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Identification of mangrove and mangrove associates in Kannur district of Kerala including their economic – ecological linkages

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Abstract
The present investigation was carried on the identification of angrove and mangrove associates in Kannur district of Kerala including their economic-ecological linkages. In the present investigation, the diversity and distribution of mangrove vegetation were studied in 2015-2016. From the study, 7 species of true mangroves, 4 species of semi-mangroves and 7 species of mangrove associates were identified in Vellikkeel. In Ezhome 10 true, 3 semi, 7 mangrove associates were identified respectively. The present study revealed that mangroves in both areas are under threat. At present, all these species are at serious risk as no systematic attempt has been made to conserve them. Mangroves provide many ecological, environmental and socioeconomic benefits to mankind. The mangroves in the state are threatened with unprecedented destruction, which includes commercial exploitation of raw materials, land reclamation for agriculture, aquaculture and housing. There have been significant changes in the traditional and present uses of resources within the mangrove system, which have implications on its depletion. Socially, afforestation programme would be benefiting people living in coastal areas in terms of protection, environmental services and support for livelihood.

Keywords: True mangroves, Semi-mangroves, Mangrove associates, Economic-ecological Linkages, Degradation and Conservation

1. Introduction
Mangroves are halophytes occurring in saline marshy places. The word mangrove is a combination of Portuguese word "Mangue" and English word "Grove". Macnae (1968) [52] coined a new term to the mangrove, "Mangal" for mangrove community and "Mangrove" for individual species. Mangroves are the trees, shrubs that colonize shorelines and islands in saline regions usually found in tropics and subtropics. The mangrove is one of the most productive ecosystems and a natural renewable resource (Kathiresan, 2003) [44]. The coastal habitat of mangrove includes the inter-tidal seaboards, backwater, river mouths, and shelter bays of the west coast of the world (Mandal and Naskar, 2008) [54].
Mangroves are generally found along the coastlines of tropical and subtropical regions, usually between 25^0N and 25^0S latitude, throught the world. As an exception to these, mangroves are found as far south as New Zealand and as far as north as Japan (Choudhury, 1997) [24]. Plants in mangroves are diverse but all are able to exploit their habitat that lives at or near the water's edge in protected marine habitats (Ong *et al*., 2004) [67]. There is a large amount of inorganic nutrients from the land and decomposed leaves supply valuable organic nutrients. Thus mangrove swamps serve as feeding, breeding, spawning and nursery ground for many marine organisms (Muraleedharan *et al*., 2009) [61].
As the abode of rich biodiversity, their role in the sustainability of sea food species and shoreline stability, economic standing and the survival of selected communities and in the context of the predicted scenarios of global warming and sea level rise, conservation of mangrove vegetation is very important (Deshmukh, 1991) [28]. Large scale afforestation, control on developmental activities in the mangrove areas and ecotourism, give better results in the conservation of mangroves (Sheela francis, 2013) [82].
India with a long coastline of about 7516.6 km, including the island territories (Anonymous 1984), has a mangrove cover of about 6,749 km^2, the fourth largest mangrove area in the world (Naskar & Mandal, 1999) [64]. Kerala had very thick mangrove vegetation especially along its coastline. According to an estimate, Kerala once supported about 700 km^2 of mangroves along its coast (Ramachandran *et al.*, 1986) [71]. In Kerala only Kannur has good natural patches than that in the other districts. There was approximately 755 hectare of mangrove forest in Kannur. However it has declined to 17 km^2 (Basha, 1991) [12]. Hence the present study on "Identification of Mangrove and Mangrove associates in Kannur District of Kerala Including their Economic-ecological Linkages" was attempted with identification, medicinal, economic values, ecological functions, economic profits, socio-economic causatives and conservation.

2. Materials and Methods
2.1 Study Area
The study was constituted in '*Vellikkeel'* and '*Ezhome'* region of Kannur district of Kerala. Kannur district encompasses with highest extent of mangroves among Kerala. The '*Vellikkeel',* estuary is situated in the latitude 11.987° N and longitude 75.349° E. It has an average elevation of 1 metre on the bank of '*Vellikkeel River'*. The average high temperatures rise to 33.1°C here in April and fall to 26.1^0C with an annual average rainfall is 3438 mm. The '*Vellikkeel'* is rich in species diversity of mangroves. Eco-tourism as well as other biotic interference has created large scale disruption of this fragile community. This in turn has resulted in a huge decline of

mangrove cover and ultimately affected the natural regeneration. '*Ezhome'* is situated at 12° 57' N latitude and 75° 15' E on the bank of '*Pazhayangadi River'*. The average annual temperature in Ezhome is 27.1°C and the rain fall is 3510 mm.

