IMPACT ASSESSMENT OF LNG TERMINAL AUGMENTATION PROJECT BY M/S PLL ON THE TERRESTRIAL FLORA AND FAUNA AT PUTHUVYPEEN, KERALA

Final Report

Project Team:

Dr. Arun P R, Dr. Azeez P A, Dr. Murugesan M & Dr. Nikhil Raj P P

Sálim Ali Centre for Ornithology and Natural History
Coimbatore – 641108

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Mr. Neelakandan, LNG

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Mr. S. Prasanth Narayan, M.G. University, Kottayam

Ms. J. Ranjini, SACON, Coimbatore

Mr. M.Manoharan, SACON, Coimbatore

Declaration

Updation of EIA for Augmentation Project of LNG Terminal at Puthuvypeen-Kochi, Kerala

I hereby certify that I was part of the EIA team in the following capacity that developed this EIA.

Functional Area of Expert:	Ecology & Biodiversity
Period of involvement:	June, 2011 to September, 2011
Tasks:	Supervision of collection of data on flora & fauna and impact assessment & management plan preparation. Specific review w.r.t. drainage pattern for impact assessment on mangroves, other flora & fauna.
Name:	Parappurath Abdul Azeez
Contact Details:	9442013942

Signature
Date:

1 Introduction

Energy is one of the primary requisites for the economic development and the energy security is the prime concerns among countries all over the world. In a developing country like India where the energy sector is struggling to cope with the ever increasing demand and pollution from traditional fuels necessitate large scale investment in exploring new avenues of cleaner energy. The Rapid economic expansion is continuously hits on India's energy needs. The Natural gas is increasingly being looked upon as a cleaner alternate fuel with minimal environmental impacts. According to some recent estimates, Natural gas meets 23% of worlds energy needs.

The LNG terminal and regasification facility presently being developed by M/s Petronet LNG Ltd. (PLL) at Puthuvypeen would facilitate import, storage, regasification, and distribution of Liquified Natural Gas (stored at around -165^{o}C). The LNG will be imported via sea route through special LNG tankers from Qatar. The terminal is expected to cater to the growing needs of industrial and power sectors of Kerala. The project is expected to be a big boost to Kerala's economy and the state-based companies like Fertilisers and Chemicals Travancore Ltd (FACT) and Kayamkulam Thermal Power Plant of NTPC will benefit from the high availability of LNG. As per the initial plan, for which the environmental clearance has already been obtained by PLL (existing consent no.PCB/CE/R5/1446/2008 dated 17.05.2010), two insulated LNG tanks each of 10,000 m^3 capacity are being built at Puthuvypeen site along with associated port and regasification facilities and are in the advanced stage of completion.

Due to change in market scenario M/S PLL plan to expand this LNG re-gasification facility from the existing 2.5 MMTPA to 5 MMTPA, comprising of additional two heat exchangers and connected pumps and flow meters.

There will be no additional land or storage tank requirements for this expansion.

1.1 PRESENT STUDY

The present short term study was taken up to collect and updates the baseline environmental data on the terrestrial flora and fauna around the LNG terminal project by Petronet LNG Ltd., as part of the environmental clearance requirements. The present study was of 3 months duration starting from July 2011. Further to the initial reconnaissance survey, the area falling within 10km radial distance on the landward side was marked on the satellite imageries and was divided into four equal sectors and further into eight sub sections for convenience of stratification of sampling efforts as detailed under methodology section.

1.2 METHODOLOGY

The area under 10 km radial distance from the LNG terminal selected for the present study was marked on the Survey of India (SOI) topographic maps and google earth imageries. Since the proposed project is located along the coast line bordering Arabian Sea, only 50% of the 10km radial distance zone comes in the landward side. The study area was delineated by taking the proposed LNG project area at Puthuvypeen as the centre and plotting two circles of radii 5 and 10 km respectively. For effective representative sampling of the area, the semicircular area of 10km diameter on landward side was further subdivided into 4 equal sectors with 3 radial lines at 45^{o} anglular distances as shown in the map (Figure 1). A significant proportion of this study area was covered by water bodies mainly backwater channels.

The study area was thus demarcated into eight distinct sections. Two sections each falling along four different directions from the project site; ie. towards North (N1 & N2), North-east (NE1 & NE2), South-east (SE1 & SE2) and South

(S1 & S2). With the aid of the topographic maps and the latest imageries available in GoogleEarth, sample points were selected randomly in each of the eight blocks.

Floral and faunal surveys were carried out in all the randomly selected plots of each block. Visual Encounter Survey (VES, search) was carried out for documenting the herpetofauna. The identification of herpetofauna was done with the help of Das and Dutta (1998) for amphibians and Das (1997) for reptiles.The bird survey were done following Herzog *et al* (2002). Birds were recorded by direct sighting and calls. We followed the nomenclature and taxonomic sequence of Grimmett et al. (2000). Similarly quadrats of 10 x 10 m size were laid in the randomly selected areas to study the plant species using standard methods as described under the Flora section of this report.

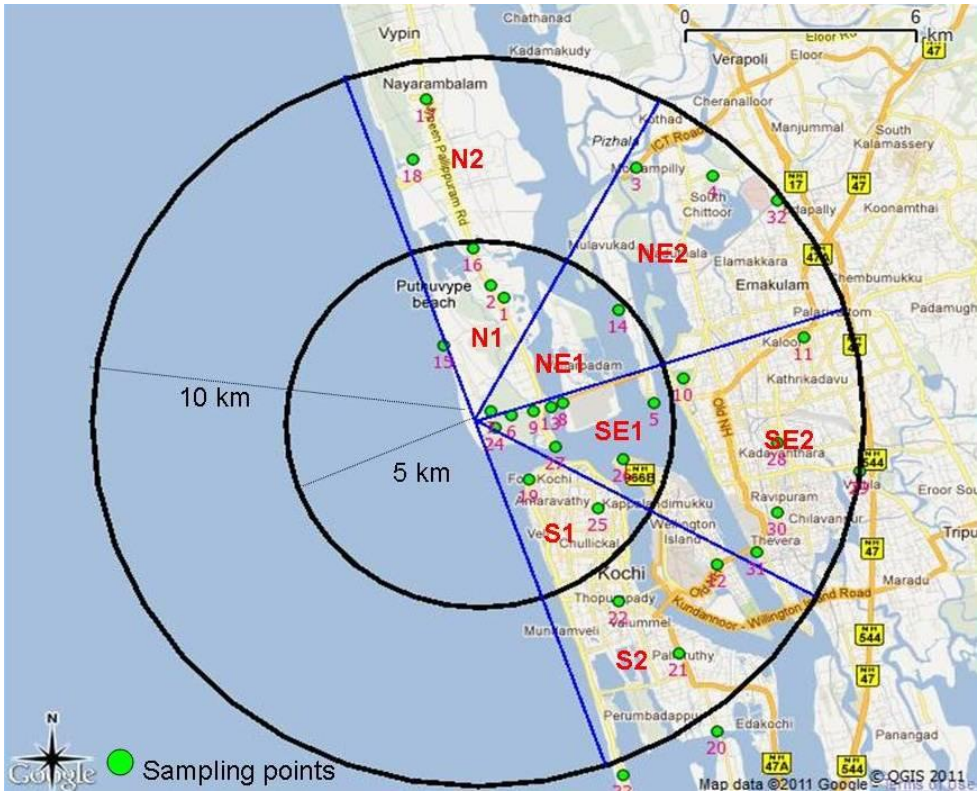

Figure 1. Map showing the sampling design and location of sampling sites

Quadrats of 10 x 10 m size were laid in the randomly selected areas to study the plant species using standard methods as described under the Flora section of this report.

The present status of mangrove vegetation in the study area was assessed using direct observations and recent satellite imageries and was compared with historical imageries of the area since the year 2002 to understand the changes happened to this sensitive ecosystem over the recent past and the causative factors responsible for the same.

Table 1 Geographic location of sampling points

No	Sampling Location	Longitude (Degrees)	Latitude (Degrees)
1	N 1	76.232	10.010
2	N 1	76.218	9.998
3	N 1	76.225	10.022
4	N 1	76.229	10.013
5	N 2	76.214	10.059
6	N 2	76.211	10.044
7	NE 1	76.229	9.982
8	NE 1	76.259	10.007
9	NE 2	76.263	10.042
10	NE 2	76.281	10.040
11	NE 2	76.296	10.034
12	S 1	76.238	9.965
13	S 1	76.230	9.978
14	S 1	76.254	9.958
15	S 2	76.282	9.944
16	S 2	76.282	9.903
17	S 2	76.273	9.922
18	S 2	76.259	9.935
19	S 2	76.260	9.892
20	SE 1	76.243	9.983
21	SE 1	76.267	9.984
22	SE 1	76.234	9.981
23	SE 1	76.246	9.984
24	SE 1	76.239	9.982
25	SE 1	76.260	9.970
26	SE 1	76.244	9.973

27	SE 2	76.274	9.990
28	SE 2	76.302	10.000
29	SE 2	76.296	9.974
30	SE 2	76.315	9.967
31	SE 2	76.296	9.957
32	SE 2	76.291	9.947

1.3 LEGISLATIVE FRAMEWORK

There is a strong set of environmental rules and regulations existing in India. Of these, the Environmental protection act (1986), Coastal Regulation Zone (CRZ) notification (2011) and EIA notification (2006) would specifically apply to the LNG terminal project at Puthuvypeen.

Government of India has declared the coastal stretches of the country as Coastal Regulation Zone, and regulated the developmental activities along this stretch considering its importance as unique habitat for marine animals, livelihood security for the fisher community and the local communities dependent on these natural systems. Further to this the Ministry of Environment and Forests, (MoEF, GOI) also recommends EIA clearance before the commencement of any developmental activities in the CRZ.

A State notification dated 14th October 2005 issued by the Government of Kerala (GOK) also restricts activities within 50m distance from the mangrove forests. The notification specifically restricts constructions of pipelines in 50m vicinity of mangrove and other forest areas. The notification also recommended an EIA study assessing the risk to the local environs from the proposed activities.

The necessary clearances from the concerned regulatory authorities are already available with the project proponent (PLL) for the Puthuvypeen LNG facility. The present study specifically examined the proposed augmentation proposal of the LNG terminal from the initial 2.5 MMTPA capacity to 5 MMTPA. The present augmentation proposal by PLL does not require any

additional land nor would it lead to higher emissions or water requirement. A certification by the proponent in this regard may be required to be submitted to the regulatory authority for obtaining the necessary clearances as per the EIA notification 2006 (and subsequent amendments).

2 Baseline status of terrestrial Biodiversity

2.1 FAUNA

The Kochi metropolis is among the highly populated urban centres in the state of Kerala. The Kochi and its surrounding areas are dominated by backwaters and associated wetlands, mainly, tributaries and distributaries of Vembanadu lake, the largest lake of Kerala. This vast network of vetlands comprising of stretches of paddy fields, aquaculture fields, coastal wetlands and mangroves along with small temple ponds, parks and house gardens in and around Kochi metropolis provide diverse habitats for various species of animals and plants.

The area falling within 10 km radial distance around the study area was demarcated into eight sections for convenience of representative sampling of flora and fauna as shown in the Figure 1.

2.1.1 AVIFAUNA

The area has a good population of birds with 57 species of birds observed during the present study (Table 2). Species such as House Crow (*Corvus splendens*), Little Cormorant (*Phalacrocorax niger*), Darter (*Anhinga melanogaster*), Black Kite (*Milvus migrans*), Brahminy Kite (*Haliastur indus*), Common Myna (*Acridotheres tristis*), Indian Pond-heron (*Ardeola grayii*), Indian Cormorant (*Phalacrocorax fuscicollis*), Little Egret (*Egretta garzetta*), and Intermediate Egret (*Mesophoyx intermedia*) were common in almost of all the sampling points (Figure 2 & Figure 3).

Among the birds, Ashy Drongo (*Dicrurus leucophaeus*), Chestnut-tailed Starling (*Sturnus malabaricus*), Common Sandpiper (*Actitis hypoleucos*), Common Redshank (*Tringa totanus*), Grey Heron (*Ardea cinerea*), Marsh Sandpiper (*Tringa stagnatilis*) are seasonal visitors to the area.

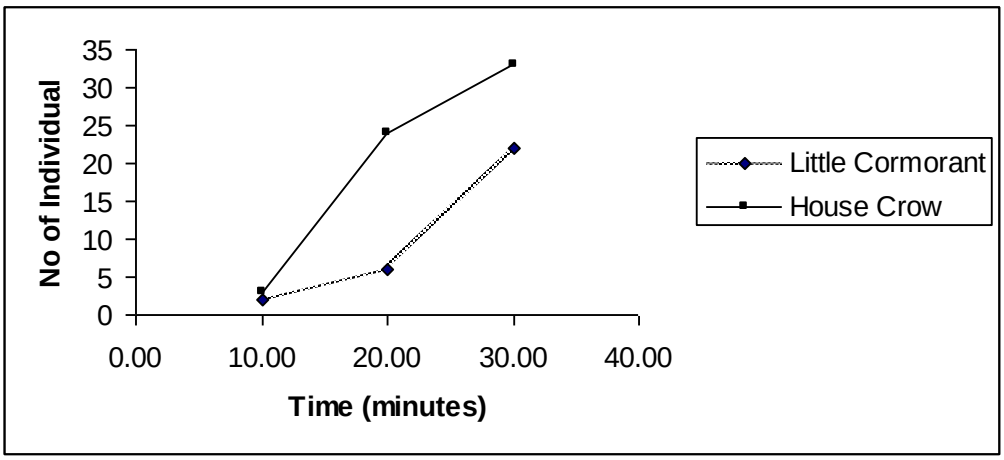

Figure 2 Encounter rate of Little Cormorant (*Phalacrocorax niger*) and House Crow (*Corvus splendens*) at Gundu Island

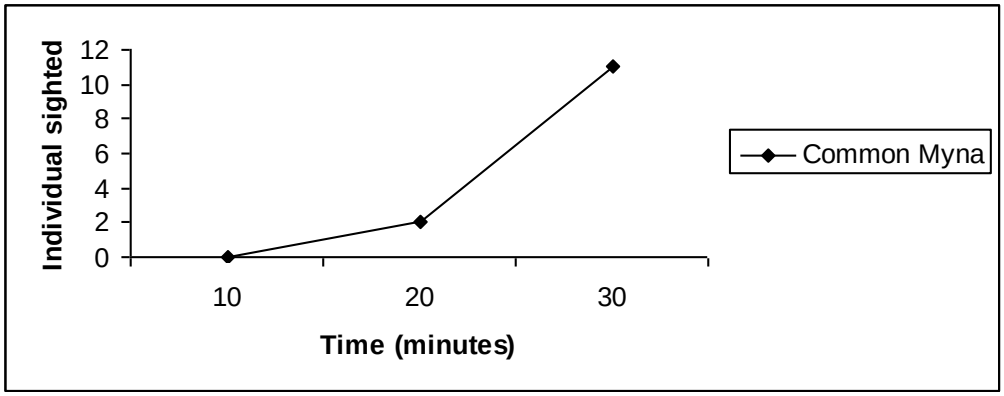

Figure 3 Encounter rate of Common Myna (*Acridotheres tristis*) at Moolampilli

According to secondary sources, Greenish Warbler (*Phylloscopus trochiloides*), Blyth's Reed-Warbler (*Acrocephalus dumetorum*), Wood Sandpiper (*Tringa glareola*), Common Greenshank (*Tringa nebularia*) and Marsh Sandpiper (*Tringa stagnatilis*) are reported as the winter visitors in the area (Azeez and Bhupathy, 2006; Nameer 2010 Appendix 1)

The wetland species like Little Cormorant (*Phalacrocorax niger*), Darter (*Anhinga melanogaster*), Indian Pond-heron (*Ardeola grayii*), and Black-headed Ibis (*Threskiornis melanocephalus*) are the most sighted species in the sampling points located in the northern parcel of the study plot. On the other hand southern portion is dominated equally by both urban (House crow

(*Corvus splendens*) and wetland species such as Little Cormorant (*Phalacrocorax niger*). The bird species in the north eastern side of the study plot are dominated by Brahminy Kite (*Haliastur Indus*), House Crow (*Corvus splendens*), Little Cormorant (*Phalacrocorax niger*) etc. In general the species sighted in the first 5 km (radial) area of the present study plot are more wetland dependent or wetland associated, and those present in the next (5km-10km radius) are more urban birds.

