Other publications have mentioned 69 species of mangroves in total, of which 59 species are from the Old World and 11 species are from the New World (Duke, 1992; IUCN, 1983). Very recently, Kathiresan (2000a) has reported that there are totally 100 global mangrove species, of which, 11 species are from the New World, and 90 species are from the Old World. There are altogether 80 countries that have mangroves and about 1.4 hectares of mangrove area throughout the world. In India, there are about 6740 sq.km mangrove areas. During the 17th century van Reed mentioned about mangroves of the Malabar Coast in his book, *Horthus malabaricus*.

3. Problem Definition

A number of physical and biological features like tide, salinity, geomorphology, species interaction etc are the determining factors for the existence of different species of mangroves (Khaleel, 2005). Floristic diversity of mangroves in Kanuur is very rich as compared to other districts of Kerala (Vidyasagaran *et al.* 2011). Apart from the details on the extend, there has no attempt to assess the present status of mangrove areas in the State. Only few studies were undertaken earlier on the extent and plant diversity of mangroves, hence it was thought worthwhile to make a study on the distribution and plant diversity of mangroves in Kerala and the results are presented in the paper.

4. Methodology/ Approach

A detailed survey and inventory on the extent of distribution, abundance and plant diversity of the left over mangroves was carried out all along the 10 coastal districts of Kerala.

All the ten districts were visited and collected maximum available information on mangroves, then extent, floristic diversity, structural attributes, degradation status and data are documented. Distribution of mangroves in various districts was studied by visits to the sites followed by the collection of secondary data from Resource Survey Details (Kerala state Land Use Board, 2013) and resource map prepared at Panchayat level. There was also discussion with local experts, social workers, environmentalists, Panchayat officials to gather secondary data pertaining to the mangroves of specific sites. Plant diversity was studied by the spot identification of plant species. Plant specimens of unidentified species were collected and identified with the help of taxonomists and identified keys.

Fig.1 Major distribution areas of mangroves and associates in Kerala (2013)

5. Results and Discussion

Mangroves in Kerala are growing in the mud flats, deltas, estuarine ridges and edges of island systems according to the specific geographical formations of the area. Kannur district occupies maximum extent of mangroves (1100 ha.) followed by Ernakulam (600 ha.) and Kasaragod (315 ha.) and minimum extend was represented by three districts namely Malappuram (26 ha.), Thiruvanthapuram (28 ha.) and Thrissur (30 ha.) (Vidyasagaran and Madhusoodanan, 2014)

During the survey, a total of 24 pure mangroves species were recorded from the mangrove areas and are belonging to 15 genera and 9 families. Rhizophoraceae represented 8 species, Acanthaceae had 4 species, 1 species each representing Myrsinaceae (or Primulaceae), Malvaceae, Combretaceae and Pteridaceae two species from Euphorbiacea followed by three each from families Lythraceae and Arecaceae respectively. Krishnamurthy *et al.* (1981) reported 110 species belonging to 60 genera and 35 families from Pitchavaram mangroves of Tamil Nadu.

Distribution of pure mangroves in different coastal districts of Kerala is shown in Table 1. Species like *Acanthus ilicifolicus*, *Excoecaria agallocha*, *Aegiceras corniculatum*, *Rhizophora mucronata*, *Sonneratia apetalae* and *Acrostichum aureum* are the species found in all the districts of Kerala,whereas *Rhizophora apiculata* is widely distributed in Kannur and Kollam districts but not found in Malappuram. *Avicennia officinalis* is one of the common species noticed in all the districts except in Ernakulam and Kannur, however, this is not the case with *A. marina* which was not seen in Trivandrum and is one of the threatened mangrove species in Kerala.