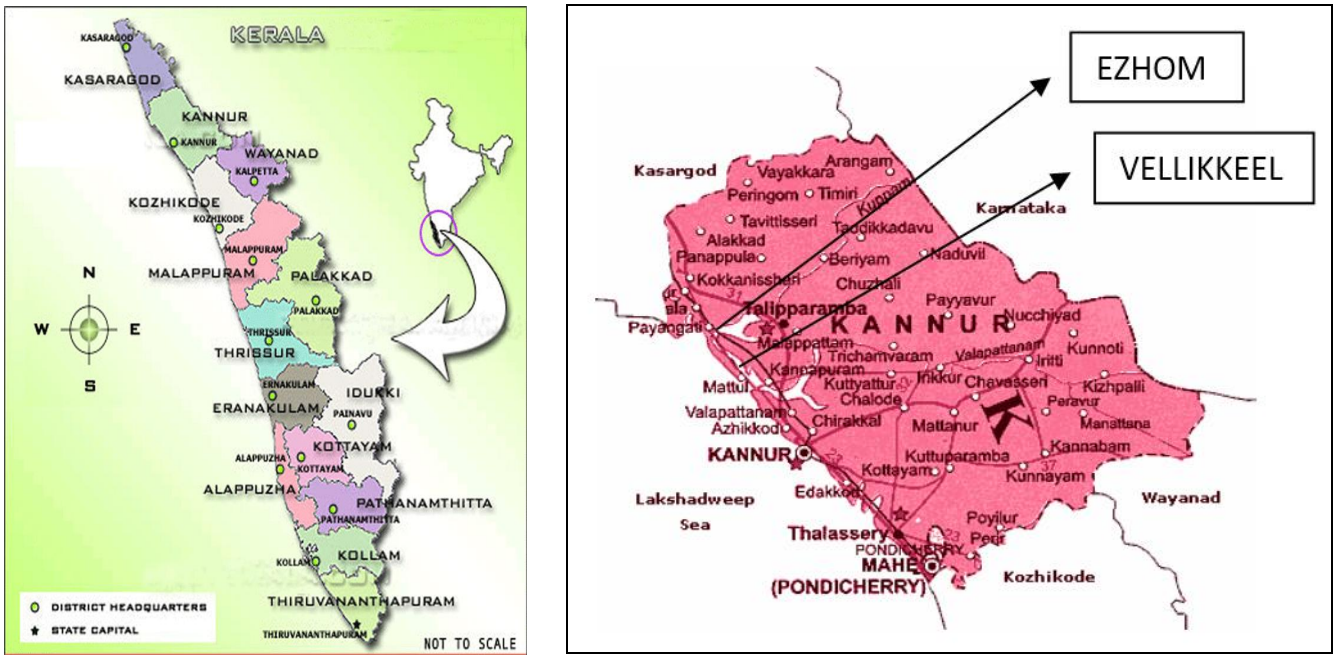

Fig 1

3. Results

3.1 Floristic Composition

Vellikkeel

The floristic composition revealed a total of 8 true mangroves, 4 semi mangroves and 7 mangrove associate species in Vellikkeel (Table 1, 2, 3). From this 8 true mangrove species include 7 genera and 5 families, Acanthaceae, Avicenniaceae, Rhizophoraceae, Euphorbiaceae and Sonneratiaceae respectively. Out of this 2 were shrubs, 1 small tree and 5 are trees. The semi mangrove species comes under 2 genera and 2 families Pteridaceae and Papilionaceae. The 4 semi mangroves belong to fern, woody climber, shrub and climbing shrub respectively. The 7 mangrove associates coming under 7 genera and 6 families, Apocynaceae, Verbenaceae, Cyperaceae, Convolvulaceae, Pandanaceae and Malvaceae. This 7 mangrove associate comes under 2 herbs, 1 shrub, 1 creeper and 3 tree species. Two monocots belong to the genus *Cyperus* was recorded from the degraded islands of Vellikkeel. The entire system looked like a *Rhizophora* dominated mangrove formation.