The mangrove vegetation and associated mudflats provides crucial habitats for various wetland birds many of which are migratory. However, rapid and haphazard developmental activities in and around the Vypeen and adjacent areas is fast consuming the remaining natural areas. The migratory species of birds observed in the study area also found distributed in the beaches and areas surrounded by aplenty of water bodies. The urban sprawl happening in the Kochi metropolis and the developmental activities in the form of roads and rail roads catering the transportation facilities of the newly opened factories and giant projects in the Vypeen and Puthuvypeen areas will be a threat for these species. It is evident that the loss of the wetlands and associated habitats will prevent the migration of the visitors in the coming future.

Table 2 List of birds recorded during the study period

	Common Name	**Scientific Name**
1	Ashy Drongo	*Dicrurus leucophaeus*
2	Ashy Prinia	*Prinia socialis*
3	Asian Koel	*Eudynamys scolopacea*
4	Asian Palm Swift	*Cypsiurus balasiensis*
5	Black Bittern	*Dupetor flavicollis*
6	Black Drongo	*Dicrurus macrocercus*
7	Black Kite	*Milvus migrans*
8	Black-crowned night Heron	*Nycticorax nycticorax*
9	Black-headed Ibis	*Threskiornis melanocephalus*
10	Black-headed Munia	*Lonchura malacca*
11	Black-rumped Flameback	*Dinopium benghalense*
12	Black-winged Stilt	*Himantopus himantopus*

	Common Name	Scientific Name
13	Blue-eared Kingfisher	*Alcedo meninting*
14	Brahminy Kite	*Haliastur indus*
15	Cattle Egret	*Bubulcus ibis*
16	Chestnut-tailed Starling	*Sturnus malabaricus*
17	Cinnamon Bittern	*Ixobrychus cinnamomeus*
18	Common Flameback	*Dinopium shorii*
19	Common Kingfisher	*Alcedo atthis*
20	Common Moorhen	*Gallinula chloropus*
21	Common Myna	*Acridotheres tristis*
22	Common Redshank	*Tringa totanus*
23	Common Sandpiper	*Actitis hypoleucos*
24	Common Tailorbird	*Orthotomus sutorius*
25	Cotton Pygmy-goose	*Nettapus coromandelianus*
26	Crimson Sunbird	*Aethopyga siparaja*
27	Darter	*Anhinga melanogaster*
28	Fulvous Whistling-duck	*Dendrocygna bicolor*
29	Greater Coucal	*Centropus sinensis*
30	Greater racket-tailed Drongo	*Dicrurus paradiseus*
31	Grey Heron	*Ardea cinerea*
32	House Crow	*Corvus splendens*
33	House Sparrow	*Passer domesticus*
34	Indian Cormorant	*Phalacrocorax fuscicollis*
35	Indian Pond-heron	*Ardeola grayii*
36	Indian Robin	*Saxicoloides fulicata*
37	Intermediate Egret	*Mesophoyx intermedia*
38	Jungle Myna	*Acridotheres fuscus*
39	Large-billed Crow	*Corvus macrorhynchos*
40	Little Cormorant	*Phalacrocorax niger*
41	Little Egret	*Egretta garzetta*
42	Little Grebe	*Tachybaptus ruficollis*
43	Little Heron	*Butorides striatus*
44	Oriental Magpie -Robin	*Copsychus saularis*
45	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*
46	Pallas's fish- Eagle	*Haliaeetus leucoryphus*
47	Pied Kingfisher	*Ceryle rudis*
48	Plain Prinia	*Prinia inornata*
49	Purple Heron	*Ardea purpurea*
50	Purple Sunbird	*Nectarinia asiatica*
51	Red-wattled Lapwing	*Vanellus indicus*
52	Rock Pigeon	*Columba livia*
53	Rose-ringed Parakeet	*Psittacula krameri*
54	Rufous Woodpecker	*Dryocopus hodgei*
55	Stork-billed Kingfisher	*Halcyon capensis*
56	White-breasted Waterhen	*Amaurornis phoenicurus*
57	White-cheeked Barbet	*Megalaima viridis*
58	White-throated Kingfisher	*Halcyon smyrnensis*

The northern parts of the study area belonging to the sections N1 and N2 were dominated by aquaculture wetlands, coastal wetlands, and coconut groves. The N1 section also had urban pockets adjoining the wetland areas. The recent establishment of large-scale developmental projects and associated development of road/rail connectivity to Puthuvypeen area have accelerated the urbanization pressure at N1. The N2 section, on the other hand is less populated with large area under aquaculture practices. However, on the either side of the Vypeen- Pallipuram road, which is going across the Northern sections (N1 & N2), is thickly populated. The major bird species observed in the N1 and N2 parcels are listed in the Table 3 & Table 4. The area especially the mangrove patches is found to harbour animals such as Common Mongoose (*Herpestes edwardsi*), Bengal Fox (*Vulpes bengalensis*) and Asian Palm Civet (*Paradoxurus hermophroditus*).

Table 3 Common bird species observed in various sampling points of parcel N1

Common Name	Scientific Name
Ashy Prinia	*Prinia socialis*
Indian Pond-heron	*Ardeola grayii*
House Crow	*Corvus splendens*
Large-billed Crow	*Corvus macrorhynchos*
Black-headed Ibis	*Threskiornis melanocephalus*
Little Cormorant	*Phalacrocorax niger*
Common Tailorbird	*Orthotomus sutorius*
Asian Koel	*Eudynamys scolopacea*
Greater racket-tailed Drongo	*Dicrurus paradiseus*
Brahminy Kite	*Haliastur indus*
White-cheeked Barbet	*Megalaima viridis*
White-throated Kingfisher	*Halcyon smyrnensis*
Common Myna	*Acridotheres tristis*
Darter	*Anhinga melanogaster*

Table 4 Common bird species observed in various sampling points of parcel N2

Common Name	Scientific Name
Stork-billed Kingfisher	*Halcyon capensis*

Little Egret	*Egretta garzetta*
House Crow	*Corvus splendens*
Indian Pond-heron	*Ardeola grayii*
Purple Heron	*Ardea purpurea*
Little Cormorant	*Phalacrocorax niger*
White-throated Kingfisher	*Halcyon smyrnensis*
Darter	*Anhinga melanogaster*
Black-headed Ibis	*Threskiornis melanocephalus*
Great Egret	*Casmerodius albus*
Grey Heron	*Ardea cinerea*
Ashy Prinia	*Prinia socialis*
Red-wattled Lapwing	*Vanellus indicus*
Common Kingfisher	*Alcedo atthis*
Black-headed Munia	*Lonchura malacca*
Lesser Whistling-duck	*Dendrocygna javanica*
Blue-eared Kingfisher	*Alcedo meninting*
Indian Cormorant	*Phalacrocorax fuscicollis*
Common Myna	*Acridotheres tristis*
White-breasted Waterhen	*Amaurornis phoenicurus*
Pied Kingfisher	*Ceryle rudis*
Ashy Drongo	*Dicrurus leucophaeus*
Brahminy Kite	*Haliastur indus*
Chestnut-tailed Starling	*Sturnus malabaricus*

Mainly, distributaries of Vembanad lake and paddy fields form the north-eastern (NE) sections of the study area (NE1 & NE2). The NE1 is less populated compared to the NE2, where the urban pressure from the city centre is severe. The establishment of new roads especially the ICT road across the NE2 parcel has contributed to major disturbances to the wetlands. The area falling under NE1 includes parts of Vallarpadam Island, Vypeen and Puthuvypeen areas. The area has mangrove patches along the wetlands that provide feeding and breeding grounds for many organisms. Bird species such as Oriental Magpie Robin (*Copsychus saularis*), Jungle Myna (*Acridotheres fuscus*) and Black Kite (*Milvus migrans*) are some of the common bird species observed from various sampling sites of NE1. Similarly White-breasted Waterhen (*Amaurornis phoenicurus*), Common Moorhen (*Gallinula*

chloropus) and Red-wattled Lapwing (*Vanellus indicus*) were some of the common bird species encountered at NE 2 (See also Table 5 & Table 6)

Table 5 Common bird species observed in various sampling points of parcel NE1

Common Name	Scientific Name
Oriental Magpie -Robin	*Copsychus saularis*
Jungle Myna	*Acridotheres fuscus*
Black Kite	*Milvus migrans*
House Crow	*Corvus splendens*
Large-billed Crow	*Corvus macrorhynchos*
Ashy Prinia	*Prinia socialis*
Rock Pigeon	*Columba livia*
Common Sandpiper	*Actitis hypoleucos*
Common Myna	*Acridotheres tristis*
Little Cormorant	*Phalacrocorax niger*
White-throated Kingfisher	*Halcyon smyrnensis*
Ashy Drongo	*Dicrurus leucophaeus*
Brahminy Kite	*Haliastur indus*
Great Egret	*Casmerodius albus*
Little Egret	*Egretta garzetta*
Rufous Woodpecker	*Dryocopus hodgei*
White-cheeked Barbet	*Megalaima viridis*

Table 6 Common bird species observed in various sampling points of parcel NE2

Common Name	Scientific Name
White-breasted Waterhen	*Amaurornis phoenicurus*
Common Moorhen	*Gallinula chloropus*
Red-wattled Lapwing	*Vanellus indicus*
Brahminy Kite	*Haliastur indus*
Little Cormorant	*Phalacrocorax niger*
White-throated Kingfisher	*Halcyon smyrnensis*
Indian Pond-heron	*Ardeola grayii*
House Crow	*Corvus splendens*

The south-eastern (SE) parts of the study area comprised of parts of Puthuvypeen, Fort Kochi, Vallarpadam, and the Vembanadu Lake. The SE1 parcel has good stretches of mangrove vegetation in and around Puthuvypeen area. Bird species recorded from SE1 area include Little Grebe

(*Tachybaptus ruficollis*), Darter (*Anhinga melanogaster*) and Black-crowned night Heron (*Nycticorax nycticorax*) (Table 7). The SE2 encompass some of the serene areas of the Kochi metro such as Bolgatty palace, and the Mangalavanam bird sanctuary. Observations made during the survey and data from various secondary sources (Nameer, 2010 and personal interactions with the local people) indicated that the area supports mammalian species such as Common Palm Squirrel (*Funambulus palmarum*), Indian Flying-fox (*Pteropus giganteus*), Asian Palm Civet (*Paradoxurus hermaphroditus*). Reptiles such as Indian Rat Snake (*Ptyas mucosus*), Keeled Grass Skink (*Eutropis carinata*), Chameleon (Chamaeleo zeylanicus) and birds such as Black Kite (*Milvus migrans*), Common Myna (*Acridotheres tristis*), Brahminy Kite (*Haliastur indus*) and Little Heron (*Butorides striatus*) were also observed from the area (Table 8).

Table 7 Common bird species observed in various sampling points of parcel SE 1

Common Name	Scientific Name
Little Grebe	*Tachybaptus ruficollis*
Darter	*Anhinga melanogaster*
Indian Pond-heron	*Ardeola grayii*
Black-headed Ibis	*Threskiornis melanocephalus*
Common Myna	*Acridotheres tristis*
Little Cormorant	*Phalacrocorax niger*
Indian Cormorant	*Phalacrocorax fuscicollis*
Purple Heron	*Ardea purpurea*
Great Egret	*Casmerodius albus*
Black Kite	*Milvus migrans*
House Crow	*Corvus splendens*
Brahminy Kite	*Haliastur indus*
Little Egret	*Egretta garzetta*
Common Tailorbird	*Orthotomus sutorius*
Red-wattled Lapwing	*Vanellus indicus*
Grey Heron	*Ardea cinerea*
Black-crowned night Heron	*Nycticorax nycticorax*
Ashy Prinia	*Prinia socialis*

Table 8 Common bird species observed in various sampling points of parcel SE 2

Common Name	Scientific Name
Black Kite	*Milvus migrans*
Little Cormorant	*Phalacrocorax niger*
Black-headed Ibis	*Threskiornis melanocephalus*
Indian Cormorant	*Phalacrocorax fuscicollis*
White-throated Kingfisher	*Halcyon smyrnensis*
Common Myna	*Acridotheres tristis*
Brahminy Kite	*Haliastur indus*
Little Heron	*Butorides striatus*
Little Egret	*Egretta garzetta*
House Crow	*Corvus splendens*

Mattancherry and the Fort Kochi regions formed the southern portion (Section S) of the study area. The area is highly populated in the S1 region while in the S2 region the built-up area was comparatively less. The Mattancherry is one of the tourist destinations of the Kochi Corporation and is a well known trade centre in the western coast of India during the historical times. Bird species such as Greater Coucal (*Centropus sinensis*), House Crow (*Corvus splendens*), Ashy Prinia (*Prinia socialis*), Little Cormorant (*Phalacrocorax niger*) etc. are observed from the S1 region. The S2 region on the other hand is comprised of Paddy fields, lakes and open lands which support species such as Little Grebe (*Tachybaptus ruficollis*), Darter (*Anhinga melanogaster*), Indian Pond-heron (*Ardeola grayii*), Black-headed Ibis (*Threskiornis melanocephalus*) etc (Table 9 & Table 10)

Table 9 Common bird species observed in various sampling points of parcel S1

Common Name	Scientific Name
Greater Coucal	*Centropus sinensis*
House Crow	*Corvus splendens*
Ashy Prinia	*Prinia socialis*
Little Cormorant	*Phalacrocorax niger*
Purple Sunbird	*Nectarinia asiatica*
Common Myna	*Acridotheres tristis*
White-throated Kingfisher	*Halcyon smyrnensis*
Indian Pond-heron	*Ardeola grayii*
Black Kite	*Milvus migrans*
Jungle Myna	*Acridotheres fuscus*

Grey Heron	*Ardea cinerea*

Table 10 Common bird species observed in various sampling points of parcel S2

Common Name	Scientific Name
Little Grebe	*Tachybaptus ruficollis*
Darter	*Anhinga melanogaster*
Indian Pond-heron	*Ardeola grayii*
Black-headed Ibis	*Threskiornis melanocephalus*
Common Myna	*Acridotheres tristis*
Little Cormorant	*Phalacrocorax niger*
Indian Cormorant	*Phalacrocorax fuscicollis*
Purple Heron	*Ardea purpurea*
Great Egret	*Casmerodius albus*
Black Kite	*Milvus migrans*
Brahminy Kite	*Haliastur indus*
House Crow	*Corvus splendens*
Brahminy Kite	*Haliastur indus*
Little Egret	*Egretta garzetta*
Common Tailorbird	*Orthotomus sutorius*
Red-wattled Lapwing	*Vanellus indicus*
Grey Heron	*Ardea cinerea*
Ashy Prinia	*Prinia socialis*

2.1.2 OTHER FAUNA

The present study recorded 5 species of Reptiles and 5 species of mammals from various locations. No amphibian species were recorded during the study period. However, referring to various reports/ secondary sources we have furnished check lists of animals that are reported from the area observed from the study site in the following tables.

