

**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL  
(SOUTHERN ZONE BENCH, CHENNAI)  
IN  
ORIGINAL APPLICATION NO. 15 OF 2020 (SZ)**

**MASTER PLAN SUBMITTED BY THE DIVISIONAL FOREST OFFICER,  
PALAKKAD / RESPONDENT**

**Index**

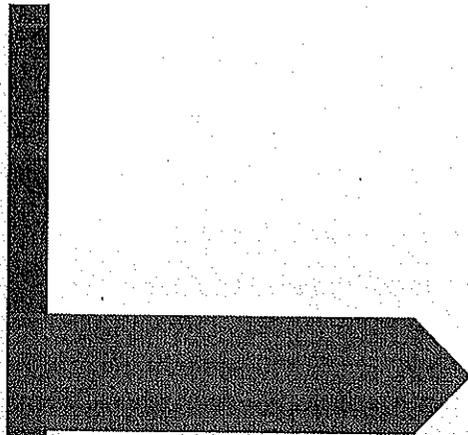
<b>S.No</b>	<b>Particulars</b>	<b>Page No.</b>
1	Master plan for conservation of Riparian Biodiversity along Bharathapuzha river	1-36

Dated at Chennai on this the 4<sup>th</sup> day of February, 2022.

**M/s. E.K.KUMARESAN**

Standing Counsel for State Government of Kerala - NGT(SZ) Chennai Bench





**MASTER PLAN FOR CONSERVATION  
OF RIPARIAN BIODIVERSITY ALONG  
BHARATHAPUZHA RIVER**



**DIVISIONAL FOREST OFFICER  
PALAKKAD**

**September 2021**

**BACKGROUND**

The National Green Tribunal registered a Suo motu case Original Application No. 15 of 2020 (SZ) on the basis of the News Paper report published in Malayala Manorama daily dated 20.01.2020 under the caption of നീരിപ്പുകഞ്ഞു നീളാതീരം -ഉണങ്ങിയ ആറ്റുവഞ്ചി പല്ലുകൾക്ക് വീണ്ടും തീയിട്ടു സാമൂഹ്യ വിരുദ്ധർ *"Burning Banks of Bharathapuzha, Anti-Social elements continue to burn dried riparian grasslands"*,

There was a fire which occurred on 19.01.2020, destroying this grass land which in fact destroyed the nests and eggs of several birds. The Tribunal had admitted the matter and appointed a Joint Committee comprising of Principal Chief Conservator of Forests (Head of Forest Force), Vazhuthacaud, Thiruvananthapuram, Divisional Forest Officer, Palakkad and District Collector, Palakkad District to look in to the matter and submit a factual and action taken report.

On 14.7.2020 the Divisional Forest Officer, Palakkad submitted an interim report on behalf of the Joint Committee. The report states that the place of incident is situated in the river bed of Bharathapuzha River in Ottapalam - II village of Ottapalam Taluk, near to the Mayannur bridge which connects Ottapalam to Thrissur district. A thorough inspection was conducted and it is seen that about one Acre of grass land area is burned in the incident and no evidence observed in the field about the damage to any birds, nest or eggs, as no remains of any birds or egg was observed on ground during field investigation. This grass land is formed by drying out of water during summer season in the river bed. This is a temporary grass land formed during the summer season and this land will submerge under water for about six months in a year during rains.

On enquiry with neighbouring people the committee could not understand that the dried river basin is being used by local people for relaxing and enjoying scenic beauty. It is also understood that this place is used by Anti social elements for anti social activities like consumption of alcohol and cooking for food. The fire noted by the Honourable Tribunal may

be caused due to above such activities. Since the area is not coming under any protected/reserve/vested forest, no regular patrolling is conducted by the Forest Department in this area.

Even though the above incident has not caused any adverse effect on the bio diversity or loss to the avian population for vegetation of this area, there is chance of affecting the same if the fire is spreading to the river banks. So, a master plan can be prepared for protection of river banks and avoiding of similar incidents as a joint venture by Revenue Department / Police and Local self-governments.