Table 1: Floristic Composition of True Mangrove Species at Vellikkeel

S. No	Species	Family	Habit	Common Name	Local Name
1	*Acanthus ilicifolius* Linn.	Acanthaceae	Shrub	Sea Holly/ Holly Mangroves	Chullikandal
2	*Avicennia officinalis* L.	Avicenniaceae	Tree	White Mangroves	Uppatti
3	*Bruguiera cylindrica* (L.) Blume.	Rhizophoraceae	Tree	Small Leaved Orange Mangrove	Kuttikandal
4	*Excoecaria agallocha* Linn.	Euphorbiaceae	Tree	Blind Your Eye Mangrove/ Blinding Tree	Kannambotti
5	*Kandelia candel* L.Druce.	Rhizophorazeae	Shrub	Narrow-Leaved Kandelia	Cherukandal Nallakandal
6	*Rhizophora apiculata* Blume.	Rhizophoraceae	Tree	Tall Stilted Mangrove	Vallikandal
7	*Rhizophora mucronata* Lamk.	Rhizophoraceae	Tree	Long Fruited Stilted Mangrove	Peekandal Pranthankandal
8	*Sonneratia alba* L.	Sonneratiaceae	Small Tree	Mangrove Apple	Kambetti Nakshathrakanl Appakkad

Table 2: Floristic Composition of Semi-Mangrove Species at Vellikkeel

S. No	Species	Family	Habit	Common Name	Local Name
1	*Acrostichum aureum* L.	Pteridaceae	Fern	Mangrove Fern	Machinthol Chavithol Thavikkad
2	*Derris scandens* Benth.	Papilionaceae	Woody Climber	Hog Creeper	Poonjali valli
3	*Derris trifoliata* L.	Papilionaceae	Shrub	Three Leaf Derris	Ponnum valli
4	*Derris uliginosa* Benth.	Papilionaceae	Climbing Shrub	Indian Beech / Pongamia oil tree.	Pongu Valli

Table 3: Floristic Composition of Mangrove Associate Species at Vellikkeel

S. No	Species	Family	Habit	Common Name	Local Name
1	*Cerbera odollam* Gaertn.	Apocynaceae	Tree	Suicide tree, pong-pong	Othalanga maram
2	*Clerodendron inerme* Gaertn.	Verbenaceae	Shrub	Garden quinine, Indian privet, Wild Jasmine	Vishamadari Puzhamulla
3	*Cyperus rotundus* Linn.	Cyperaceae	Herb	Cyperus grass	Canita
4	*Fimbristylis ferruginea* Vahl.	Cyperaceae	Herb	Rusty sedge and West Indian fimbry	Puzha potta
5	*Ipomea biloba* Forsk.	Convolvulaceae	Creeper	Beach morning glory or goat's foot	Aattadambu
6	*Pandanus tectorius* Soland.	Pandanaceae	Tree	Screw pine	Kaitha
7	*Thespesia populnea* Cav.	Malvaceae	Tree	Indian tulip tree Portia tree	Poovarasu

3.2 Ezhome

The distribution of mangroves at Ezhome indicated that there are 10 true mangrove species, 3 semi mangrove species and 7 mangrove associated species respectively (Table 4, 5, 6). The 10 true mangrove species comes under 8 genera and 7 families, Acanthaceae, Myrsinaceae, Avicenniaceae, Euphorbiaceae, Rhizophorazeae, Combretaceae and Sonneratiaceae. There are 2 shrubs, 4 small tree and 4 tree species. The 3 semi mangrove species belongs to 2 families Pteridaceae and Papilionaceae. *Acrostichum aureum* is a fern, *Derris scandens* is a woody climber and *Derris trifoliata* is a shrub. The 7 mangrove associates in Ezhome coming under 5 families, Anonaceae, Lecythidaceae, Cyperaceae, Rubicaceae and Malvaceae. They include 3 herbs and 4 tree species.