Table 11 List of Amphibians as reported (Azeez et al (2004))

Common Name	**Scientific Name**
Bull Frog	*Haplobatrachus crassus*
Cricket Frog	*Limnonectes limnocharis*
Bush Frog	*Philluatus* sp. (E)
Toad	*Bufo melanostictus*
E - Endemic taxa to the Western Ghats	

Table 12 List of Reptiles from the study area

Common Name	Scientific Name
Indian Black Turtle*	*Melanochelys trijuga* (A)
Indian Flapshell Turtle*	*Lissemys punctata* (A)
Dwarf Gecko*	*Cnemaspis sp.* (E)
Indian House Gecko	*Hemidactylus frenatus*
Indian Garden Lizard	*Calotes versicolor*
Green Calotes	*Calotes calotes*
Indian Skink	*Mabuya carinata*
Dussumier's Litter Skink*	*Sphenomorphous dussumieri* (E)
Cat Skink*	*Ristella sp.* (E)
Spotted Supple Skink*	*Riopa punctata*
Water Snake*	*Xenochrophis piscator* (A)
Indian Rat Snake	*Ptyas mucosus*
Bi-spectacled Cobra*	*Naja naja* (V)
Sea Snake -(V) *	----

A =Aquatic, E - Endemic taxa to the Western Ghats, V-venomous taxa.
*reported by Azeez *et al* (2004)

Table 13 Mammals recorded in the study area

Common Name	Scientific Name
Common mongoose	*Herpestes edwardsii*
Bengal Fox	*Vulpes bengalensis*
Asian palm civet	*Paradoxurus hermophroditus*
Three-striped Palm Squirrel	*Funambulus palmarum*
Flying-fox	*Pteropus giganteus*
Common otter	*Lutra lutra*

2.1.3 BUTTERFLIES

The butterflies present in and around the study area were documented by direct observations, random walk and opportunistic observations, by using a pair of binoculars for identification whenever required. The morning and evening hours when maximum butterfly activity was at its peak were used for butterfly sampling (mostly 7 to 11 am and 3 to 6 pm). Butterfly survey was carried out by searching 5 m distance on either side of the pathway.

Gunathilagaraj et al. (1998), Kunte (2000) and Kehimkar (2008) were referred for the identification of Butterflies.

A total number of 49 butterfly species falling under 33 genera and spreading over 5 families were recorded during the present study period (Table 14). At family level, the family Nymphalidae is the dominant with 21 species (43%) followed by Pieridae with 11 species (23%), Papilionidae with 10 species (20%) and Hesperiidae with 4 species (8%). The least number of butterfly species were recorded in the family Lycaenidae with 3 species (6%).

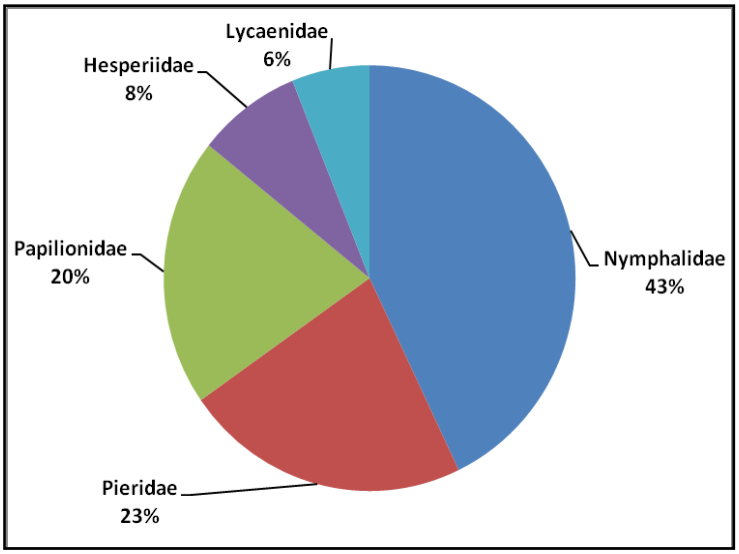

Figure 4 Family-wise distribution of the butterflies in the study area

Butterflies such as Common Castor, Common Emigrant, Common Mormon, Grey Pansy, Southern Birdwing, Chocolate Pansy, Plain Tiger, Danaid Eggfly, Common Crow, Lime Butterfly and Common Grass Yellow were commonly seen in and around the study area during the present study period. The following butterflies viz., Clipper, Malabar Banded Peacock, Red Helen, Peacock Pansy and Rustic were rarely seen in the study area.

2.1.4 ENDEMIC AND IUCN RED-LISTED BUTTERFLIES

Among the 49 species, some butterflies are coming under endemic and various IUCN red-listed categories. Two species namely, Crimson Rose and Danaid Eggfly are protected under schedule - I of Indian Wildlife Protection Act 1972. The Common Pierrot, Southern Birdwing and Common Gull are butterflies included in schedule- II. Species such as Malabar Banded Peacock, Blue Mormon, Crimson Rose and Southern Birdwing present in the area are endemic to Southern India (Kunte, 2000).

Table 14 List of butterflies recorded during the present study period

No.	Family & Common name	Scientific name	Status *
Papilionidae			
1	Blue Mormon	*Papilio polymnestor*	Endemic
2	Common Blue Bottle	*Graphium sarpedon*	
3	Common Mormon	*Papilio polytes*	
4	Common Rose	*Pachliopta aristolochiae*	
5	Crimson Rose	*Pachliopta hector*	Schedule-I
6	Lime Butterfly	*Papilio demoleus*	
7	Malabar Banded Peacock	*Papilio buddha*	Schedule-II & Endemic
8	Red Helen	*Papilio helenus*	
9	Southern Birdwing	*Troides minos*	Schedule-II & Endemic
10	Tailed Jay	*Graphium agamemnon*	
Pieridae			
11	Common Emigrant	*Catopsilia pomona*	
12	Common Jezebel	*Delias eucharis*	
13	Common Grass yellow	*Eurema hecabe*	
14	Common Gull	*Cepora nerissa*	Schedule-II
15	Common Wanderer	*Pareronia valeria*	
16	Lesser Gull	*Cepora nadina*	
17	Mottled Emigrant	*Catopsilia pyranthe*	
18	Psyche	*Leptosia nina*	
19	Small Grass Yellow	*Eurema brigitta*	
20	Spotless Grass Yellow	*Eurema laeta*	
21	White Orange Tip	*Ixias marianne*	
Nymphalidae			
22	Angled Castor	*Ariadne ariadne*	
23	Chocolate Pansy	*Junonia iphita*	

No.	Family & Common name	Scientific name	Status *
24	Clipper	*Parthenos sylvia*	
25	Common Bush Brown	*Mycalesis perseus*	
26	Common Castor	*Ariadne merione*	
27	Common Crow	*Euploea core*	Schedule-IV
28	Common Evening Brown	*Melanitis leda*	
29	Common Leopard	*Phalanta phalantha*	
30	Common Palm fly	*Elymnias hypermnestra*	
31	Common Sailor	*Neptis hylas*	
32	Danaid Eggfly	*Hypolimnas misippus*	Schedule-I
33	Dark Blue Tiger	*Tirumala septentrionis*	
34	Glassy Tiger	*Parantica aglea*	
35	Great Eggfly	*Hypolimnas bolina*	
36	Grey Pansy	*Junonia atlites*	
37	Lemon Pansy	*Junonia lemonias*	
38	Peacock Pansy	*Junonia almana*	
39	Plain Tiger	*Danaus chrysippus*	
40	Striped Tiger	*Danaus genutia*	
41	Tawny Coster	*Acraea violae*	
42	Yellow Pansy	*Junonia hierta*	
Lycaenidae			
43	Common Cerulean	*Jamides celeno*	
44	Common Pierrot	*Castalius rosimon*	Schedule, II
45	Tiny Grass Blue	*Zizula hylax*	
Hesperiidae			
46	Common Banded Awl	*Hasora chromus*	
47	Common Grass Dart	*Taractrocera maevius*	
48	Dark Palm Dart	*Telicota ancilla*	
49	Rice Swift	*Borbo cinnara*	

*Schedule of Indian Wildlife Protection Act 1972

2.2 FLORA

The area is surrounded by both aquatic and terrestrial ecosystems. Diverse systems such as marine, backwater, mangroves, cultivated lands, homesteads and urban sprawls are present in the study area that supported diverse floral species. A major portion of the study area being highly urbanised, the

methodology was suitably modified for documenting the urban diversity of flora as well.

2.2.1 METHODOLOGY

Vegetation is universally recognized as an integral component of ecosystems, which indicates the effects of changing environmental conditions in an obvious and easily measurable manner and is much important in site evaluation and classification. Vegetation sampling was undertaken in order to find out the plant community structure including species diversity and species richness. Careful analysis of vegetation is very important to know the distribution and types of floral components in an ecosystem. For phytosociological analysis quadrat method was used in the present study which is the most widely used technique for plant census.

During the initial stage of the study, an extensive filed survey had been conducted for adopting suitable standard methods to document the biological elements in the study area. For documenting overall plant species occurring in the study area, a vegetation survey was made in areas within 10 km radial distance from the LNG site covering different habitats such as water bodies, human habitations, agricultural lands, homesteads etc.

Since the present study area is located in and around the dense human habitation, the detailed phytosociological study was mainly focussed only on natural vegetation patches, especially mangroves. Within urban areas there was no sizeable natural patch of vegetations available to lay even minimum size quadrats. To study the flora of the study area in general and to estimate the mangrove plant species community in particular, quadrats of 10 x 10 m size were laid in the various mangrove patches found within the 10 km radius. A total number of 20 such quadrats were laid during the present study. Species encountered during the vegetation sampling and surveys were

recorded. The identification of plants was done with the help of standard floras such as Hooker (1872-97), Gamble (1957), Matthew, (1983), Banerjee et al., (1989), Matthew (1999). The unidentified plants were collected and carefully preserved in 10% formaldehyde and brought to the Botanical Survey of India, Madras Herbarium (MH) Coimbatore for further identification by experts. The nomenclature given in the present study was based on the Flora of Tamil Nadu Series 1: Analysis vols. 1-3 (1983-1989).

The vegetation data collected from the different mangrove patches were analysed by using various softwares to obtain the quantitative structure and composition of mangrove plant communities. For understanding the characters of the mangrove vegetation, the species richness and diversity of species were calculated. The vegetation data were tabulated for frequency, density, abundance, relative frequency, relative density, relative abundance, IVI, Simpson Index and composition of plant communities, following Curtis and Mc Intosh (1950), Philips (1959), Ludwig and Reynolds (1988) and Lande (1996). The Shannon-Wiener's index of diversity (H') and Fisher's alpha diversity were also calculated using the software 'Species diversity and richness (version 2.65, Colwell, 1994-2004; see also Table 15).

Table 15 Calculation of quantitative structure and composition of mangrove areas

Parameters	Formula adopted
Frequency (%)	(No. of quadrats in which a species occurred/ Total no. of quadrats studied) × 100
Abundance	Total number of individuals of the species/ No. of quadrats in which the species occurred
Density	Total no. of individuals of a given species/ Total no. of quadrats examined
Relative density	No. of individuals/ No. of individuals of all species
Relative abundance	(Abundance of species x 100)/ Sum of all abundances
Relative frequency	Number of quadrats occurring/ Total no. of quadrats
IVI	Relative density + Relative dominance + Relative

	frequency
Simpson Index	$D=\Sigma (n/N)^2$

2.2.2 FLORAL ANALYSIS

As far as the diversity of plants is concerned, the present study area was very rich. The study area was surrounded by dense human settlements of Kochi metropolitan City, mangrove forest patches, agricultural lands and various water bodies including rivers lakes and coastal wetlands. The present documentation was done in all the above said habitats/ecosystems. A total of 422 species under 290 genera belonging to 94 families were recorded during the present study period within the 10 km radius area from LNG site (Appendix i). Most of the plant species recorded in and around the human habitations in the study area.

2.2.3 HABIT-WISE ANALYSIS OF PLANTS

Since the present study area is coming under humid tropical climate, plant community was very rich and diverse. Among the total number of 422 species recorded here, trees are represented by maximum number of species (n=191; 40%) followed by herbaceous plants (n=115; 27%), shrubs (n=48; 12%), stragglers/climbers (n=38; 9%) and grasses with 30 species (7%) (Figure 5).

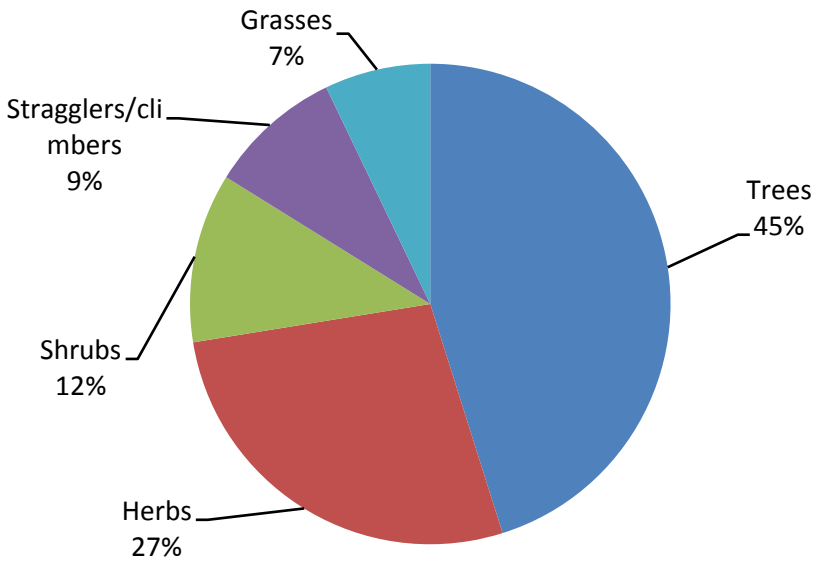

Figure 5 Habit-wise analysis of plants in the study area

2.2.4 FAMILIAL COMPOSITION

Among the 94 families of plants documented during the present study period from the study area, family Poaceae is represented by maximum number of plant species (n=30). The other notable plant families recorded in the study area are Euphorbiaceae with 28 species, Fabaceae 26 species, Caesalpiniaceae 19 species and Moraceae 18 species (Figure 6). The following plant families such as Aracauriaceae, Asparagaceae, Bixaceae, Cannaceae, Casuarinaceae, Costaceae, Dipterocarpaceae, Dioscoriaceae, Elaeocarpaceae, Goodinaiaceae, Helicorniaceae, Hypoxidaceae, Lecythidaceae, Leaceae, Lemnaceae, Musaceae, Najadaceae, Pandanaceae, Phytolaccaceae, Proteaceae, Pteridaceae, Salviniaceae, Santalaceae, Strelitziaceae and Violaceae were represented by single species.