The Divisional Forest Officer, Palakkad submitted a Master Plan for conservation of riparian biodiversity along Bharathapuzha river. On 28.01.2021, the Joint Committee Report dated 18.1.2021 and also the proposed Master Plan submitted are accepted by the court and directed the committee to conduct the study, that has been proposed to be conducted as per the Master Plan during dry season and then complete the process of preparation of Master Plan.

The tribunal disposed of by accepting the Master Plan submitted by the fifth respondent with a direction to the State and District Administration and the authorities who have been mentioned in the Master Plan to carry out the same within a time frame and then submit a compliance report to this Tribunal.

### **Bharathapuzha River**

Total Basin area	:	6186 km <sup>2</sup>
Basin area in Kerala State	:	4400 km <sup>2</sup>
District in which basin are located	:	Palakkad, Malappuram, Thrissur
Origin of River	:	Annamalai Hills
Length of main stream	:	209 km
Main tributaries	:	Gayathripuzha, Chitturpuzha, Kalpathipuzha, Thuthapuzha

## Introduction

The River Bharathapuzha also known as Nila. It is the second-longest river in Kerala, after the Periyar River, with a total length of about 209km, takes its origin at Kovittola Betta of Kundra reserve forest of Tamil Nadu in the Western Ghats at an elevation of 2,336m and flows through Coimbatore district of Tamil Nadu, and Palakkad, Malappuram and Thrissur districts of Kerala and finally empties into Lakshadweep Sea at Ponnani. For the first 40, the Bharathapuzha follows an almost northerly course till Pollachi. At Parli both Kannadippuzha and Kalpathippuzha merge and the river acquires the name Bharathapuzha and follow a westerly course until it empties into the Arabian Sea at Ponnani. Thootha River merges with Nila at Pallipuram. As Thootha river is rich in water, after its merger, Nila becomes thicker in flow.

The Bharathapuzha is the lifeline of many cities and villages; (in Chittur, Bharathapuzha is known as "Sokanasini", (Chittur-Thathamangalam,) (Kodumbu-Thiruvallathur) Palakkad, (Parli-Kottayi), (Mankara-Perigottukurissi), (Lakkidi-Thiruvilwamala Killikkurussimangalam, Ottappalam, Shoranur, Cheruthuruthy Pattambi, Thrithala, Thiruvegappura, Kudallur, Pallipuram and Kumbidi. The village of Parudur, including the town of Pallipuram, stand near the confluence of this river and the River Thootha or, simply, Thuthapuzha.

The Bharathapuzha watershed lies between  $10^{\circ} 25' - 11^{\circ} 15' N$  &  $75^{\circ} 50' - 76^{\circ} 55' E$ , covering an area of 4400 sq.km. The upper reaches of the watershed consist mainly of agricultural land, a few water bodies and forestland. Agricultural land, forestland and wasteland occupy the middle region, while the lower regions are covered mainly by agricultural land and to a lesser extent by water bodies.

Bharathapuzha comprises one of the sixteen catchments in the southern Western Ghats that has the highest species richness and endemism of freshwater taxa (a group of populations of organisms) including fish, mollusc, and odonates. A total of 116 species of fish have been recorded

from the entire river, with threespecies being endemic to the river. 28 per cent of fish species (33) that occur in the Bharatapuzha are endemic to the Western Ghats. Bharatapuzha are listed as threatened in the IUCN (International Union for Conservation of Nature) RedList of Threatened Species.