Table 4: Floristic Composition of True Mangrove Species at Ezhome

S. No	Species	Family	Habit	Common Name	Local Name
1	*Acanthus ilicifolius* Linn.	Acanthaceae	Shrub	Sea Holly/ Holly Mangroves	Chullikandal
2	*Aegiceras corniculatum* Blanco.	Myrsinaceae	Small Tree	River Mangrove	Pookandal
3	*Avicennia marina* (Forssk.) Vierh	Acanthaceae	Small Tree	Grey Mangrove	Cheru Uppatti
4	*Avicennia officinalis* L.	Avicenniaceae	Tree	White Mangroves	Uppatti
5	*Excoecaria agallocha* Linn.	Euphorbiaceae	Tree	Blind Your Eye Mangrove/ Blinding Tree	Kannambotti
6	*Kandelia candel* L.Druce	Rhizophorazeae	Shrub	Narrow-Leaved Kandelia	Cherukandal /Nallakandal
7	*Luminitzera racemosa* Wild.	Combretaceae	Small Tree	Black Mangrove	Kadakandal
8	*Rhizophora apiculata* Blume.	Rhizophoraceae	Tree	Tall Stilted Mangrove	Vallikandal
9	*Rhizophora mucronata* Lamk.	Rhizophoraceae	Tree	Long Fruited Stilted Mangrove	Peekandal /Pranthankandal
10	*Sonneratia caceolaris* Engl.	Sonneratiaceae	Small Tree	Apple Mangrove	Blathi Kandal Chakkara Kandal

Table 5: Floristic Composition of Semi-Mangrove Species at Ezhome

S. No	Species	Family	Habit	Common Name	Local Name
1	*Acrostichum aureum* L.	Pteridaceae	Fern	Mangrove Fern	Machinthol Chavithol Thavikkad
2	*Derris scandens* Benth.	Papilionaceae	Woody Climber	Hog Creeper	Poonjali valli
3	*Derris trifoliata* L.	Papilionaceae	Shrub	Three Leaf Derris	Ponnum valli

Table 6: Floristic Composition of Mangrove Associate Species at Ezhome

S. No	Species	Family	Habit	Common Name	Local Name
1	*Anona glabra* L.	Anonaceae	Tree	Aligator apple monkey apple	Kadalatha
2	*Barringtonia racemosa* Roxb.	Lecythidaceae	Tree	Powder-puff tree	Samudrachampa
3	*Cyperus rotundus* Linn.	Cyperaceae	Herb	Cyperus grass	Canita
4	*Fimbristylis dichotoma* Vahl.	Cyperaceae	Herb	Two rowed rush	Puzha potta
5	*Fimbristylis ferruginea* Vahl.	Cyperaceae	Herb	Rusty sedge and West Indian fimbry	Potta
6	*Morinda citriflolia* Linn.	Rubicaceae	Tree	Indian mulberry beach mulberry cheese fruit	Cherumanjanathi
7	*Thespesia populnea* Cav.	Malvaceae	Tree	Indian tulip tree Portia tree	Poovarasu

3.4 Medicinal & Economic Uses of Mangroves

The commonly used plant parts are leaves, flower, fruit, bark, tubers, root, seeds, wood and stem. The values of mangrove ecosystem includes direct uses such as firewood, poles, construction materials, fishing gear, tanning, medicines and fishery products.

Table 7: Medicinal and Economic uses of True Mangrove Species

S. No	Species	Family	Parts Used	Uses
1	*Acanthus ilicifolius* Linn.	Acanthaceae	Roots & Seeds	Roots are used to cure asthma, tiredness and stomach disorders. Kidney shaped seeds are used for rheumatic disorders.
2	*Aegiceras corniculatum*	Myrsinaceae	Flowers & Wood	Honey is extracted from the fragrant flowers. Honey wax obtained is also important. Wood is used as fuel and used for building purposes.