Out of four species belonging to the genus Bruguiera, *B. cylindrica* has relatively wide distribution, however, it is not recorded from in Kottayam district. *B. gymnorrhiza* is a rare species which is not represented in Malapuram, Kozhikode, Kannur and Kasargode. *B. sexangula* is one of the endangered species, which is represented only in two districts namely Kollam and Ernakulam. *B. parviflora* has wide distribution in the northern parts of Kerala which is not present in Trivandrum, Kollam, Alappuzha and Kottayam. *Kandelia kandal* is also a rare species which is distributed in all districts except Trivandrum, so also *Sonneratia caseolaris* which is found in five districts namely Trivandrum, Kollam, Alappuzha, Kannur and Kasargode, whereas, *S. alba* is becoming endangered due to its small populations in the districts of Ernakulam, Kozhikode, Kannur and Kasargode. *Lumnitzera racemosa* is one of the rarest mangrove species in Kerala found in four districts namely, Trivandrum, Kollam, Alappuzha and Kannur, however, *Ceriops tagal*, the species which believed to be extinct from Kerala coast was rediscovered from the Ashtamudi estuary during the present survey. It is not reported from any other districts in Kerala so far. *Shirakiopsis indica* one of the endangered species is seen only in three districts namely Kollam, Alappuzha and Ernakulam. *Heritiera littoralis* is believed to be an extinct species but relocated during the present study from Kollam. *Nypa fruticans* is an endangered mangrove palm seen in Ernakulam and Thrissur. Of the two species of Phoenix, *P. sylvestris* is seen in Trivandrum, Thrissur and Kozhikode, whereas, *P. humilis* var. *pedunculata* is seen only at Kollam and Kannur *(http://indiabiodiversity.org)*. The present study on the distribution of pure mangroves of Kerala revealed that *Lumnitzera racemosa*, *Nypa fruticans*, *P. sylvestris*, *P. humilis* var. *pedunculata* and *Ceriops tagal* are the most threatened species in the west coast. Similarly *Bruguiera sexangula* is also confined in few places wherein their population is facing further decline (Tresa Radhakrishnan and Anil Kumar, 2014).

Asramam is one of the most famous mangrove sites in Kollam district which had undergone severe destruction due to land reclamation/conversion and real estate activities. The most critically endangered species, *Syzygium travancoricum*, very few numbers is found here, similarly, *Lumnitzera racemosa*, one of the rare mangrove species in Kerala, has shown its restricted distribution in Asramam area. *Ceriops tagal*, believed to be extinct in Kerala coast was being rediscovered from Vincent Island of Kollam district (Vimal Raj *et al*., 2014). Though degradation is vehemently noticed in certain areas of the district, it is observed few signs of regeneration of mangroves in certain other areas.

One of the endangered pure mangrove species, *Bruguiera sexangula* is also recorded first time in Kasaragod district during the present survey. A list of true mangroves of Kerala is displayed in Figs. 2 to 25. A total of 15 pure mangrove species and about 33 semi mangrove species were recorded in the study done by Vidyasagaran and Madhusoodanan (2014). Investigation on floristic diversity of mangroves of Kannur indicated that the study area constituted 12 species under nine genera belonging to seven families. Rhizophoraceae represented maximum genera of four species (Vidyasagaran *et al*., 2011).

Status of mangroves represented at district level was examined in detail. Results indicated that Trivandrum district was endowed with luxuriant growth of mangroves had undergone severe degradation. The major threat was reclamation of most of the backwaters for housing, industrialization and other developmental activities. The remnants of past glory of mangroves in Veli backwater was remain confined in the areas under the custody of ISRO/VSSC, Thumba, Trivandrum. Kollam district encompasses with highest extent of mangroves among southern districts. However, degradation and conversion of mangroves is profoundly experienced in many parts of Kollam especially Kayamkulam, Ashtamudi and Paravoor areas. Asramam is one of the most famous mangrove sites in Kollam district had undergone severe destruction due to conversion and real estate activities. The most critically endangered species, *Syzygium travancoricum* is found in very few numbers here. Similarly, *Lumnitzera racemosa*, which is one of the rare mangrove species in Kerala, has shown its restricted distribution in Asramam area of this district. *Ceriops tagal*, believed to be extinct in Kerala coast was being rediscovered from Vincent island of Kollam district (Vimal Raj *et al*., 2014). Though degradation is vehemently noticed in certain areas of the district, it is observed few signs of regeneration of mangroves in certain other areas.

Alapuzha was once famous for backwaters and swamps on which mangroves could be able to establish profusely. But now it is very difficult to locate good mangrove patches in Alapuzha district. Presently the available patches are confined in Kayamkulam and Pathiramanal Vembanad backwater areas. Due to blockade in saline water availability, many areas are invaded by semi mangroves like *Barringtonia recemosa*, *Annona glabra* and *Pandanus tectorius*. In Kottayam district, mangroves are mainly distributed in Kumarakom, which is represented as fragmented assemblage of few species. Tourism is causing severe damage to the existing mangroves in Kumaragum. Now good patches of mangroves confined in the protected areas under KTDC.