**Location map of Bharathapuzha**

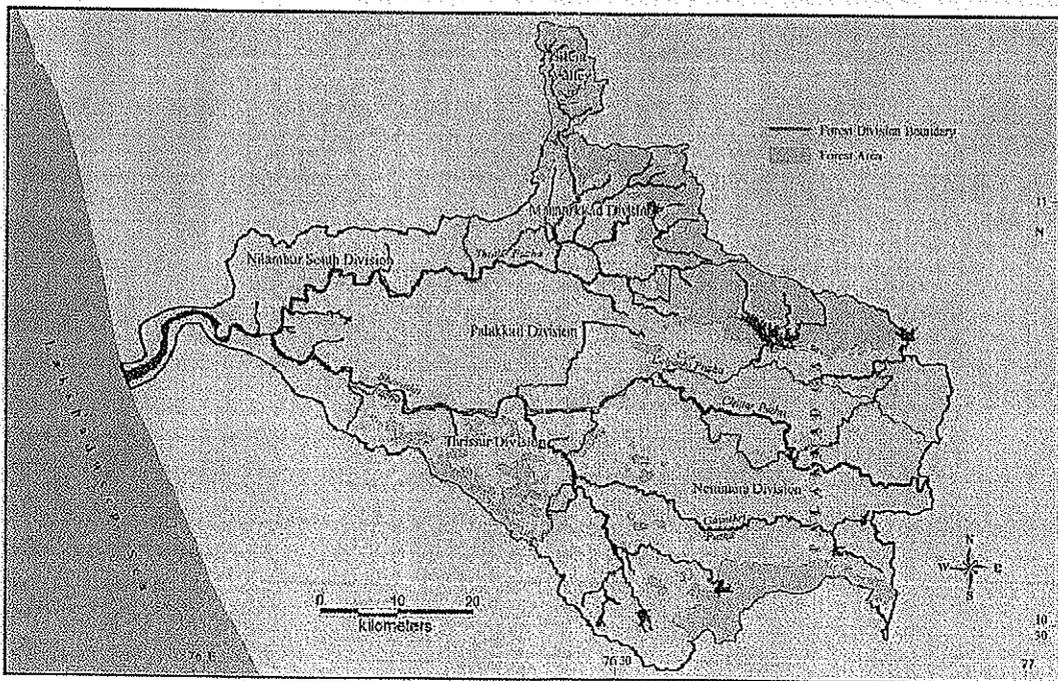
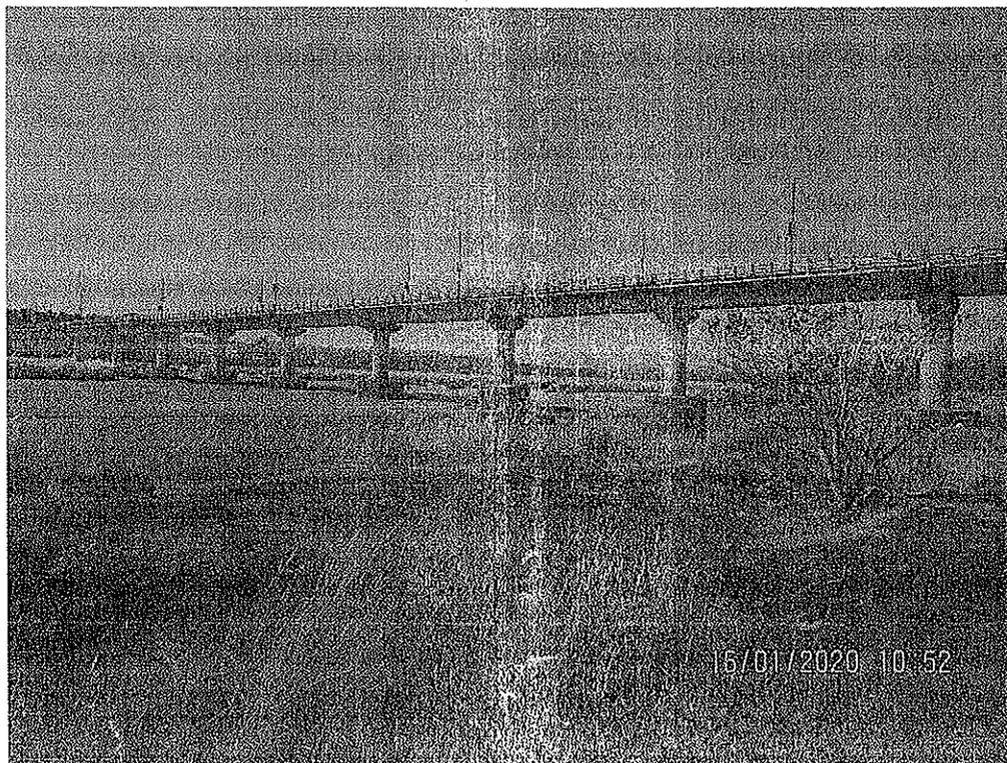