	Blanco.			
3	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Flower, Wood & Leaves	Flower is used in honey industry. Particular oil syrup obtain from the plant is used as abortificient. Wood is used as fuel. Leaves are used as cattle fodder.
4	*Avicennia officinalis* L.	Avicenniaceae	Flowers, Seeds, Wood, Leaves & Bark	Honey is extracted from the flower. Seeds are used as food in some areas. Wood is used for building purposes and making furniture. Used as a medicine for tuberculosis. Resin obtains from the plant used as medicine. Unripened fruit used to cure skin sores.
5	*Bruguiera cylindrica* (L.) Blume.	Rhizophoraceae	Wood & Bark	Wood is used for making furniture. Different medicines and tannins are obtained from the bark.
6	*Excoecaria agallocha* Linn.	Euphorbiaceae	Leaves & Wood	Whitish exudates produce from the leaf twig is highly medicinal and used to cure tuberculosis. Soft wood is used for making match box, plywood, and paper industry.
7	*Kandelia candel* L.Druce	Rhizophorazeae	Wood, Leaves & Seeds	It is used as fuel wood. Leaves are used as cattle feed. Steamed seeds are used as food. Medicine obtains from the plant is used to cure diabetes.
8	*Luminitzera racemosa* Wild.	Combretaceae	Wood	Wood is used as fuel. It is used in tannin industry. Medicines obtained from the plant are used against itching.
9	*Rhizophora apiculata* Blume.	Rhizophoraceae	Stem & Leaves	Tannin, gum, dyes, rayon, pulp, plywood etc is obtaining from the stem. Leaves used as cattle feed.
10	*Rhizophora mucronata* Lamk.	Rhizophoraceae	Wood, Bark, Seed, Young Shoots & Leaves	Wood is used as fuel and making furniture. Tannin, gum, dyes and rayon is obtained from the bark. Seeds and young shoots are used as food. Leaves are used as cattle feed. Medicine obtains from the bark used to cure diabetes and heart disorders.
11	*Sonneratia alba* L.	Sonneratiaceae	Leaves & Fruits	Leaves are used as cattle feed. Fleshy fruits used in curries and pickles.
12	*Sonneratia caceolaris* Engl.	Sonneratiaceae	Leaves, Wood & Fruit	Leaves are used as cattle feed and its medicinal property will cure sterility in cattle. Wood is used as fuel and building purposes. Fruit is used in curries. Vinegar is obtained from the plant. It is used as medicine for wormal diseases.

Table 8: Medicinal and Economic uses of Semi- Mangrove Species

S. No	Species	Family	Part Used	Uses
1	*Acrostichum aureum* L.	Pteridaceae	Shoot, Leaves & Rhizome	The young shoots can be eaten raw as a salad or cooked. Older leaves when dried are parchment-like and used as fire-resistant roof thatch. The fibres of old leaves may also be used to make cord. Rhizomes are used to treat wounds and boils. Leaves are used to stop bleeding and used as cattlefeed.
2	*Derris scandens* Benth.	Papilionaceae	Roots	Used as an organic insecticide used to control pests on crops such as peas. Derris root, when crushed, releases rotenon. Roots used in fishing.
3	*Derris trifoliata* L.	Papilionaceae	Stem & Seeds	Fibres obtain from the plant stem is used to make ropes. The fishermen use their seeds in fishing net because of their toxicity. Used against nervine disorders.
4	*Derris uliginosa* Benth.	Papilionaceae	Root, Flowers & Seeds	Used for skin diseases— eczema, scabies, leprosy, and for ulcers, tumours, piles, enlargement of spleen, vaginal and urinary discharges. Juice of root—used for closing fistulous sores and cleaning foul ulcers. Flowers— used in diabetes. Powder of seeds— used for whooping and irritating coughs of children. Seed oil—used in cutaneous affections, herpes and scabies.

Table 9: Medicinal and Economic uses of Mangrove Associate Species

S. No	Species	Family	Part Used	Uses
1	*Anona glabra* L.	Anonaceae	Fruit & Seeds	The fruit is edible for humans and its taste is reminiscent of ripe Honeydewmelon. It can be made into jam and it is a popular ingredient of fresh fruitdrinks. Anticancer Research, suggests that its alcoholic seed extract contains anticancer compounds that could be used pharmaceutically.
2	*Barringtonia racemosa* Roxb.	Lecythidaceae	Leaves, Seeds, Bark & Fruit	Young leaves - raw or cooked as a vegetable. They are usually soaked in lime water first in order to remove their bitterness. The seeds are pounded to extract the starchy content, which is made into cakes. A decoction of the bark is externally applied as an antirheumatic and to treat chickenpox. The fruit is used externally for poulticing sore throat and skin eruptions. Oil is obtained from the seed. Used as an illuminant. The bark yields tannin.
3	*Cerbera odollam* Gaertn.	Apocynaceae	Fruit & Seeds	The fruits are used for manufacturing bio insecticides and deodorants. Investigations have also been made into the feasibility of using the seeds as a feedstock in the production of biodiesel.