Ernakulam district occupy second highest extent of mangroves in the state after Kannur district. In the state, maximum extent of mangrove destruction was reported from this district. When Cochin became industrial capital of the state, there was flooding of developmental projects which took away prime areas of mangroves from Panangad, Gosree, Vallarpadam, Vypin and Puthuvypin. The silver line in the conservation of mangroves in Ernakulam district is one with the declaration of Mangalavanam as bird sanctuary. Thrissur district consists of very less extent of mangrove in the state. Presently mangroves are confined in backwaters of Chettuwai, Azhikkodu, Kodungallur and few patches in Venkidung and Pavaraty Panchayats. Mangrove destruction is going on in Chettuwai by the name ecotourism whereas real estate activities took away good patches of mangroves in Pulloot of Kodungallur. Malappuram district occupy very less extent of mangroves in the state. Kadalundi, Kerala's first community reserve is endowed with relatively good patches of mangroves, however, Pulluni of Thirur, Murukummadu, Kootaikadavu are few places where relatively good patches of mangroves are found. However,

Pulluni mangroves face acute threat from developmental activities. Kozhikode district once occupied good extent of mangroves, but most of these luxuriant mangroves have been taken away by faulty land use and land reclaimation. Part of Kadalundi community reserve is located in Kozhikode district also, however, Beypore, Kottooli, Akalapuzha are still supporting good patches of mangroves which is also under threat. Highest extent of mangroves in the state is occupied by Kannur district hence it is named as the capital of mangroves in Kerala.

More than 60 per cent of the total mangrove areas is under private ownership. Mangroves are luxuriant in certain areas due to the absence of so called developmental activities. Plant diversity of pure mangroves is also very high in Kannur when compared to other districts (12 out of 15 pure mangrove species). This is the only district which had undertaken extensive mangrove afforestation programmes with the auspices of Kerala Forest Department. The uncultivated Kaipppad fields are being profusely invaded by mangroves. Places like Dalil, Kunhimangalam Kalliassery, Olavailam, Edat, Thekkumpadu, Cherukunnu are few places where mangroves are protected and devoid of any kind of human interference. Kasaragod faced less degradation of mangroves which in turn helped the protection of existing mangroves. Arekode mangroves are found along Kumbalapuzha has been considered as the largest patch of mangroves in Kasaragod district. One of the endangered pure mangrove species, *Bruguiera sexangula* is also recorded first time in Kasaragod district during the present survey.

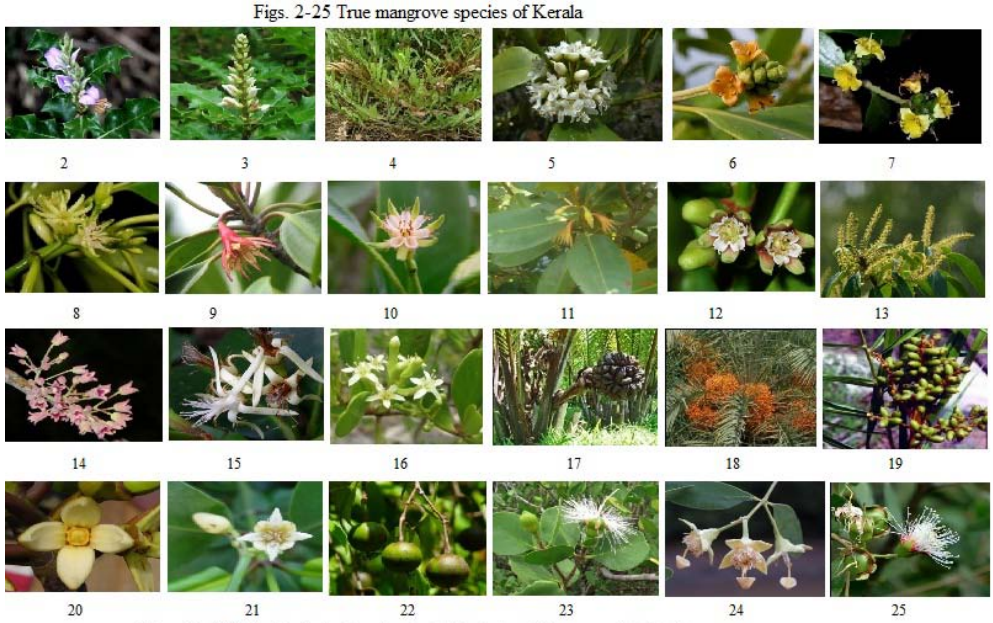
Most of the mangroves in Kerala are in an irreversible process of degradation. Mangroves in Veli and Asramam are completely fragmented and destroyed and need immediate conservation. Similarly Kumarakom of Kottayam district is also facing major threat from ecotourism. Major portion of Puthuvyppu mangroves have been disappeared due to the establishment of LNG terminal. Chettuwai mangroves are threatened mainly from tourism and encroachment. Pulluni of Thirur, Malappuram district is facing destruction as good patches of mangroves along with an endangered species, *Bruguiera sexangula*. Kallai of Kozhkode district lost its past glory of mangroves due to faulty land use and Kannur though have maximum extent of mangroves in Kerala, they are destroyed in few areas namely Irinavu, Pazhayangadi, Papinissery, Thalassery, Melur and Thazhaekavu.