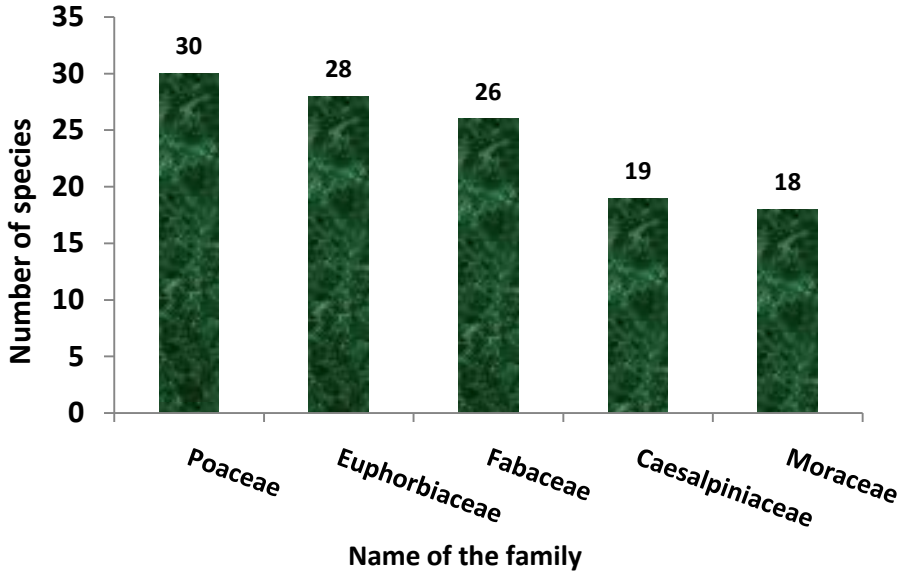

Figure 6 Dominant plant families in the study area

2.2.5 MAJOR VEGETATION IN AND AROUND THE STUDY AREA

The mangrove forests are the major forest type represented the study area. Mangrove vegetation is seen along with the backwater channels and the banks of estuarine waterbodies, in the form of small patches or continuous narrow stripes. The immediate surrounding of the LNG Terminal site is dominated by well established mangrove forests and various human habitations on one side and Arabian Sea on the another side. In the present study area, mangrove forests are present in Puthuvypeen, Kannamali, Narakkel, Kumbalangi, Kandalvanam, Mangalavanam, etc. Mangrove species such as *Acanthus illicifolius*, *Acrostichum aureum, Avicennia marina, A. officinalis, Bruguiera cylindrica, B. gymnorhiza, Derris trifoliata, Cissus trifoliata, Exoecaria agallocha, E. indica, Kandelia candel, Ceriops decandra, Rhizoiphora apiculata, R. mucronata, Sonneratia apetala, S. caeseolaris* etc. were encountered during the present study period. The species such as *Barringtonia racemosa, Calophyllum inophyllum, Cerbera odollum, Dolichandrone spathacea, Hibiscus tiliaceous, Morinda citrifolia, Premna serratifolia, Thespesia populnea, T. populneoides,* etc. were the important

mangrove associated species seen in the study area. Species such as *Avicennia offcinalis, A. marina* and *Excoecaria agallocha* were abundant in the study area.

The other notable tree species recorded in the study area are *Ailanthus triphysa, Alstonia scholaris, Anthocephalus cadamba, Artocarpus hirsutus, A. incisus, Calophyllum inophyllum, Cerbera odollum, Chrysophyllum chinito, Garcinia gummi-gutta, Elaeocarpus serratus, Ficus nervosa, Giliricidia sepium, Hibiscus tiliaceous, Lannea coromandelica, Mimusops elengi, Madhuca longifolia, Morinda tinctoria, Samanea saman, Spathodea campanulata, Spondias pinnata, Syzygium cumini, S. malaccense, S. samarangense, Swietenia macrophylla, Tectona grandis, Thespesia populnea, Vateria indica* etc.

The shrubs such as *Abutilon indicum, A. hirtum, Bixa orellana, Breynia vitis-idaea, Caesalpinia bonduc, C. sappan, Clerodendrum inerme, C. indicum, C. infortunatum, C. viscosum, Cassia alata, C. auriculata, Helicteres isora, Holarrhena antidysenterica, Cressa cretica, Jatropha curcas, Ipomoea carnea, Hibiscus vitifolius, Nerium oleander, Phyllanthus reticulatus, Scaveola taccada, Sesbania procumbens, Thottea siliquosa,* etc.

The plants such *as Acrostichum aureum, Alternanthera sessilis, A. Bacoba monnerii, Crotalaria* spp. *Cyperus* spp. *Fimbristylis*, spp. Cassia occidentalis, C. tora, Tephrosia purpurea, *Cleome felina, Croton hirtum, Commelina longifolia, C. benghalensis, C. clavata, Eclipta alba, Hygrophila auriculata*, *Micrococca mercurialis*, *Mimosa pudica, Ottelia alismoides, Salvinia molesta, Scoparia dulcis, Sebastiania chaemelia, Sesuvium portulacastrum, Sida rhomboidea, Synedrella nodiflora,* etc. are the common herbaceous plants documented in the study area.

The species such as *Anamirta cocculus, Abrus precatorius, Aristolochia indica, Cardiospermum halicacabum, Carissa carandas, Cayratia pedata, Cissus trifoliata, Derris trifoliata, D. scandens, Ficus pumila, Ipomoea pescarpae, Passiflora edulis, Piper nigrum, P. longum, Pothos scandens, Raphidophora aurea, R. pertusa, Tiliacora acuminata, Tragia involucrata,* etc. are the most common climbers/stragglers recorded during the present study period.

The common grasses recorded in the study area include *Bothriochloa pertusa, Cenchrus ciliaris, Chloris barbata, Cymbopogon citratus, Cynodon dactylon, Cyrtococcum trigonum, Dactyloctenium aegyptium, Eleusine indica, Imperata cylindrica, Rottboellia exaltata, Setaria palmifolia, Zoysia materella* etc.

2.2.6 PLANTS RECORDED IN AND AROUND HUMAN SETTLEMENTS

Plants species recorded in and around the human habitation in the study area were broadly classified in to following two major types based on their usefulness.

2.2.7 FOOD/FRUIT YIELDING PLANTS

The common food/fruit yielding plant species observed in and around the human habitation include *Achras sapota, Garcinia gummi-gutta, Artocarpus heterophyllus, A. hirsutus, A. incisus, Annona squamosa, A. reticulata, Eugenia uniflora, Citrus limon, C. grandis, Passiflora edulis, Tamarindus indicus, Cocos nucifera, Myristica fragrans, Muntingia calubra, Elaeocarpus serratus, Avehhora bilimbii, A. carambola, Anacardium occidentale, Phyllanthus acida, P. emblica, Carissa carandas, Mangifera indica, Syzygium cumini, S. jambos, S. malaccense, S. samarngense, Spondias pinnata, Theobroma cocoa,* etc.

The food/fruit yielding plants recorded in the study area were found in almost all the sampling areas (namely North 1 (N1), North 2 (N2), North-East

1 (NE1), North-East 2 (NE2), South 1 (S1), South 2 (S2), South-east 1 (SE1) and South-East 2 (SE2)). The common food/fruit yielding plant species observed in and around the human habitation are given in the table.

2.2.8 ORNAMENTAL PLANTS

The common ornamental plants documented during the present study period in the human settlements include *Allamanda cathertica, Araucaria columnaris, Areca lutescens, Bauhinia acuminata, B. purpurea, B. tomentosa, Bixa orellana, Butea monosperma, Callistemon lanceolatus, Canna indica, Clerodendrum indicum, C. infortunatum, Cyrtostachys renda, Vateria indica, Diospyros microphyllus, Duranta repens, Ficus pumila, Haemalia patens, Gliricidia sepium*, *Ailanthus triphysa, Sterculia foetida, Pisonia alba, Helicornia rostarta, Hibiscus rosa-sinensis, Ixora coccinea, Ravenala madacascariensis, Raphodophora aurea, R. pertusa, Saraca asoka, Cassia fistula, Manilkara hexandra,* etc (Appendix iii).

2.2.9 ENDEMIC PLANTS RECORDED IN THE STUDY AREA

Six plant species namely *Artocarpus hirsutus, Hardwickia binata, Lagerstroemia microcarpa, Phyllanthus rotundifolius, Terminalia paniculata* and *Vateria indica* are endemic species encountered during the present study period. Though these species are commonly seen in the study area and surroundings, their distribution is restricted only to Southern India and these are coming under rare and endemic category.

Table 16 List of important grops of plants recoded from the study area

Plant Name	Sampling Points
Food/fruit yielding plants	
Achras sapota	All the sampling locations
Garcinia gummi-gutta	All the sampling locations
Artocarpus heterophyllus	All the sampling locations
A. hirsutus	All the sampling locations
A. incisus	All the sampling locations

Annona squamosa	All the sampling locations
A. reticulata	All the sampling locations
Eugenia uniflora	N1, N2 and SE2
Citrus limon	All the sampling locations
C. grandis	All the sampling locations
Passiflora edulis	All the sampling locations
Tamarindus indicus	N1, NE1, NE2 and S1
Cocos nucifera	All the sampling locations
Myristica fragrans	All the sampling locations
Muntingia calubra	All the sampling locations
Elaeocarpus serratus	N1 and N2
Avehhora bilimbii	All the sampling locations
A. carambola	All the sampling locations
Anacardium occidentale	All the sampling locations
Phyllanthus acida	All the sampling locations
P. emblica	All the sampling locations
Carissa carandas	All the sampling locations
Mangifera indica	All the sampling locations
Syzygium cumini	All the sampling locations
S. jambos	All the sampling locations
S. malaccense	All the sampling locations
S. samarngense	All the sampling locations
Spondias pinnata	All the sampling locations
Theobroma cocoa	NE1 and NE2
Ornamental plants	
Allamanda cathartica	All the sampling locations
Araucaria columnaris	All the sampling locations except NE2
Areca lutescens	All the sampling locations
Bauhinia acuminata	All the sampling locations
B. purpurea	All the sampling locations
B. tomentosa	All the sampling locations
Bixa orellana	N1, N2, S1, S2 and SE1
Butea monosperma	N1, N2 and SE1
Callistemon lanceolatus	All the sampling locations
Canna indica	All the sampling locations
Clerodendrum indicum	N2 and NE1
C. infortunatum	All the sampling locations
Cyrtostachys renda	All the sampling locations
Diospyros microphyllus	All the sampling locations
Duranta repens	All the sampling locations
Ficus pumila	All the sampling locations
Haemalia patens	All the sampling locations
Gliricidia sepium	All the sampling locations

Ailanthus triphysa	All the sampling locations
Sterculia foetida	All the sampling locations
Pisonia alba	All the sampling locations
Helicornia rostarta	All the sampling locations
Hibiscus rosa-sinensis	All the sampling locations
Ixora coccinea	All the sampling locations
Ravenala madacascariensis	All the sampling locations except NE2
Raphodophora aurea	All the sampling locations
R. pertusa	All the sampling locations
Saraca asoca	All the sampling locations
Cassia fistula	All the sampling locations
Manilkara hexandra	N1, NE1, S1 and SE2
Endemic plants	
Artocarpus hirsutus	All the sampling locations
Hardwickia binata	N1 and NE1
Lagerstroemia microcarpa	N2, S1, S2 and NE1
Phyllanthus rotundifolius	N2
Terminalia paniculata	S1, S2 and SE2
Vateria indica	N1, N2 S1, S2, and NE1
Medicinal Plants	
Abrus precatorius	N1, N2, S1 and S2
Adhatoda vasica	All the sampling locations
Aegle marmelos	All the sampling locations
Anamirta cocculus	NE1
Anthocephalus cadamba	All the sampling locations
Azadirachta indica	All the sampling locations
Bacoba monnieri	All the sampling locations
Cadaba indica	NE2
Caesalpinia sappan	All the sampling locations
Cardiospermum halicacabum	S1 and NE1
Costos speciosus	All the sampling locations
Couroupita guianensis	N1, N2, S1, S2 and Se1
Ionidium suffruticosum	S1 and SE2
Santalum album	All the sampling locations
Pterocarpus marsupium	N2, NE2
Aristolochia indica	All the sampling locations
A. tagala	NE1
Curculigo orchioides	All the sampling locations
Vateria indica	N1, N2 S1, S2, and NE1
Cinnamomum zeylanicum	S1, S2 and SE1
Elaeocarpus serratus	N1 and N2
Garcinia gummi-gutta	All the sampling locations
Madhuca longifolia	All the sampling locations

Michelia champaca	All the sampling locations
Sapindus emarginatus	All the sampling locations
Piper nigrum	All the sampling locations
Piper longum	All the sampling locations
Pseudarthria viscida	N1, N2 and NE2
Saraca asoca	All the sampling locations

2.2.10 IMPORTANT MEDICINAL PLANTS

The present study area has rich and diverse medicinal plant community. Some important medicinal plants recorded during the present study include *Abrus precatorius, Adhatoda vasica, Aegle marmelos, Anamirta cocculus, Anthocephalus cadamba, Azadirachta indica, Bacoba monnieri, Cadaba indica, Caesalpinia sappan, Cardiospermum halicacabum, Costos speciosus, Couroupita guianensis, Ionidium suffruticosum, Santalum album, Pterocarpus marsupium, Aristolochia indica, A. tagala, Curculigo orchioides, Vateria indica,* etc. The list of medicinal plants recorded in the study area during the present study period was givan in the Appendix ii

2.2.11 PHYTOSOCIOLOGY

Since there was a little information available on the mangrove patches of the area, an extensive surevy was carried out as part of the present study. Phytosociological studies were carriedout during the present study period in different mangrove patches of the study area. A total number of 1942 individuals, belonging to 23 mangrove species, coming under 15 genera and spread over 11 families, in 20 quadrats (10 x 10 m), were recorded during the present study period from the different mangrove patches. The mangrove vegetation community parameters were calculated from the data and presented in the Table 18

Among the 23 species, the shrub, *Acanthus ilicifolius* was represented by maximum number of individuals (n=310) followed by *Bruguiera gymnorhiza* (n=195), *Exocaeria agallocha* (n=187), *Sonneratia caeseolaris* (n=121) and

Rhizophora apiculata and *Rhizophora mucronata* with 115 species each. Likewise, the species such as *Cerbera odollum* (n=8) *Calophyllum inophyllum* (n=5) were represented by least number of individuals, recorded during the present study period.

The maximum density value recorded for *Acanthus ilicifolius* (19.00) followed by *Bruguiera gymnorhiza* (9.75), *Exocaeria agallocha* (9.35), *Sonneratia caeseolaris* (6.05) and *Rhizophora apiculata* & *Rhizophora mucronata* (5.75) each. The highest Relative density value recorded for *Acanthus ilicifolius* (19.57) followed by *Bruguiera gymnorhiza* (10.04), *Exocaeria agallocha* (9.63), *Sonneratia caeseolaris* (6.23) and *Rhizophora apiculata* and *Rhizophora mucronata* (5.92) each.

The maximum abundance value recorded for *Acanthus ilicifolius* (23.75) followed by *Bruguiera gymnorhiza* (12.19), *Exocaeria agallocha* (9.35), *Sonneratia caeseolaris* (8.07) and and *Rhizophora mucronata* (7.67) each. The highest relative abundance value recorded for *Acanthus ilicifolius* (17.44) followed by *Bruguiera gymnorhiza* (8.95), *Exocaeria agallocha* (8.08), *Sonneratia caeseolaris* (5.92) and and *Rhizophora mucronata* (5.63) each.

The highest Important Value Index (IVI) was recorded for *Acanthus ilicifolius* (42.77) followed by *Bruguiera gymnorhiza* (24.75), *Exocaeria agallocha* (11.00), *Sonneratia caeseolaris* (17.55) and *Rhizophora apiculata* (17.01).

The Shannon-Weiner index of diversity for mangrove vegetation community in the study area is 2.7269. The Simpson index of diversity is 0.91. The Fishers Alpha diversity is 3.6683.