4	*Clerodendron inerme* Gaertn	Verbenaceae	Flower & Leaves	Flowers and leaves traditionally used for ornamental purposes in home gardens.
5	*Cyperus rotundus* Linn.	Cyperaceae	Leaves & Tubers	Leaves are traditionally used to produce the mat. It has edible tubers and is grown commercially for these; they are eaten as vegetables, made into sweets. Tubers were a mainstay food. They are grown as ornamental or pot plants. These are the crops for paper and biofuel production. It used in folk medicine. It is an abortificient.
6	Fimbristylisdichotoma Vahl.	Cyperaceae	Rizome	The rhizomes are a diuretic and its pastes are taken to treat kidney problems. It is also collected in India for its aromatic properties. It is grown for slope stabilization and is harvested as animal (cattle) fodder.
7	*Fimbristylis ferruginea* Vahl.	Cyperaceae	Stem	The stems are beaten to soften the fibres and are then plaited to make screens for huts.
8	*Ipomea biloba* Forsk.	Convolvulaceae	Leaves	The leaves are eaten as a vegetable.
9	*Morinda citriflolia* Linn.	Rubicaceae	Bark, Seeds & Roots	Bark produces a brownish-purplish dye that may be used for making batik. Yellowish dye is extracted from its roots to dye cloth. Seed oilwhich contains linoleicacid. Roots have been used to treat abdominal pain, importence, and menstrual disorders.
10	*Pandanus tectorius* Soland.	Pandanaceae	Fruit & Leaves	The fruit can be eaten raw or cooked and is a major source of food. The leaves are often used as flavoring for sweet dishes such as kava jam. The leaves are used to flavor a variety of curries. Leaves were used to make baskets, mats, outrigger, canoesails, thatch roofs and grass skirts.
11	*Thespesia populnea* Cav.	Malvaceae	Wood	The heart wood is used to make the thavil, a Carnatic musical instrument of South India.

Fig 1: True Mangroves

Acanthus ilicifolius Linn.

Excoecaria agallocha Linn.

Kandelia candel L.Druce.

Rhizophora mucronata Lamk.

Luminitzera racemosa Wild.

Aegiceras corniculatum Blanko**.**

Fig 2: Semi Mangroves

Acrostichum aureum L.

Derris scandens Benth.

Derris trifoliata L.

Fig 3; Mangrove Associates

Clerodendron inerme Gaertn.

Fimbristylis ferruginea Vahl.

Pandanus tectorius Soland.

Thespesia populnea Cav.

Cyperus rotundus Linn.

Anona glabra L.

3.5 Ecological Functions of Mangroves

The mangrove vegetation possesses number of ecological functions. The mangrove ecosystem represents an inter phase between two contrasting types of communities, terrestrial and marine ecosystems.

Table 13: Ecological Functions of Mangrove vegetation

S. No	Function	Ecology
1	Shoreline stabilization	Reduce erosion of coastlines, binding and stabilization of soil by plant root and deposit vegetative matter. Reduce erosion forces such as waves, wind energy and floods.
2	Ground water recharge	Provide supply of surface water into the ground water flow system. Supply water to surrounding areas and sustain water table.
3	Ground water discharge	The movement is usually upwards of groundwater into surface water as springs. Mangroves typically have moderate or uncertain groundwater discharge functions.
4	Flood and flow control	The excess amounts of water which may occur in times of heavy rainfall or high flows in rivers enter a mangrove and are stored or delayed in their down slope journey
5	Sediment and nutrient retention	The physical properties of mangroves (vegetation, size, water depth) tend to slow down the flow of water. This facilitates sediment deposition. This deposition is closely linked to the beneficial removal of toxicants and nutrients since these substances are often bound to sediment particles. Nutrients are often associated with sediments and therefore can be deposited at the same time.
6	Habitat protection and biodiversity	Habitat may provide both food and shelter to organisms. Mangroves provide important habitats for the life cycle of important plants and animal species. Aquatic animals such as fish and prawn which depend on mangrove areas for spawning and juvenile development. Many species of migratory birds depend on mangroves for part of their life cycle for resting or feeding while on migration.
7	Biomass and productivity	The plant biomass represents the 'natural capital' of the system that is combined with nutrients, water, and light to maintain the existing biomass, grow new biomass, and support the rest of the food chain. Plant biomass is also important as a structural, abiotic feature in the landscape. It can perform physical as well as biological functions, like trapping sediments and serving as nesting sites for animals.
8	Improve coastal water quality	Maintain coastal water quality by abiotic and biotic retention, removal, and cycling of nutrients, pollutants, and particulate matter from land-based sources, filtering these materials from water before they reach seaward coral reef and seagrass habitats. Specialised secretary glands in roots excrete the salt contained in the absorbed water.