Image 2. Extent of forest cover in the Bharathapuzha River basin



A view of Bharathapuzha near Mayannur Bridge

#### **PURPOSE OF THIS MASTER PLAN**

This plan will provide general guidelines for the protection of Bharathapuzha river banks, bio stabilization to control the river flow and rebuild riparian habitat. This also aims to provide technical advice that will assist local government, community groups and landholders to restore, protect and manage river bank.

This incorporates a general discussion on site preparation, plant materials selection criteria, zonation of river bank, planting, its monitoring and maintenance and other river bank stabilization treatments including species selection and maintenance. Successful application of these guidelines will ensure the protection of river banks from fire and further degradation.

## **GOALS AND OBJECTIVES**

The goals of a river restoration programme can be broadly classified as ecological and socioeconomic goals.

- **To stabilize and restore the riverine ecosystem.**
- **To protect the riverine habitat from degradation**
- **A convergent effort from line departments for a common goal**

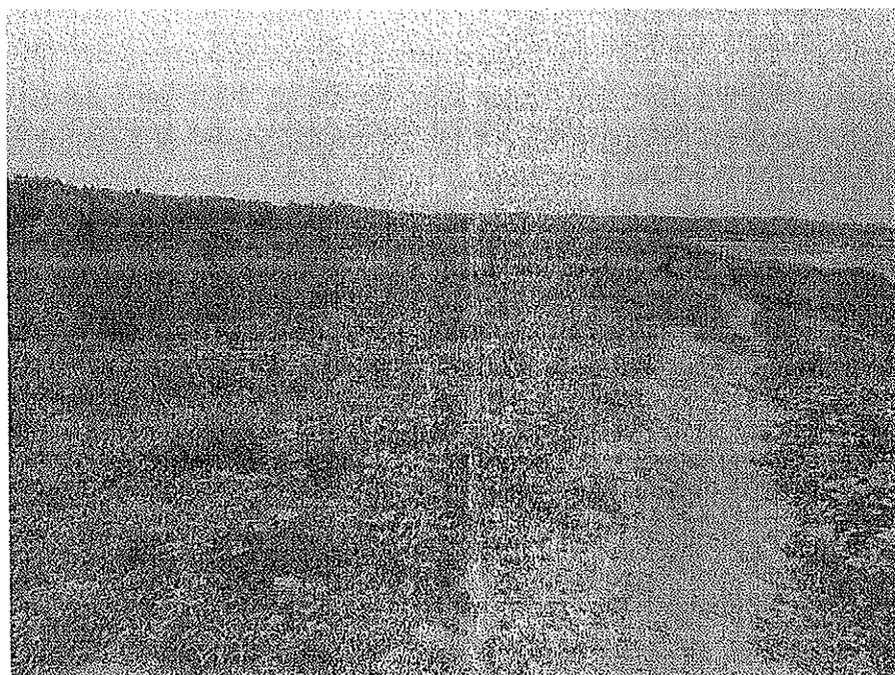
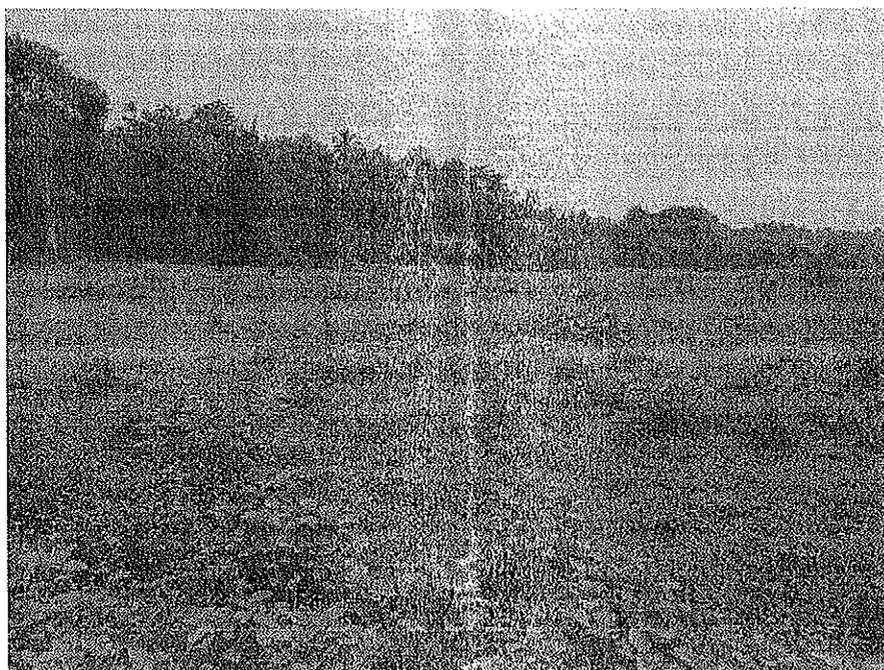
Objectives need to be specific, realistic, achievable and measurable. Exploring project objectives at the beginning of the project helps for planning and designing of activities, which will limit the changes and costs that can surface later in the design.