Table 17 Population density of plant species with their Density, Abundance, Relative density, Relative Abundance and Important Value Index

No.	Name of the species	Abu	Den	RA	RD	IVI
1.	*Acanthus ilicifolius*	23.75	19.00	17.44	19.57	42.77
2.	*Rhizophora apiculata*	6.76	5.75	4.97	5.92	17.01
3.	*Rhizophora mucronata*	7.67	5.75	5.63	5.92	16.95
4.	*Avicennia officinalis*	5.94	5.05	4.36	5.20	15.68

No.	Name of the species	Abu	Den	RA	RD	IVI
5.	*Avicennia alba*	2.57	0.90	1.89	0.93	5.33
6.	*Excoecaria agallocha*	11.00	9.35	8.08	9.63	23.82
7.	*Excoecaria indica*	5.00	2.75	3.67	2.83	10.46
8.	*Ceriops decandra*	2.67	0.80	1.96	0.82	4.94
9.	*Avicennia marina*	4.81	3.85	3.53	3.96	13.25
10	*Sonneratia apetala*	6.00	4.20	4.41	4.33	13.77
11	*Derris trifoliata*	4.88	4.15	3.59	4.27	13.97
12	*Bruguiera gymnorhiza*	12.19	9.75	8.95	10.04	24.75
13	*Bruguiera sexangula*	3.50	1.05	2.57	1.08	5.81
14	*Acrosticum aureum*	7.40	5.55	5.43	5.72	16.55
15	*Thespesia populneoides*	2.11	0.95	1.55	0.98	5.77
16	*Bruguiera cylindrica*	7.06	5.65	5.19	5.82	16.76
17	*Kandelia candel*	2.50	1.00	1.84	1.03	5.74
18	*Sonneratia caeseolaris*	8.07	6.05	5.92	6.23	17.55
19	*Thespesia populnea*	2.25	1.35	1.65	1.39	7.36
20	*Morinda citrifolia*	1.67	0.75	1.22	0.77	5.23
21	*Cerbera odollum*	1.60	0.40	1.18	0.41	3.39
22	*Calophyllum inophyllum*	1.67	0.25	1.22	0.26	2.56
23	*Cissus trifoliata*	5.09	2.80	3.74	2.88	10.58

Where: Abu-Abundance; Den-Density; RA-Relative Abundance; RD-Relative Density; IVI-Important value Index

Table 18 Phytosociological parameters of the mangrove vegetation in the present study area

Name of the species	Ind.	Qn	Fre (%)	Abu	Den	RF	RA	RD	IVI
Acanthus ilicifolius	380	16	80.00	23.75	19.00	5.76	17.44	19.57	42.77
Rhizophora apiculata	115	17	85.00	6.76	5.75	6.12	4.97	5.92	17.01
Rhizophora mucronata	115	15	75.00	7.67	5.75	5.40	5.63	5.92	16.95
Avicennia officinalis	101	17	85.00	5.94	5.05	6.12	4.36	5.20	15.68
Avicennia alba	18	7	35.00	2.57	0.90	2.52	1.89	0.93	5.33
Excoecaria agallocha	187	17	85.00	11.00	9.35	6.12	8.08	9.63	23.82
Excoecaria indica	55	11	55.00	5.00	2.75	3.96	3.67	2.83	10.46
Ceriops decandra	16	6	30.00	2.67	0.80	2.16	1.96	0.82	4.94
Avicennia marina	77	16	80.00	4.81	3.85	5.76	3.53	3.96	13.25
Sonneratia apetala	84	14	70.00	6.00	4.20	5.04	4.41	4.33	13.77
Derris trifoliata	83	17	85.00	4.88	4.15	6.12	3.59	4.27	13.97
Bruguiera gymnorhiza	195	16	80.00	12.19	9.75	5.76	8.95	10.04	24.75
Bruguiera sexangula	21	6	30.00	3.50	1.05	2.16	2.57	1.08	5.81
Acrosticum aureum	111	15	75.00	7.40	5.55	5.40	5.43	5.72	16.55
Thespesia populneoides	19	9	45.00	2.11	0.95	3.24	1.55	0.98	5.77

Name of the species	Ind.	Qn	Fre (%)	Abu	Den	RF	RA	RD	IVI
Bruguiera cylindrica	113	16	80.00	7.06	5.65	5.76	5.19	5.82	16.76
Kandelia candel	20	8	40.00	2.50	1.00	2.88	1.84	1.03	5.74
Sonneratia caeseolaris	121	15	75.00	8.07	6.05	5.40	5.92	6.23	17.55
Thespesia populnea	27	12	60.00	2.25	1.35	4.32	1.65	1.39	7.36
Morinda citrifolia	15	9	45.00	1.67	0.75	3.24	1.22	0.77	5.23
Cerbera odollum	8	5	25.00	1.60	0.40	1.80	1.18	0.41	3.39
Calophyllum inophyllum	5	3	15.00	1.67	0.25	1.08	1.22	0.26	2.56
Cissus trifoliata	56	11	55.00	5.09	2.80	3.96	3.74	2.88	10.58

Where: Ind.-Number of Individuals; Qn-Number of Quadrats of occurrence; Fre (%)-Frequency; Abu-Abundance; Den-Density; RF-Relative Frequency; RA-Relative Abundance; RD-Relative Density; IVI-Important value Index

2.3 SENSITIVE AREAS

The proposed site for the LNG terminal is in close proximity to the cityscape of Kochi and there is only one natural protected area available within 10 km radial distance around the facility namely the Mangalavanam Bird Sanctuary. Vembanad kole wetland is the nearest Ramsar site (wetland of International Importance) located at a distance of about 40 km.

2.3.1 MANGALAVANAM BIRD SANCTUARY

The Mangalavanam Bird Sanctuary is the prominent natural haven for birds and other wildlife situated in the Kochi City at around five kilometres from the LNG site in the vicinity of the project area. There has been concerns in the past regarding the urbanization pressure leading to declining bird population of the area. However the Mangalavanam bird sanctuary is at considerable distance away from the LNG project site and is unlikely to have any direct impact on the sanctuary.

Figure 7. Map showing the mangrove degradation and location of blockages

2.3.2 THE MANGROVES

Mangroves are important coastal ecosystems that play crucial roles in the local ecology and also in livelihood security of human populations around. The mangroves being a specialized system adapted to the unique conditions that exist along the interphase of land and water are sensitive systems that with high conservation priority. The most important natural ecosystem of the present study area is the already degraded mangrove area adjacent to the LNG project site on its east covering about 1 km^2 area.

During the present study, it was noticed that the mangrove area adjacent to the Puthuvypeen LNG facility has undergone serious degradation starting from 2007 as inferred from an analysis of historical satellite pictures of the area. The single contiguous patch of mangroves that existed prior to the year 2007 got fragmented by new roads and bunds that came up later (Figure 7). There are three major areas within this patch where mangroves has been severely affected and resulted in the death of mangrove trees as marked on

the map (marked with numbers **01, 02** and **03 in** Figure 7). There are four major causes that has apparantly caused this mangrove degradation;

1) The Road that traverse the mangrove patch,
2) the bund along the eastern water front edge of the mangroves,
3) The clear felling of mangroves (marked as 02 in the figure) and
4) The dredge spoils dump in the mangrove area (marked as D1 in the Figure 7).

Among these the first three reasons are unrelated with the activities of LNG terminal development. However due to the dumping of dredge spoils on mangrove areas (at around 9°58'28.02"N & 76°13'56.39"E) during the LNG port development works has contributed to the blockage and siltation in the mangrove area around 9°58'36.90"N & 76°14'1.72"E and it need to be removed and water channel be restored urgently to stop the rapid degradation of the mangrove forests of the area.

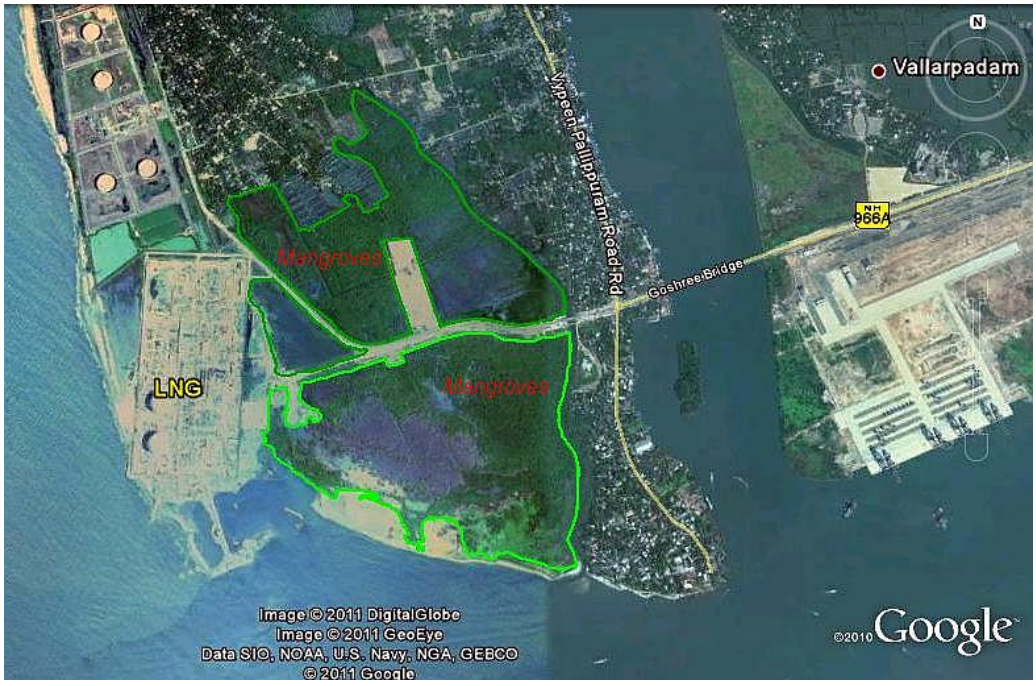

Figure 8 Mangrove patches near the project site

3 Impacts from the Augmentation project

The proposed capacity augmentation of the LNG terminal facility from 2.5 MMTPA to 5 MMTPA as proposed by M/s PLL does not involve additional tank construction or any land requirement. Only additionality involved are two additional pumps within the existing tanks and an additional regasification facility and associated pipelines within the existing area for which the space had already been provisioned in the earlier site plan for which due environmental clearance is already in place.

Since the augmentation as proposed does not involve any significant perceivable additional source of impact the additionality of impacts as far as flora and fauna around the site is concerned would be negligible. However, proper environmental management towards conservation of mangroves of the area is required for the long-term survival of these mangroves. Since the mangrove areas and the causes of degradation such as blockages of drainage due to roads and stone quarry debris dumping etc. are not the result of direct actions of M/s PLL; concerned authorities such as Cochin Port Trust should be urged to tke the initiatives to remove the blockages (see Figure 7) and restore the drainage channels connecting the mangrove patches and the creek/ sea waters. The dredge spoils dumped on the mangrove area (marked as **D2** in the Figure 7) need to be removed to restore the health of the mangrove system of this area.

4 Management plan

The augmentation proposal as proposed by M/s PLL does not involve new land acquisition nor does it involve any significant additional emissions or water consumption. Moreover, the hot ambient air is proposed to be used for LNG vapourization instead of seawater, thus avoiding the seawater

requirement as envisaged in earlier EIA. This has further reduced any likely impact to marine life from thermal pollution. Hence the management plan as suggested in the earlier EIA report for the initial 2.5 MMTPA LNG facility (Giridhar *et al.* 1999) may be strictly followed. Certain additional safeguards and environmental management measures especially for the conservation of degraded mangroves forests near the LNG facility, which is a recent development and hence does not find mention in the earlier EIA report of 1999 (Giridhar *et al.* 1999) need to be followed as discussed below.

4.1 MANGROVE CONSERVATION

As already discussed elsewhere in this report, the the present augmentation proposal of LNG facility is unlikely to cause any mangrove destruction. However, as observed in certain areas of the present study area the dredge spoils dumped on the mangroves has contributed to the blockage of drainage and siltation in the surrounding mangrove areas and it need to be removed and water channel needs to be restored urgently to stop the degradation of the mangrove area. Efforts should also be made consultation with Cochin Port Trust authorities to regenerate the lost mangrove patch on the western side of the LNG facility through planting local mangrove plant species such as *Acanthus illicifolius*, *Avicennia marina, A. officinalis, Bruguiera cylindrica, B. gymnorhiza, Exoecaria agallocha, E. indica, Kandelia candel, Ceriops decandra, Rhizoiphora apiculata, R. mucronata, Sonneratia apetala* and *S. Caeseolaris*.

Development of a Green belt around the facility with suitable tree species as described below may also be taken up.

4.2 DEVELOPMENT OF GREEN BELT

There is only minimum construction activity will be involved in the present augmentation project with no forest land to be required to be diverted while

executing this project. Hence, the compensatory afforestation programme is not mandatory. However, as a commitment for nature conservation and environmental protection, the Petronet LNG Ltd. may arrange some plantation programmes, especially in their own designated Green belt development area and also it's surrounding areas as far as possible with co-operation from Cochin Port Trust.

4.2.1 SUGGESTED PLANTS FOR GREENBELT

The selection of plant species for the green belt development depends on various factors such as climate, elevation and soil. The plants suggested here for green belt were selected keeping in mind the following desirable characteristics.

- Fast growing and providing optimum penetrability.
- Evergreen with minimal litter fall.
- Wind-firm and deep rooted.
- Forms a dense canopy.
- As far as possible, the species should be indigenous and locally available.
- Trees with high foliage density, large size of leaves and hairy on both the surfaces.
- Ability to withstand conditions like inundation and drought.
- Soil improving plants, such as nitrogen fixing plants, rapidly decomposable leaf litter.
- Attractive appearance with good flowering and fruit bearing.
- Bird and insect attracting tree species.
- Sustainable green cover with minimal maintenance
- Species which can trap/sequester more carbon

Some of the species that can be considered for planting are given in the following table. A total of 46 plant species recommended for planting in and around the project site (Table 19).

Table 19 List of plants suggested for greenbelt development around the LNG site.

Sl. No.	Binomial name	Family
1.	*Rhizophora apiculata*	Rhizophoraceae
2.	*Rhizophora mucronata*	Rhizophoraceae
3.	*Anthocephalus cadamba*	Rubiaceae
4.	*Bruguiera cylindrica*	Rhizophoraceae
5.	*Bruguiera gymnorrhiza*	Rhizophoraceae
6.	*Avicennia alba*	Avicenniaceae
7.	*Avicennia marina*	Avicenniaceae
8.	*Avicennia officinalis*	Avicenniaceae
9.	*Barringtonia acutangula*	Lecythidaceae
10.	*Barringtonia asiatica*	Lecythidaceae
11.	*Barringtonia racemosa*	Lecythidaceae
12.	*Ailanthus triphysa*	Simaroubaceae
13.	*Alstonia scholaris*	Apocynaceae
14.	*Calophyllum inophyllum*	Clusiaceae
15.	Cerbera odollum	Aoocynaceae
16.	*Couroupita guianensis*	Lecythidaceae
17.	*Filicium decipiens*	Sapindaceae
18.	*Hibiscus tiliaceous*	Malvaceae
19.	*Lagerstroemia indica*	Lythraceae
20.	*Lagerstroemia microcarpa*	Lythraceae
21.	*Lagerstroemia reginae*	Lythraceae
22.	*Macaranga peltata*	Euphorbiaceae
23.	*Madhuca longifolia*	Sapotaceae
24.	*Mallotus philippensis*	Euphorbiaceae
25.	*Mangifera indica*	Anacardiaceae
26.	*Manilkara hexandra*	Sapotaceae
27.	*Mimusops elengi*	Sapotaceae
28.	*Morinda citrifolia*	Rubiaceae
29.	*Myristica fragrans*	Myristicaceae
30.	*Plumeria acuminata*	Apocynaceae
31.	*Plumeria alba*	Apocynaceae
32.	*Plumeria rubra*	Apocynaceae
33.	*Simarouba glauca*	Simaroubaceae
34.	*Syzygium cumini*	Myrtaceae
35.	*Syzygium jambos*	Myrtaceae
36.	*Syzygium malaccense*	Myrtaceae
37.	*Syzygium samarangense*	Myrtaceae
38.	*Terminalia bellirica*	Combretaceae
39.	*Terminalia catappa*	Combretaceae

Sl. No.	Binomial name	Family
40.	*Terminalia crenulata*	Combretaceae
41.	*Terminalia paniculata*	Combretaceae
42.	*Thespesia populnea*	Malvaceae
43.	*Thespesia populneoides*	Malvaceae
44.	*Vateria indica*	Dipterocarpaceae
45.	*Xylia xylocarpa*	Mimosaceae
46.	*Zanthoxylum rhetsa*	Rutaceae

The species suggested here are commonly seen in and around the project area, fast growing and drought resistant. Seedlings / saplings of these species can be easily procured from local nurseries.