3.6 The Economic Profits of Mangrove Ecosystem

Mangrove resources are harvested for subsistence as well as commercial purposes. The people undertake a variety of economic activities such as fishing, prawn catching, crab catching, shell mining, sand mining and coir retting services. Fishing helps the workers to earn money and to meet their subsistence. The shrimp farming includes different steps, preparation of pond, stocking rate and feeding. They also collect firewood, fodder from the mangroves. The eco-tourism is one of the more profitable processes in association with mangrove ecosystem. Eco-tourism is the prominent economic aspect in Vellikkeel. The agricultural activities nearby mangrove areas and ecological factors in the mangrove areas influence the agricultural productivities in kaipad rice cultivation in low lying areas. Generally long varieties are grown, considering flooding during the monsoon season.

3.7 Economic – Ecological Linkages

There is a large amount of inorganic nutrients from the land and decomposed leaves supply valuable organic nutrients. Thus mangrove swamps serve as feeding, breeding, and spawning, nursery ground for many marine organisms. The tidal characteristics of the mangrove swamps offers great productivity potential for marine biota and specifically are well suited for fish and shrimp production. Human effects in the mangrove areas are use of land for inhabitation and agriculture and the utilization of mangrove resources for economic profit. As mentioned earlier, there has been a drastic reduction in the area under mangrove ecosystem because of growing human settlement and enlarging agricultural areas. The kaipad cultivation and shrimp farm carried out in the mangrove areas are classic examples for agricultural development. Wood cutting for construction and fuel wood requirements was in practice in olden days. Pest & diseases are most common in the kaipad cultivation areas so shrimp farming as a result of which many farmers have given up these activities in many places.

3.8 Socio-Economic Causatives & Importance of Conservation

The mangroves in the study sites are threatened with commercial exploitation of raw materials, agricultural utilization of land, aquaculture and housing. Increase in population, sand mining, and exploitation of mangrove forests without replanting are some of the other factors influencing depletion of mangroves. The mangrove dependents combined the use of land, sea, and inter-tidal resources. Basically involved primary subsistence activities are agriculture and fishing. In both the study sites, Vellikkeel and Ehzome are under high degree of destruction because of dumping plastic, glass and poultry waste. Some newly reforested land areas with small growing mangroves are well protected.

Fig 4: Mangrove Degradation

4. Discussion

The floristic composition in Vellikkeel and Ezhome, Kannur district of Kerala revealed that there are 8 and 10 true mangrove species respectively. Mainly they belong to five families, Acanthaceae, Avicenniaceae, Rhizophoraceae, Euphorbiaceae and Sonneratiaceae. Rhizophora is the dominated species in both sites. According to Vidyasagaran *et al.*, (2011) [99] the floristic study in various sites of Kannur district revealed that the occurrence of a total 12 species belonging to seven families. 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 aspects of Kerala Forest Department (Mini Mohandas *et al.*, 2014) [57]. Mangrove plantations are one among the most productive ecosystems on this planet. They serve as custodians of their juvenile stock and form most valuable biomass (Odum, 1971) [66]. The livelihoods of the local coastal communities have been diminished or totally lost by the destruction or degradation of mangroves (Macinto and Ashton, 2003) [51]. Unfortunately, mangroves are seriously threatened ecosystems (Valiela *et al.*, 2001) [98], with threats coming from coastal development, conversion to aquaculture, overharvesting of trees, pollution and global climate change (Adeel and Pomeroy, 2002, Alongi, 2002; Macintosh and Ashton, 2003) [1, 5, 51]. This highlights that there is an urgent need to find conservation strategies that lead to successful biological outcomes, while accounting for the needs of rural coastal inhabitants who depend on the resource. Community-based mangrove management and protection, therefore, provides one possible mechanism to achieve the goal of mangrove ecosystem conservation (Sudtongkong and Webb, 2008) [85].

It is suggested that the studied two mangrove estuary must be given conservation priority to protect the fragile community and the river banks. Therefore many anthropogenic activities, antisocial elements must be checked so as to protect the species in their habitats. Further, ecosystem-specific management plans must be developed to protect the individual species in this mangrove vegetation.

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