The objectives of this master plan may ultimately aim to achieve the following benefits;

- To reduce erosion and stabilize stream banks
- To restore riparian forests
- To increase biodiversity
- To protect riparian vegetation from damages of fire and other degradation.

## **PRELIMINARY ECOLOGICAL SURVEY**

A preliminary survey of natural vegetation along the riparian zone of Bharathapuzha river to assess the biodiversity and its threats was conducted by a team from mercy college Palakkad guided by Dr. Rekha Vasudevan A. They done an explorative survey at selected locations along the banks of Bharathapuzha. Field visits were conducted along several sites along the riparian zones of both banks of Bharathapuzha River. Sample plots of 5 x 5m were explored and the plants were identified using standard flora and relevant literature. The list of species were analysed for an assessment of ecological stability of these regions.



**Plate 1. Natural vegetation on the banks of Bharathapuzha during the dry season**

**Observations:**

**Physio-geographic character:**

The banks are seasonally flooded and exposed in the wet and dry seasons, respectively. But this has been altered in several places due to the construction of check dams. Water level near the check dams being high the banks remain under water, while beyond the check dams water flow is narrower and hence the banks are extensively exposed. Sand covered banks allow seasonal herbaceous flora to thrive in such places.

**Enumeration of species:**

The survey has revealed the **presence of 126 species of angiosperm and 3 species of pteridophytes in the riparian zones of Bharathapuzha** (Table 1). These plants belong to 41 families of angiosperms and three families of pteridophytes (Table 2). Among the total **129 species 27 are non-native** and recognised as invasive species (Table 3).