The mangrove forests are considered to be as unique as human population. Under Sec.2(i) of Forest (Conservation Act 1980), no forest land can be diverted for non forestry purpose without prior approval of the Central Government. This description covers all statutorily recognized forests whether designated as ‘reserve, protected forest’ or otherwise for the purpose of Sec.2 (i) of FCA 1980. According to this clarification all mangrove areas qualify for the definition of forest irrespective of ownership. A complete ban on the conversion of mangrove areas, which are under the control of private agencies, should be encouraged. Preparation of a management plan by considering ecological amplitude, zonation, morphological and physiological adaptation of the species to their specific environment should immediately be initiated in order to conserve the remaining mangrove areas. A serious attempt has to be made inorder to conserve existing luxuriant patches of mangroves in Vincent Island of Kollam, Arikadi of Kasaragod, Puthuvyppu of Ernakulam, Pulluni of Malappuram and Chettuwai of Thrissur districts.

Table 1 District wise distribution of pure mangroves

Sl. No.	Name of Species	TVM	KLM	ALP	KTM	EKM	TCR	MLPM	KKD	KNR	KSD
1	*Acanthus ilicifolicus* L	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	*Acanthus ebracteatus* Vahl	✓	✓		✓	✓	✓	✓	✓	✓	✓
3	*Avicennia marina* (Forssk.) Vierh.	X	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	*Avicenia officinalis* L.	✓	✓	✓	✓	X	✓	✓	✓	X	✓
5	*Aegiceras corniculatum* (L.) Balsco	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	*Bruguiera cylindrica* (L.) Blume	✓	✓	✓	X	✓	✓	✓	✓	✓	✓
7	*Bruguiera gymnorrhiza* (L.) Savi.	✓	✓	✓	✓	✓	✓	X	X	X	X
8	*Bruguera parviflora* (Roxb.) Wight & Arn. ex Griff.	X	X	X	X	✓	✓	✓	✓	✓	✓
9	*Bruguiera sexangula* (Lour.) Poir.	X	✓	X	X	✓	X	X	X	X	X
10	*Ceriops tagal* (Perr.) C. B. Robins.	X	✓	X	X	X	X	X	X	X	X
11	*Kandelia candel* (L.) Druce	X	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	*Rhizophora apiculata* Blume	✓	✓	✓	✓	✓	✓	X	✓	✓	✓
13	*Rhizophora mucronata* Poir.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	*Shirakiopsis indica* (Willd.) Esser	X	✓	✓	X	✓	X	X	X	X	X
15	*Excoecaria agallocha* L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	*Heritiera littoralis* Dryand.	X	✓	X	X	X	X	X	X	X	X
17	*Lumnitzera racemosa* Willd.	✓	✓	✓	X	X	X	X	X	✓	X
18	*Sonneratia alba* J. E.Smith	X	X	X	X	✓	X	X	✓	✓	✓
19	*Sonneratia apetalae* L. f.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	*Sonneratia caseolaris* (L.) Engl.	✓	✓	✓	X	X	X	X	X	✓	✓
21	*Nypa fruticans* Wurmb	X	X	X	X	✓	✓	X	X	X	X
22	*Phoenix sylvestris* Roxb.	✓	X	X	X	X	✓	X	✓	X	X
23	*Phoenix humilis* var. *pedunculata* Becc.	X	✓	X	X	X	X	X	X	✓	X
24	*Acrostichum aureum* L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Figs. 2-25 True mangrove species of Kerala