5 Conclusion

The present study documented the major elements of the flora and fauna of the area mainly through direct field data collection following standard methods supported by secondary data sources wherever necessary. The restricted study period of three months was the major limitation to check the faunal diversity of the area comprehensively. However in addition to our own field observations, the possible faunal species of the area from various secondary sources are also incorporated in this report.

Most of the areas at 10km radial distance from the LNG facility are covered by sea and backwaters. The present study was focussed on the terrestrial biodiversity aspects and most of the land area coming within the 10km radial distance was urban areas with very little scope for natural vegetation. Despite these restricted habitat availability and urbanization pressure, the study area showed reasonably good diversity and abundance of floral and faunal species.

The study area showed good diversity (Shannon-Weiner index: 2.727) and abundance in terms of floral species. The diversity for mangrove vegetation

in the study area was also high with Simpson index of diversity 0.91 (Fishers Alpha diversity = 3.6683).

A major cause of concern in the area is the degradation of the Mangrove patch adjacent to the PLL's LNG facility caused by various reasons as discussed earlier in relevant sections of this report. The M/s PLL may take active steps to manage this issue as suggested under the management plan section of this report.

Considering the urbanised environment of the study area, the diversity of faunal and floral elements recorded during the present study was relatively good. However being a predominatly urban area the species recored were mostly common ones and none was restricted to this area or its immediate environs. As discussed elsewhere in this report, specific impact from the proposed Augmentation project activities would be minimal on the flora and fauna provided the management plans as per the present report and the EIA report of 1999 are followed meticulously.

6 Plates


Grey pansy butterfly


Crimson rose butterfly


Mangrove- Rhizophora


Common Mormon Butterfly


Rhizophora mucronata


Indian Flying fox


Eichorrnia, Salvinia & Pistia


Eichorrnia in Flower


Chasalia curviflora


Mangrove fern- Acrostichum sp.


Drying mangroves


Common Palmfly

Plate 1 Glimpses of the Biodiversity from the study areas

Flame backed Woodpecker

Common Sand piper

Red wattled lapwing

Darter

Brahminy Kite

Greater Racket-tailed Drongo

Plain Prinia

Purple Heron

Plate 2 Some of the bird species recorded from the study area

View of Mangroves (at SE1)

Open landscape near lighthouse (at N1)

Mangrove tourism facility (at N2)

Landscape at NE1

Beach at N1

Agricultural/ acquaculture area (at NE2)

Plate 3 Snapshots of salient features of study area landscape

New road and pipelines (at NE1)

Dredge spoils dumped on mangroves (at SE1)

View of Mangalavanam bird sanctuary (at SE2)

Remnants of Mangrove trees (at NE1)

Chinese Fishing nets (at S2)

Fishing boats (at SE1)

Plate 4 Snapshots of salient features of the study area landcape- 2

7 Appendices

Appendix i List of plants recorded during the present study

Sl. No.	Name of the Plant	Family	Habit
1.	*Abrus precatorius*	Fabaceae	Straggler
2.	*Abutilon hirtum*	Malvaceae	Shrub
3.	*Abutilon indicum*	Malvaceae	Shrub
4.	*Acacia auriculiformis*	Mimosaceae	Tree
5.	*Acacia mangium*	Mimosaceae	Tree
6.	*Acalypha brachystachya*	Euphorbiaceae	Herb
7.	*Acalypha indica*	Euphorbiaceae	Herb
8.	*Acalypha malabarica*	Euphorbiaceae	Herb
9.	*Acalypha paniculata*	Euphorbiaceae	Herb
10.	*Acanthus ilicifolius*	Acanthaceae	Shrub
11.	*Achras sapota*	Sapotaceae	Tree
12.	*Acrostichum aureum*	Pteridaceae	Herb
13.	*Adenanthera pavoniana*	Mimosaceae	Tree
14.	*Adhatoda vasica*	Acanthaceae	Shrub
15.	*Adina cordifolia*	Rubiaceae	Tree
16.	*Aegle marmelos*	Rutaceae	Tree
17.	*Ailanthus excelsa*	Simaroubaceae	Tree
18.	*Ailanthus triphysa*	Simaroubaceae	Tree
19.	*Albizia lebbeck*	Mimosaceae	Tree
20.	*Allamanda cathertica*	Apocynaceae	Straggler
21.	*Alstonia scholaris*	Apocynaceae	Tree
22.	*Alternanthera paronychioides*	Amaranthaceae	Herb
23.	*Alternanthera sessilis*	Amaranthaceae	Herb
24.	*Alternanthera tenella*	Amaranthaceae	Herb
25.	*Alysicarpus rugosus*	Fabaceae	Herb
26.	*Amaranthus spinosus*	Amaranthaceae	Herb
27.	*Amaranthus viridis*	Amaranthaceae	Herb
28.	*Anacardium occidentale*	Anacardiaceae	Tree
29.	*Anamirta cocculus*	Menispermaceae	Climber
30.	*Aneliema* sp.	Commelinaceae	Herb
31.	*Annona muricata*	Annonaceae	Tree
32.	*Annona reticulata*	Annonaceae	Tree
33.	*Annona squamosa*	Annonaceae	Tree
34.	*Anthocephalus cadamba*	Rubiaceae	Tree
35.	*Antigonon leptopus*	Polygonaceae	Climber
36.	*Araucaria columnaris*	Araucariaceae	Tree
37.	*Areca catechu*	Arecaceae	Tree

Sl. No.	Name of the Plant	Family	Habit
38.	*Areca lutescens*	Arecaceae	Tree
39.	*Aristolochia indica*	Aristolochiaceae	Climber
40.	*Aristolochia tagala*	Aristolochiaceae	Climber
41.	*Artocarpus hirsutus*	Moraceae	Tree
42.	*Artocarpus incisus*	Moraceae	Tree
43.	*Artocarpus integrifolius*	Moraceae	Tree
44.	*Asparagus racemosus*	Asparagaceae	Straggler
45.	*Asystasia dalzelii*	Acanthaceae	Herb
46.	*Asystasia gangetica*	Acanthaceae	Herb
47.	*Averrhoa bilimbi*	Averrhoaceae	Tree
48.	*Averrhoa carambola*	Averrhoaceae	Tree
49.	*Avicennia alba*	Avicenniaceae	Tree
50.	*Avicennia marina*	Avicenniaceae	Tree
51.	*Avicennia officinalis*	Avicenniaceae	Tree
52.	*Azadirachta indica*	Meliaceae	Tree
53.	*Bacoba monnieri*	Scrophulariaceae	Herb
54.	*Bambusa arundinacea*	Poaceae	Grass
55.	*Bambusa vulgaris*	Poaceae	Grass
56.	*Barringtonia acutangula*	Lecythidaceae	Tree
57.	*Barringtonia asiatica*	Lecythidaceae	Tree
58.	*Barringtonia racemosa*	Lecythidaceae	Tree
59.	*Bauhinia acuminata*	Caesalpiniaceae	Tree
60.	*Bauhinia purpurea*	Caesalpiniaceae	Tree
61.	*Bauhinia racemosa*	Caesalpiniaceae	Tree
62.	*Bauhinia tomentosa*	Caesalpiniaceae	Shrub
63.	*Bixa orellana*	Bixaceae	Shrub
64.	*Blumea lacera*	Asteraceae	Herb
65.	*Boerhavia diffusa*	Nyctaginaceae	Herb
66.	*Bombax malabaricum*	Bombacaceae	Tree
67.	*Borassus flabellifer*	Arecaceae	Tree
68.	*Borreria hispida*	Rubiaceae	Herb
69.	*Borreria ocymoides*	Rubiaceae	Herb
70.	*Bothriochloa pertusa*	Poaceae	Grass
71.	*Bougainvillea spectabilis*	Nyctaginaceae	Straggler
72.	*Brachiaria* sp.	Poaceae	Grass
73.	*Breynia vitis-idaea*	Euphorbiaceae	Shrub
74.	*Bridelia crenulata*	Euphorbiaceae	Tree
75.	*Bruguiera cylindrica*	Rhizophoraceae	Tree
76.	*Bruguiera gymnorrhiza*	Rhizophoraceae	Tree
77.	*Bruguiera sexangula*	Rhizophoraceae	Tree
78.	*Butea monosperma*	Fabaceae	Tree

Sl. No.	Name of the Plant	Family	Habit
79.	*Cadaba indica*	Capparidaceae	Straggler
80.	*Caesalpinia bonduc*	Caesalpiniaceae	Shrub
81.	*Caesalpinia sappan*	Caesalpiniaceae	Shrub
82.	*Caesalpnia coriaria*	Caesalpiniaceae	Tree
83.	*Callistemon lanceolatus*	Myrtaceae	Tree
84.	*Calophyllum inophyllum*	Clusiaceae	Tree
85.	*Canavalia cathartica*	Fabaceae	Straggler
86.	*Canna indica*	Cannaceae	Herb
87.	*Cardiospermum halicacabum*	Sapindaceae	Climber
88.	*Carissa carandas*	Apocynaceae	Straggler
89.	*Caryota urens*	Arecaceae	Tree
90.	*Cassia alata*	Caesalpiniaceae	Shrub
91.	*Cassia auriculata*	Caesalpiniaceae	Shrub
92.	*Cassia fistula*	Fabaceae	Tree
93.	*Cassia javanica*	Caesalpiniaceae	Tree
94.	*Cassia nodosa*	Caesalpiniaceae	Tree
95.	*Cassia obtusa*	Caesalpiniaceae	Shrub
96.	*Cassia occidentalis*	Caesalpiniaceae	Herb
97.	*Cassia siamea*	Caesalpiniaceae	Tree
98.	*Cassia tora*	Caesalpiniaceae	Herb
99.	*Cassytha filiformis*	Lauraceae	Climber
100.	*Casuarina equisetifolia*	Casuarinaceae	Tree
101.	*Cayratia pedata*	Vitaceae	Climber
102.	*Ceiba pentandra*	Bombacaceae	Tree
103.	*Cenchrus ciliaris*	Poaceae	Grass
104.	*Cerbera odollum*	Apocynaceae	Tree
105.	*Ceriops decandra*	Rhizophoraceae	Shrub
106.	*Ceriops tagal*	Rhizophoraceae	Shrub
107.	*Chasalia curviflora* var. *ophioxyloides*	Rubiaceae	Herb
108.	*Chloris barbata*	Poaceae	Grass
109.	*Chromolaena odorata*	Asteraceae	Shrub
110.	*Chrysophyllum cainito*	Sapotaceae	Tree
111.	*Cinnamomum zeylanicum*	Lauraceae	Tree
112.	*Cissus trifoliata*	Vitaceae	Climber
113.	*Citharexylum subserratum*	Verbenaceae	Tree
114.	*Citrus grandis*	Rutaceae	Tree
115.	*Citrus limon*	Rutaceae	Tree
116.	*Cleistanthus collinus*	Euphorbiaceae	Tree
117.	*Cleome felina*	Capparidaceae	Herb
118.	*Clerodendrum indicum*	Verbenaceae	Shrub

Sl. No.	Name of the Plant	Family	Habit
119.	*Clerodendrum inerme*	Verbenaceae	Shrub
120.	*Clerodendrum infortunatum*	Verbenaceae	Shrub
121.	*Clerodendrum serratum*	Verbenaceae	Shrub
122.	*Clerodendrum viscosum*	Verbenaceae	Shrub
123.	*Coccinia grandis*	Cucurbitaceae	Climber
124.	*Cocus nucifera*	Arecaceae	Tree
125.	*Coffea arabica*	Rubiaceae	Shrub
126.	*Coix lacryma-jobi*	Poaceae	Grass
127.	*Colocasia esculenta*	Araceae	Herb
128.	*Commelina benghalensis*	Commelinaceae	Herb
129.	*Commelina clavata*	Commelinaceae	Herb
130.	*Commelina longifolia*	Commelinaceae	Herb
131.	*Conyza leucantha*	Asteraceae	Herb
132.	*Corchorus aestuans*	Tiliaceae	Herb
133.	*Cordia obliqua*	Boraginaceae	Tree
134.	*Cordia sebastiana*	Boraginaceae	Tree
135.	*Costos speciosus*	Costaceae	Herb
136.	*Couroupita guianensis*	Lecythidaceae	Tree
137.	*Cressa cretica*	Convolvulaceae	Shrub
138.	*Crotalaria juncea*	Fabaceae	Shrub
139.	*Crotalaria mysorensis*	Fabaceae	Herb
140.	*Crotalaria pallida*	Fabaceae	Herb
141.	*Crotalaria retusa*	Fabaceae	Herb
142.	*Crotalaria verrucosa*	Fabaceae	Shrub
143.	*Croton hirtum*	Euphorbiaceae	Herb
144.	*Curculigo orchioides*	Hypoxidaceae	Herb
145.	*Cuscuta reflexa*	Convolvulaceae	Climber
146.	*Cymbopogon citratus*	Poaceae	Grass
147.	*Cynodon dactylon*	Poaceae	Grass
148.	*Cynotis cristata*	Commelinaceae	Herb
149.	*Cyperus difformis*	Cyperaceae	Herb
150.	*Cyperus exaltatus*	Cyperaceae	Herb
151.	*Cyperus iria*	Cyperaceae	Herb
152.	*Cyperus pangorei*	Cyperaceae	Herb
153.	*Cyperus rotundus*	Cyperaceae	Herb
154.	*Cyrtococcum trigonum*	Poaceae	Grass
155.	*Cyrtostachys renda*	Arecaceae	Tree
156.	*Dactyloctenium aegyptium*	Poaceae	Grass
157.	*Dalbergia latifolia*	Fabaceae	Tree
158.	*Dalbergia sissoo*	Fabaceae	Tree
159.	*Dalbergia spinosa*	Fabaceae	Shrub