2. *Acanthus ilicifolicus* L., 3. *Acanthus ebracteatus* Vah, 4. *Acrostichum aureum* L., 5. *Aegiceras corniculatum* (L.) Balsco, 6. *Avicennia marina* (Forssk.) Vierh., 7. *Avicenia officinalis* L., 8.*Bruguiera cylindrica* (L.) Blume, 9. *Bruguiera gymnorrhiza* (L.) Savi., 10. *Bruguera parviflora* (Roxb.) Wight & Arn. ex Griff., 11. *Bruguiera sexangula* (Lour.) Poir., 12. *Ceriops tagal* (Perr.) C. B. Robins., 13. *Excoecaria agallocha* L., 14. *Heritiera littoralis* Dryand., 15. *Kandelia candel* (L.) Druce, 16. *Lumnitzera racemosa* Willd., 17. *Nypa fruticans* Wurmb, 18. *Phoenix sylvestris* Roxb., 19. *Phoenix humilis* var. *pedunculata* Becc., 20. *Rhizophora apiculata* Blume, 21. *Rhizophora mucronata* Poir., 22. *Shirakiopsis indica* (Willd.) Esser, 23. *Sonneratia alba* J. E.Smith, 24. *Sonneratia apetalae* L. f., 25. *Sonneratia caseolaris* (L.) Engl.

6. Conclusion

Present investigation on the distribution and plant diversity of mangroves revealed that out of the total extent of mangroves in Kerala (2502 ha.), 1313 ha. is under private ownership and 1189 ha. belongs to the State. Studies on floristic composition indicated that a total of 24 pure mangroves species were recorded from the mangrove areas and are belonged to 15 genera and 9 families. Similarly, there were 98 mangrove associates identified from various locations in different districts. Distribution of pure mangroves in Kerala revealed that *Lumnitzera racemosa*, *Nypa fruticans*, *P. sylvestris*, *P. humilis* var. *pedunculata* and *Ceriops tagal* are the most threatened species in the west coast of India. Mangroves of Kerala are considered as the relics of the past. Invasion by encroachers made extensive clearing and degradation of many areas. Hence there is an urgent need to protect the remaining mangrove areas and a massive afforestation campaign is to be initiated with the full hearted support and cooperation of the common people.

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References

[1] Kerala State Land use Board. Land Resources of Kerala, Government of Kerala, Trivandrum. 2013.
[2] Khaleel K. M. Study of the quantitave structure of the true mangroves present in the mangal forests of Thellicherry, Pappinissery and Kunhimangalam of Kannur district. *Indian Forester*. 131, pp 81-89. 2005.
[3] Krishnamurthy K, Kannan L, Jeyaseelan M. J. P., Palaniappan R, Ali M. A. S. A floristic study of the halophytes of the Pichavaram mangroves. *Bull. Bot. Sur. India.* 23 (344), pp 114-120. 1981.
[4] Tresa Radhakrishnan and Anilkumar M. R. Kandal, Kerala's Vanishing Asset, Akshara Laser and Offset printers and Pubishers, Trivandrum, Kerala, India. pp 302. 2014.
[5] Vidyasagaran K and Madhusoodanan V. K. Distribution and plant diversity of mangroves in the west coast of Kerala, India. *Journal of Biodiversity and Environmental Studies*, 4:5, pp 38-45. 2014.
[6] Vidyasagaran K, Ranjan M. V., Maneeshkumar M., Praseeda T. P. Phytosociological analysis of mangroves at Kannur District, Kerala. *International Journal of Environmental Sciences* 2: pp 671-677. 2011.
[7] Vimal Raj R. V., Binushma Raju, W. Soumya, A. Shibu, S. Lekshmi, Y. Shibu Vardhanan, S. Sruthi and Tresa Radhakrishnan. Aquatic bioresources of Ashtamudi Lake, Ramsar Site, Kerala. *Journal of Aquatic Biology & Fisheries*, 2: pp 297-303 2014.
[8] Tomlinson, P.B. The Botany of Mangroves.Cambridge University Press, Cambridge, London, New York. 1986.
[9] Blasco, F. The Mangroves in India. Institute Francais de Pondicherry. Sect.Sci.Tech. India, 14, pp 180. 1975.
[10] Singh, V.P., L.P. Mall, A. Garge and S.M. Pathak Human impact assessment of mangrove forest of Andamans Islands. Indian Forester, 116: pp 131-1391990.
[11] Duke, N.C. Mangrove Flora and Biogeography.In, Coastal and Estuarine Studies: Tropical Mangrove Ecosystems, (A. I. Robertson and D.M. Alongi (eds.),

American Geophysical Union, Washington DC., USA, pp 63-100. 1992.
[12] IUCN Global Status of Mangrove Ecosystems.In, Commission on Ecology Papers No. 3, (P. Saenger, E.J Hegerl and J. D. S. Davie,eds.), International Union for Conservation of Nature and Natural Resources, Gland, Switzerland, pp 88. 1983.
[13] Kathiresan, K. Mangrove Atlas and Status, Species in India. Report submitted to the Ministry of Environment and Forest, Govt of India, New Delhi, pp 235. 2000a.

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