Sl. No.	Name of the Plant	Family	Habit
160.	*Delonix regia*	Caesalpiniaceae	Tree
161.	*Derris scandens*	Fabaceae	Straggler
162.	*Derris trifoliata*	Fabaceae	Straggler
163.	*Desmodium triflorum*	Fabaceae	Herb
164.	*Digitalis purpurea*	Plantaginaceae	Herb
165.	*Digitaria bicornis*	Poaceae	Grass
166.	*Dioscorea batatus*	Dioscoriaceae	Climber
167.	*Diospyros microphyllus*	Ebenaceae	Tree
168.	*Diospyros peregrina*	Ebenaceae	Tree
169.	*Dolichandrone spathacea*	Bignoniaceae	Tree
170.	*Drypetes roxburghii*	Euphorbiaceae	Tree
171.	*Duranta repens*	Verbenaceae	Shrub
172.	*Eclipta alba*	Asteraceae	Herb
173.	*Eichorrnia crassipes*	Pontederiaceae	Herb
174.	*Elaeocarpus serratus*	Elaeocarpaceae	Tree
175.	*Elesine indica*	Poaceae	Grass
176.	*Emelia sonchifolia*	Asteraceae	Herb
177.	*Eragrostis plumosa*	Poaceae	Grass
178.	*Erythrina indica*	Fabaceae	Tree
179.	*Eucalyptus tereticornis*	Myrtaceae	Tree
180.	*Euphorbia geniculata*	Euphorbiaceae	Herb
181.	*Euphorbia hirta*	Euphorbiaceae	Herb
182.	*Euphorbia tirucalli*	Euphorbiaceae	Tree
183.	*Excoecaria agallocha*	Euphorbiaceae	Tree
184.	*Excoecaria indica*	Euphorbiaceae	Tree
185.	*Ficus auriculata*	Moraceae	Tree
186.	*Ficus benghalensis*	Moraceae	Tree
187.	*Ficus benjamina* var. *benjamina*	Moraceae	Tree
188.	*Ficus benjamina* var. *varigata*	Moraceae	Tree
189.	*Ficus callosa*	Moraceae	Tree
190.	*Ficus carica*	Moraceae	Tree
191.	*Ficus elastica*	Moraceae	Tree
192.	*Ficus exasperata*	Moraceae	Tree
193.	*Ficus hispida*	Moraceae	Tree
194.	*Ficus nervosa*	Moraceae	Tree
195.	*Ficus pumila*	Moraceae	Climber
196.	*Ficus religiosa*	Moraceae	Tree
197.	*Ficus tinctoria* ssp. *parasitica*	Moraceae	Tree
198.	*Filicium decipiens*	Sapindaceae	Tree
199.	*Fimbristylis argentea*	Cyperaceae	Herb
200.	*Fimbristylis complanata*	Cyperaceae	Herb

Sl. No.	Name of the Plant	Family	Habit
201.	*Fimbristylis dichotoma*	Cyperaceae	Herb
202.	*Fimbristylis tetragona*	Cyperaceae	Herb
203.	*Garcinia gummi-gutta*	Clusiaceae	Tree
204.	*Gliricidia sepium*	Fabaceae	Tree
205.	*Glochidion* sp.	Euphorbiaceae	Tree
206.	*Gmelina arborea*	Verbenaceae	Tree
207.	*Grevillea robusta*	Proteaceae	Tree
208.	*Guettarda speciosa*	Rubiaceae	Tree
209.	*Hamelia patens*	Rubiaceae	Shrub
210.	*Hardwickia binata*	Caesalpiniaceae	Tree
211.	*Helicornia rostrata*	Helicorniaceae	Herb
212.	*Helicteres isora*	Sterculiaceae	Shrub
213.	*Heliotropium indicum*	Boraginaceae	Herb
214.	*Hibiscus rosa-sinensis*	Malvaceae	Tree
215.	*Hibiscus surretensis*	Malvaceae	Shrub
216.	*Hibiscus tiliaceous*	Malvaceae	Tree
217.	*Hibiscus vitifolius*	Malvaceae	Shrub
218.	*Holarrhena antidysenterica*	Apocynaceae	Shrub
219.	*Holoptelea integrifolia*	Ulmaceae	Tree
220.	*Hydrilla verticillata*	Hydrocharitaceae	Herb
221.	*Hygrophila auriculata*	Acanthaceae	Herb
222.	*Imperata cylindrica*	Poaceae	Grass
223.	*Ionidiun suffruticosum*	Violaceae	Herb
224.	*Ipomoea alba*	Convolvulaceae	Climber
225.	*Ipomoea aquatica*	Convolvulaceae	Climber
226.	*Ipomoea biloba*	Convolvulaceae	Climber
227.	*Ipomoea carnea*	Convolvulaceae	Shrub
228.	*Ipomoea muricata*	Convolvulaceae	Climber
229.	*Ipomoea pescarpae*	Convolvulaceae	Climber
230.	*Ixora coccinia*	Rubiaceae	Tree
231.	*Jatropha curcas*	Euphorbiaceae	Shrub
232.	*Justicia betonica*	Acanthaceae	Shrub
233.	*Justicia procumbens*	Acanthaceae	Herb
234.	*Kandelia candel*	Rhizophoraceae	Tree
235.	*Kleinhovia hospita*	Sterculiaceae	Tree
236.	*Lagerstroemia indica*	Lythraceae	Tree
237.	*Lagerstroemia microcarpa*	Lythraceae	Tree
238.	*Lagerstroemia reginae*	Lythraceae	Tree
239.	*Lannea coromandelica*	Anacardiaceae	Tree
240.	*Lantana camara*	Verbenaceae	Shrub
241.	*Lawsonia inermis*	Lythraceae	Tree

Sl. No.	Name of the Plant	Family	Habit
242.	*Leanotis nepetiifolia*	Lamiaceae	Herb
243.	*Leea indica*	Leeaceae	Tree
244.	*Lemna minor*	Lemnaceae	Herb
245.	*Leucanea leucocephala*	Mimosaceae	Tree
246.	*Leucas aspera*	Lamiaceae	Herb
247.	*Lindernia antipoda*	Scrophulariaceae	Herb
248.	*Lindernia oppositifolia*	Scrophulariaceae	Herb
249.	*Ludwigia parviflora*	Onagraceae	Herb
250.	*Ludwigia peruviana*	Onagraceae	Herb
251.	*Lumnitzera racemosa*	Combretaceae	Shrub
252.	*Macaranga peltata*	Euphorbiaceae	Tree
253.	*Madhuca longifolia*	Sapotaceae	Tree
254.	*Mallotus philippensis*	Euphorbiaceae	Tree
255.	*Mangifera indica*	Anacardiaceae	Tree
256.	*Manihot esculenta*	Euphorbiaceae	Tree
257.	*Manihot glaziovii*	Euphorbiaceae	Tree
258.	*Manilkara hexandra*	Sapotaceae	tree
259.	*Mariscus squarossus*	Cyperaceae	Herb
260.	*Melaleuca leucodendron*	Myrtaceae	Tree
261.	*Melastoma malabathrum*	Melastomataceae	Herb
262.	*Melia azedarach*	Meliaceae	Tree
263.	*Michelia champaca*	Annonaceae	Tree
264.	*Micrococca mercurialis*	Euphorbiaceae	Herb
265.	*Millingtonia hortensis*	Bignoniaceae	Tree
266.	*Mimosa pudica*	Mimosaceae	Herb
267.	*Mimusops elengi*	Sapotaceae	Tree
268.	*Morinda citrifolia*	Rubiaceae	Tree
269.	*Morinda tinctoria*	Rubiaceae	Tree
270.	*Morus alba*	Moraceae	Shrub
271.	*Mukia maderaspatana*	Cucurbitaceae	Climber
272.	*Murraya koenigii*	Rutaceae	Tree
273.	*Murraya paniculata*	Rutaceae	Shrub
274.	*Musa paradisiaca*	Musaceae	Shrub
275.	*Mussanda* sp.	Rubiaceae	Shrub
276.	*Myristica fragrans*	Myristicaceae	Tree
277.	*Najas minor*	Najadaceae	Herb
278.	*Nerium oleander*	Apocynaceae	Shrub
279.	*Nyctanthes arbor-tristis*	Oleaceae	Tree
280.	*Oldenlandia alata*	Rubiaceae	Herb
281.	*Oldenlandia biflora*	Rubiaceae	Herb
282.	*Oldenlandia corymbosa*	Rubiaceae	Herb

Sl. No.	Name of the Plant	Family	Habit
283.	*Oldenlandia umbellata*	Rubiaceae	Herb
284.	*Oplismenus compositus*	Poaceae	Grass
285.	*Ottelia alismoides*	Hydrocharitaceae	Herb
286.	*Pandanus odoratissimus*	Pandanaceae	Tree
287.	*Panicum trypheron*	Poaceae	Grass
288.	*Parthenium hysterophorus*	Asteraceae	Herb
289.	*Paspalidium flavidum*	Poaceae	Grass
290.	*Paspalidium geminatum*	Poaceae	Grass
291.	*Paspalum scrobiculatum*	Poaceae	Grass
292.	*Passiflora edulis*	Passifloraceae	Climber
293.	*Passiflora foetida*	Passifloraceae	Climber
294.	*Pavonia procumbens*	Malvaceae	Herb
295.	*Pavonia zeylanica*	Malvaceae	Herb
296.	*Pennisetum* sp.	Poaceae	Grass
297.	*Persea americana*	Lauraceae	Tree
298.	*Phoenix laurierii*	Arecaceae	Tree
299.	*Phoenix sylvestris*	Arecaceae	Tree
300.	*Phragmites karka*	Poaceae	Grass
301.	*Phyla nodiflora*	Verbenaceae	Herb
302.	*Phyllanthus amarus*	Euphorbiaceae	Herb
303.	*Phyllanthus emblica*	Euphorbiaceae	Tree
304.	*Phyllanthus reticulatus*	Euphorbiaceae	Shrub
305.	*Phyllanthus rotundifolius*	Euphorbiaceae	Herb
306.	*Phyllanthus urinaria*	Euphorbiaceae	Herb
307.	*Physalis minima*	Solanaceae	Herb
308.	*Pilea trinervia*	Urticaceae	Herb
309.	*Pimenta dioica*	Myrtaceae	Tree
310.	*Piper longum*	Piperaceae	Climber
311.	*Piper nigrum*	Piperaceae	Climber
312.	*Pisonia alba*	Nyctaginaceae	Tree
313.	*Pistia stratiotes*	Araceae	Herb
314.	*Pletophorum pterocarpum*	Caesalpiniaceae	Tree
315.	*Plumeria acuminata*	Apocynaceae	Tree
316.	*Plumeria alba*	Apocynaceae	Tree
317.	*Plumeria rubra*	Apocynaceae	Tree
318.	*Polyalthia longifolia*	Annonaceae	Tree
319.	*Polygala* sp.	Polygalaceae	Herb
320.	*Pongamia pinnata*	Fabaceae	Tree
321.	*Pothos scandens*	Araceae	Climber
322.	*Pouzolzia bennettiana*	Urticaceae	Shrub
323.	*Premna serratifolia*	Verbenaceae	Tree

Sl. No.	Name of the Plant	Family	Habit
324.	*Prosopis juliflora*	Mimosaceae	Tree
325.	*Psidium quajava*	Myrtaceae	Tree
326.	*Psychotria* sp.	Rubiaceae	Shrub
327.	*Pterocarpus marsupium*	Fabaceae	Tree
328.	*Quisqualis indica*	Combretaceae	Climber
329.	*Raphidophora aurea*	Araceae	Climber
330.	*Raphidophora pertusa*	Araceae	Climber
331.	*Ravenala madagascariensis*	Strelitziaceae	Tree
332.	*Rhizophora apiculata*	Rhizophoraceae	Tree
333.	*Rhizophora mucronata*	Rhizophoraceae	Tree
334.	*Rhynchosia minima*	Fabaceae	Herb
335.	*Rivia hypocraterifromis*	Convolvulaceae	Straggler
336.	*Rivina humilis*	Phytolaccaceae	Herb
337.	*Rottboellia exaltata*	Poaceae	Grass
338.	*Saccharum spontaneum*	Poaceae	Grass
339.	*Salvinia molesta*	Salviniaceae	Herb
340.	*Samanea saman*	Mimosaceae	Tree
341.	*Santalum album*	Santalaceae	Tree
342.	*Sapindus emarginatus*	Sapindaceae	Tree
343.	*Saraca asoka*	Fabaceae	Tree
344.	*Scaevola taccada*	Goodeniaceae	Shrub
345.	*Scoparia dulcis*	Scrophulariaceae	Herb
346.	*Sebastiania chaemelia*	Euphorbiaceae	Herb
347.	*Sesamum orientale*	Pedaliaceae	Herb
348.	*Sesbania procumbens*	Fabaceae	Shrub
349.	*Sesuvium portulcastrum*	Aizoaceae	Herb
350.	*Setaria palmifolia*	Poaceae	Grass
351.	*Setaria verticillata*	Poaceae	Grass
352.	*Sida acuta*	Malvaceae	Herb
353.	*Sida rhomboidea*	Malvaceae	Herb
354.	*Simarouba glauca*	Simaroubaceae	Tree
355.	*Solanum torvum*	Solanaceae	Tree
356.	*Sonneratia alba*	Sonneratiaceae	Tree
357.	*Sonneratia apetala*	Sonneratiaceae	Tree
358.	*Sonneratia caseolaris*	Sonneratiaceae	Tree
359.	*Sorghum halpense*	Poaceae	Grass
360.	*Spathodea campanulata*	Bignoniaceae	Tree
361.	*Spathoglottis plicata*	Orchidaceae	Herb
362.	*Sphearanthus indicus*	Asteraceae	Herb
363.	*Spondias pinnata*	Anacardiaceae	Tree
364.	*Stachytarpheta jamaicensis*	Verbenaceae	Herb

Sl. No.	Name of the Plant	Family	Habit
365.	*Stemodia viscosa*	Scrophulariaceae	Herb
366.	*Sterculia foetida*	Sterculiaceae	Tree
367.	*Sterculia guttata*	Sterculiaceae	Tree
368.	*Streblus asper*	Moraceae	Tree
369.	*Strychnos nux-vomica*	Loganiaceae	Tree
370.	*Suaeda maritima*	Chenopodiaceae	Herb
371.	*Suaeda monoica*	Chenopodiaceae	Herb
372.	*Swietenia macrophylla*	Meliaceae	Tree
373.	*Swietenia mahogani*	Meliaceae	Tree
374.	*Synedrella nodiflora*	Asteraceae	Herb
375.	*Syzygium cumini*	Myrtaceae	Tree
376.	*Syzygium jambos*	Myrtaceae	Tree
377.	*Syzygium malaccense*	Myrtaceae	Tree
378.	*Syzygium samarangense*	Myrtaceae	Tree
379.	*Tabernaemontana divaricata*	Apocynaceae	Shrub
380.	*Tabeubia argentea*	Bignoniaceae	Tree
381.	*Tabeubia rosea*	Bignoniaceae	Tree
382.	*Tagetes erecta*	Asteraceae	Herb
383.	*Tamarindus indicus*	Caesalpiniaceae	Tree
384.	*Tecoma stans*	Bignoniaceae	Tree
385.	*Tectona grandis*	Verbenaceae	Tree
386.	*Tephrosia purpurea*	Fabaceae	Herb
387.	*Tephrosia villosa*	Fabaceae	Herb
388.	*Terminalia bellirica*	Combretaceae	Tree
389.	*Terminalia catappa*	Combretaceae	Tree
390.	*Terminalia crenulata*	Combretaceae	Tree
391.	*Terminalia paniculata*	Combretaceae	Tree
392.	*Theabroma cacao*	Sterculiaceae	Tree
393.	*Thespesia populnea*	Malvaceae	Tree
394.	*Thespesia populneoides*	Malvaceae	Tree
395.	*Thevetia peruviana*	Apocynaceae	Tree
396.	*Thottea siliquosa*	Aristolochiaceae	Shrub
397.	*Tiliacora acuminata*	Menispermaceae	Climber
398.	*Tragia involucrata*	Euphorbiaceae	Climber
399.	*Trema orientalis*	Ulmaceae	Tree
400.	*Trianthema portulacastrum*	Aizoaceae	Herb
401.	*Tridax procumbens*	Asteraceae	Herb
402.	*Triphasia trifoliata*	Rutaceae	Tree
403.	*Triumfetta pentandra*	Tiliaceae	Herb
404.	*Typha angustifolia*	Poaceae	Grass
405.	*Urena lobata*	Malvaceae	Herb

Sl. No.	Name of the Plant	Family	Habit
406.	*Vanda tesellata*	Orchidaceae	Herb
407.	*Vateria indica*	Dipterocarpaceae	Tree
408.	*Vernonia cinerea*	Asteraceae	Herb
409.	*Vetiveria zizanioides*	Poaceae	Grass
410.	*Vitex altissima*	Verbenaceae	Tree
411.	*Vitex negundo*	Verbenaceae	Tree
412.	*Wedelia chinensis*	Asteraceae	Herb
413.	*Wedelia urticaefolia*	Asteraceae	Herb
414.	*Wrightia arborea*	Apocynaceae	Tree
415.	*Wrightia tinctoria*	Apocynaceae	Tree
416.	*Xylia xylocarpa*	Mimosaceae	Tree
417.	*Xylocarpus granatum*	Meliaceae	Tree
418.	*Xylocarpus moluccansis*	Meliaceae	Tree
419.	*Zanthoxylum rhetsa*	Rutaceae	Tree
420.	*Zingiber* sp.	Zingiberaceae	Herb
421.	*Ziziphus jujuba*	Rhamnaceae	Tree
422.	*Zoysia materella*	Poaceae	Grass

Appendix ii List of medicinal plants recorded during the present study period

Sl.No.	Name of the species	Family	Habit
1.	*Abrus precatorius*	Fabaceae	Straggler
2.	*Abutilon indicum*	Malvaceae	Shrub
3.	*Acanthus ilicifolius*	Acanthaceae	Shrub
4.	*Adenanthera pavoniana*	Mimosaceae	Tree
5.	*Adhatoda vasica*	Acanthaceae	Shrub
6.	*Adina cordifolia*	Rubiaceae	Tree
7.	*Aegle marmelos*	Rutaceae	Tree
8.	*Ailanthus excelsa*	Simaroubaceae	Tree
9.	*Alstonia scholaris*	Apocynaceae	Tree
10.	*Alternanthera sessilis*	Amaranthaceae	Herb
11.	*Anamirta cocculus*	Menispermaceae	Climber
12.	*Annona muricata*	Annonaceae	Tree
13.	*Anthocephalus cadamba*	Rubiaceae	Tree
14.	*Aristolochia indica*	Aristolochiaceae	Climber
15.	*Aristolochia tagala*	Aristolochiaceae	Climber
16.	*Artocarpus hirsutus*	Moraceae	Tree
17.	*Asparagus racemosus*	Asparagaceae	Straggler
18.	*Averrhoa bilimbi*	Averrhoaceae	Tree
19.	*Averrhoa carambola*	Averrhoaceae	Tree
20.	*Azadirachta indica*	Meliaceae	Tree
21.	*Bacoba monnieri*	Scrophulariaceae	Herb
22.	*Blumea lacera*	Asteraceae	Herb
23.	*Boerhavia diffusa*	Nyctaginaceae	Herb
24.	*Bombax malabaricum*	Bombacaceae	Tree
25.	*Bridelia crenulata*	Euphorbiaceae	Tree
26.	*Butea monosperma*	Fabaceae	Tree
27.	*Cadaba indica*	Capparidaceae	Straggler
28.	*Caesalpinia bonduc*	Caesalpiniaceae	Shrub
29.	*Caesalpinia sappan*	Caesalpiniaceae	Shrub
30.	*Calophyllum inophyllum*	Clusiaceae	Tree
31.	*Cardiospermum halicacabum*	Sapindaceae	Climber
32.	*Carissa carandas*	Apocynaceae	Straggler
33.	*Cassia auriculata*	Caesalpiniaceae	Shrub
34.	*Cassia fistula*	Fabaceae	Tree
35.	*Cassia occidentalis*	Caesalpiniaceae	Herb
36.	*Cassia siamea*	Caesalpiniaceae	Tree
37.	*Cassia tora*	Caesalpiniaceae	Herb
38.	*Cassytha filiformis*	Lauraceae	Climber

Sl.No.	Name of the species	Family	Habit
39.	*Cayratia pedata*	Vitaceae	Climber
40.	*Chasalia curviflora* var. *ophioxyloides*	Rubiaceae	Herb
41.	*Clerodendrum inerme*	Verbenaceae	Shrub
42.	*Clerodendrum viscosum*	Verbenaceae	Shrub
43.	*Coccinia grandis*	Cucurbitaceae	Climber
44.	*Coix lacryma-jobi*	Poaceae	Grass
45.	*Commelina clavata*	Commelinaceae	Herb
46.	*Commelina longifolia*	Commelinaceae	Herb
47.	*Cordia obliqua*	Boraginaceae	Tree
48.	*Costos speciosus*	Costaceae	Herb
49.	*Couroupita guianensis*	Lecythidaceae	Tree
50.	*Crotalaria verrucosa*	Fabaceae	Shrub
51.	*Croton hirtum*	Euphorbiaceae	Herb
52.	*Curculigo orchioides*	Hypoxidaceae	Herb
53.	*Cuscuta reflexa*	Convolvulaceae	Climber
54.	*Cymbopogon citratus*	Poaceae	Grass
55.	*Cynodon dactylon*	Poaceae	Grass
56.	*Dalbergia latifolia*	Fabaceae	Tree
57.	*Derris scandens*	Fabaceae	Straggler
58.	*Derris trifoliata*	Fabaceae	Straggler
59.	*Dioscorea batatus*	Dioscoriaceae	Climber
60.	*Diospyros microphyllus*	Ebenaceae	Tree
61.	*Diospyros peregrina*	Ebenaceae	Tree
62.	*Drypetes roxburghii*	Euphorbiaceae	Tree
63.	*Eclipta alba*	Asteraceae	Herb
64.	*Elaeocarpus serratus*	Elaeocarpaceae	Tree
65.	*Erythrina indica*	Fabaceae	Tree
66.	*Euphorbia hirta*	Euphorbiaceae	Herb
67.	*Euphorbia tirucalli*	Euphorbiaceae	Tree
68.	*Excoecaria agallocha*	Euphorbiaceae	Tree
69.	*Excoecaria indica*	Euphorbiaceae	Tree
70.	*Ficus auriculata*	Moraceae	Tree
71.	*Ficus benghalensis*	Moraceae	Tree
72.	*Ficus callosa*	Moraceae	Tree
73.	*Ficus exasperata*	Moraceae	Tree
74.	*Ficus hispida*	Moraceae	Tree
75.	*Ficus nervosa*	Moraceae	Tree
76.	*Ficus religiosa*	Moraceae	Tree
77.	*Ficus tinctoria* ssp. *parasitica*	Moraceae	Tree

Sl.No.	Name of the species	Family	Habit
78.	*Filicium decipiens*	Sapindaceae	Tree
79.	*Garcinia gummi-gutta*	Clusiaceae	Tree
80.	*Gmelina arborea*	Verbenaceae	Tree
81.	*Guettarda speciosa*	Rubiaceae	Tree
82.	*Hardwickia binata*	Caesalpiniaceae	Tree
83.	*Helicteres isora*	Sterculiaceae	Shrub
84.	*Holarrhena antidysenterica*	Apocynaceae	Shrub
85.	*Hygrophila auriculata*	Acanthaceae	Herb
86.	*Imperata cylindrica*	Poaceae	Grass
87.	*Ionidiun suffruticosum*	Violaceae	Herb
88.	*Jatropha curcas*	Euphorbiaceae	Shrub
89.	*Justicia betonica*	Acanthaceae	Shrub
90.	*Justicia procumbens*	Acanthaceae	Herb
91.	*Kandelia candel*	Rhizophoraceae	Tree
92.	*Kleinhovia hospita*	Sterculiaceae	Tree
93.	*Lannea coromandelica*	Anacardiaceae	Tree
94.	*Lawsonia inermis*	Lythraceae	Tree
95.	*Leanotis nepetifolia*	Lamiaceae	Herb
96.	*Leea indica*	Leeaceae	Tree
97.	*Leucas aspera*	Lamiaceae	Herb
98.	*Macaranga peltata*	Euphorbiaceae	Tree
99.	*Madhuca longifolia*	Sapotaceae	Tree
100.	*Mallotus philippensis*	Euphorbiaceae	Tree
101.	*Mangifera indica*	Anacardiaceae	Tree
102.	*Manilkara hexandra*	Sapotaceae	tree
103.	*Michelia champaca*	Annonaceae	Tree
104.	*Micrococca mercurialis*	Euphorbiaceae	Herb
105.	*Mimusops elengi*	Sapotaceae	Tree
106.	*Morinda citrifolia*	Rubiaceae	Tree
107.	*Morinda tinctoria*	Rubiaceae	Tree
108.	*Mukia maderaspatana*	Cucurbitaceae	Climber
109.	*Murraya paniculata*	Rutaceae	Shrub
110.	*Myristica fragrans*	Myristicaceae	Tree
111.	*Pavonia procumbens*	Malvaceae	Herb
112.	*Pavonia zeylanica*	Malvaceae	Herb
113.	*Phoenix laurierii*	Arecaceae	Tree
114.	*Phyla nodiflora*	Verbenaceae	Herb
115.	*Phyllanthus amarus*	Euphorbiaceae	Herb
116.	*Phyllanthus emblica*	Euphorbiaceae	Tree

Sl.No.	Name of the species	Family	Habit
117.	*Phyllanthus reticulatus*	Euphorbiaceae	Shrub
118.	*Piper longum*	Piperaceae	Climber
119.	*Piper nigrum*	Piperaceae	Climber
120.	*Pisonia alba*	Nyctaginaceae	Tree
121.	*Pistia stratiotes*	Araceae	Herb
122.	*Pongamia pinnata*	Fabaceae	Tree
123.	*Premna serratifolia*	Verbenaceae	Tree
124.	*Pterocarpus marsupium*	Fabaceae	Tree
125.	*Santalum album*	Santalaceae	Tree
126.	*Sapindus emarginatus*	Sapindaceae	Tree
127.	*Saraca asoka*	Fabaceae	Tree
128.	*Scaevola taccada*	Goodeniaceae	Shrub
129.	*Scoparia dulcis*	Scrophulariaceae	Herb
130.	*Solanum torvum*	Solanaceae	Tree
131.	*Sphearanthus indicus*	Asteraceae	Herb
132.	*Spondias pinnata*	Anacardiaceae	Tree
133.	*Stachytarpheta jamaicensis*	Verbenaceae	Herb
134.	*Stemodia viscosa*	Scrophulariaceae	Herb
135.	*Streblus asper*	Moraceae	Tree
136.	*Strychnos nux-vomica*	Loganiaceae	Tree
137.	*Swietenia macrophylla*	Meliaceae	Tree
138.	*Swietenia mahogani*	Meliaceae	Tree
139.	*Synedrella nodiflora*	Asteraceae	Herb
140.	*Syzygium cumini*	Myrtaceae	Tree
141.	*Terminalia bellirica*	Combretaceae	Tree
142.	*Terminalia crenulata*	Combretaceae	Tree
143.	*Terminalia paniculata*	Combretaceae	Tree
144.	*Thespesia populnea*	Malvaceae	Tree
145.	*Thespesia populneoides*	Malvaceae	Tree
146.	*Thottea siliquosa*	Aristolochiaceae	Shrub
147.	*Tiliacora acuminata*	Menispermaceae	Climber
148.	*Tridax procumbens*	Asteraceae	Herb
149.	*Vateria indica*	Dipterocarpaceae	Tree
150.	*Vernonia cinerea*	Asteraceae	Herb
151.	*Vetiveria zizanioides*	Poaceae	Grass
152.	*Vitex altissima*	Verbenaceae	Tree
153.	*Vitex negundo*	Verbenaceae	Tree
154.	*Wedelia chinensis*	Asteraceae	Herb
155.	*Wedelia urticaefolia*	Asteraceae	Herb

Sl.No.	Name of the species	Family	Habit
156.	*Wrightia arborea*	Apocynaceae	Tree
157.	*Wrightia tinctoria*	Apocynaceae	Tree
158.	*Xylia xylocarpa*	Mimosaceae	Tree
159.	*Zanthoxylum rhetsa*	Rutaceae	Tree

Appendix iii List of ornamental plants recorded in the study area

Sl. No.	Name of the plant species	Family	Habit
1.	*Acacia auriculiformis*	Mimosaceae	Tree
2.	*Acacia mangium*	Mimosaceae	Tree
3.	*Adhatoda vasica*	Acanthaceae	Shrub
4.	*Allamanda cathertica*	Apocynaceae	Straggler
5.	*Antigonon leptopus*	Polygonaceae	Climber
6.	*Araucaria columnaris*	Araucariaceae	Tree
7.	*Bambusa vulgaris*	Poaceae	Grass
8.	*Bauhinia purpurea*	Caesalpiniaceae	Tree
9.	*Bauhinia tomentosa*	Caesalpiniaceae	Shrub
10.	*Bixa orellana*	Bixaceae	Shrub
11.	*Bougainvillea spectabilis*	Nyctaginaceae	Straggler
12.	*Bruguiera gymnorrhiza*	Rhizophoraceae	Tree
13.	*Butea monosperma*	Fabaceae	Tree
14.	*Caesalpinia sappan*	Caesalpiniaceae	Shrub
15.	*Caesalpnia coriaria*	Caesalpiniaceae	Tree
16.	*Callistemon lanceolatus*	Myrtaceae	Tree
17.	*Calophyllum inophyllum*	Clusiaceae	Tree
18.	*Canna indica*	cannaceae	Herb
19.	*Cassia alata*	Caesalpiniaceae	Shrub
20.	*Cyrtostachys renda*	Arecaceae	Tree
21.	*Digitalis purpurea*	Plantaginaceae	Herb
22.	*Diospyros microphyllus*	Ebenaceae	Tree
23.	*Duranta repens*	Verbenaceae	Shrub
24.	*Ficus elastica*	Moraceae	Tree
25.	*Ficus pumila*	Moraceae	Climber
26.	*Grevillea robusta*	Proteaceae	Tree
27.	*Hamelia patens*	Rubiaceae	Shrub
28.	*Helicornia rostrata*	Heliconiaceae	Herb
29.	*Hibiscus rosa-sinensis*	Malvaceae	Tree
30.	*Ixora coccinia*	Rubiaceae	Tree
31.	*Lagerstroemia indica*	Lythraceae	Tree
32.	*Lagerstroemia reginae*	Lythraceae	Tree

Sl. No.	Name of the plant species	Family	Habit
33.	*Lawsonia inermis*	Lythraceae	Tree
34.	*Melaleuca leucodendron*	Myrtaceae	Tree
35.	*Millingtonia hortensis*	Bignoniaceae	Tree
36.	*Murraya paniculata*	Rutaceae	Shrub
37.	*Mussanda* sp.	Rubiaceae	Shrub
38.	*Nerium oleander*	Apocynaceae	Shrub
39.	*Nyctanthes arbor-tristis*	Oleaceae	Tree
40.	*Pandanus odoratissimus*	Pandanaceae	Tree
41.	*Plumeria acuminata*	Apocynaceae	Tree
42.	*Plumeria al ba*	Apocynaceae	Tree
43.	*Plumeria rubra*	Apocynaceae	Tree
44.	*Quisqualis indica*	Combretaceae	Climber
45.	*Raphidophora aurea*	Araceae	Climber
46.	*Raphidophora pertusa*	Araceae	Climber
47.	*Ravenala madagascariensis*	Streliziaceae	Tree
48.	*Spathoglottis plicata*	Orchidaceae	Herb
49.	*Syzygium malaccense*	Myrtaceae	Tree
50.	*Syzygium samarangense*	Myrtaceae	Tree
51.	*Tabernaemontana divaricata*	Apocynaceae	Shrub
52.	*Tabeubia argentea*	Bignoniaceae	Tree
53.	*Tabeubia rosea*	Bignoniaceae	Tree
54.	*Tagetes erecta*	Asteraceae	Herb
55.	*Wedelia chinensis*	Asteraceae	Herb
56.	*Wedelia urticaefolia*	Asteraceae	Herb

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