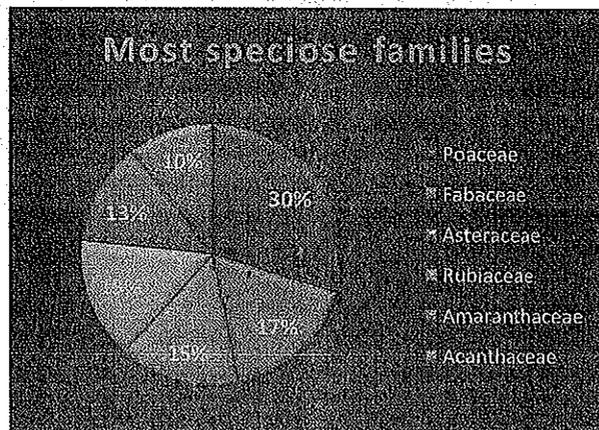


Figure 1. Families with most no. of species

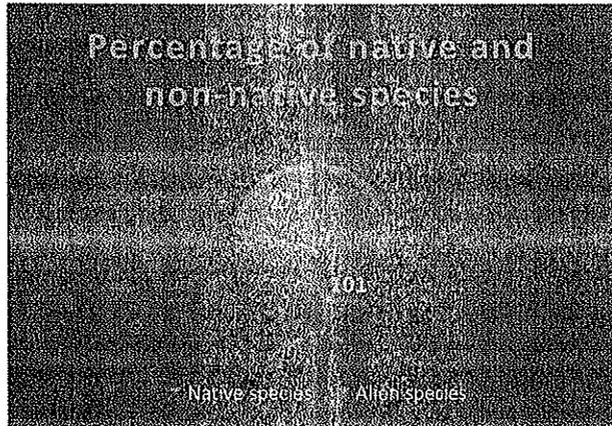


Figure 3. Nativity of species



Plate 2. Plant species recorded

- a. *Alternanthera tenella* Moq.in DC.
- b. *Barleria courtallica* Nees in DC.
- c. *Cardiospermum halicacabum* L.
- d. *Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult.
- e. *Ichnocarpus frutescens* (L.) R.Br.
- f. *Mitracarpus verticillatus* (Schum.&Thonn.) Vice



Plate 3. Invasive species recorded

- a. *Calotropis gigantea* (L.) R.
- b. *Cleome monophylla* L.
- c. *Eclipta prostrata* (L.) L.
- d. *Ipomea hederifolia* L.
- e. *Sphagneticola trilobata* (L.) Pruski
- f. *Synedrella nodiflora* (L.) Gaertn.

**Table 1. Plants recorded from river banks of Bharathapuzha**

List of plants identified		
Herbaceous species		
No	Binomial	Family
1	<i>Achyranthus aspera</i> L.	Amaranthaceae
2	<i>Acrostichum aureum</i> L.*	Pteridaceae
3	<i>Aerva lanata</i> (L.) Juss.ex Schul	Amaranthaceae
4	<i>Aeschynomene americana</i>	Fabaceae
5	<i>Ageratum conyzoides</i> (L.) L.	Asteraceae
6	<i>Allopteroopsis semialata</i> (R.Br.) Hitch.	Poaceae
7	<i>Alternanthera ficoidea</i> (L.) Sm.	Amaranthaceae
8	<i>Alternanthera sessilis</i> (L.) R.Br.ex.DC	Amaranthaceae
9	<i>Alternanthera tenella</i> Moq.in DC.	Amaranthaceae
10	<i>Amaranthus spinosus</i> L.	Amaranthaceae
11	<i>Ammania baccifera</i> L.	Lythraceae
12	<i>Andrographis paniculata</i> (Burm.f) Wall.ex Nees.	Acanthaceae
13	<i>Apluda mutica</i> Linn.	Poaceae
14	<i>Asparagus racemosus</i> Willd.	Asperagaceae
15	<i>Asystasia gangetica</i> (L.) T.Anderson	Acanthaceae
16	<i>Barleria courtallica</i> Nees in DC.	Acanthaceae
17	<i>Blumea oxydonta</i> DC.in Wight	Asteraceae
18	<i>Boerhaavia diffusa</i> L.	Nyctaginaceae
19	<i>Calotropis gigantea</i> (L.) R.	Apocynaceae
20	<i>Canscora diffusa</i> (Vahl) R.Br. ex Roem. & Schult.	Gentianaceae
21	<i>Cardiospermum halicacabum</i> L.	Sapindaceae
22	<i>Cassia tora</i> L.	Fabaceae
23	<i>Centrosema pubescens</i> Benth.	Fabaceae
24	<i>Chromolaena odorata</i> (L.) King & Rorins	Asteraceae
25	<i>Cleome aspera</i> Koenig ex DC.	Cleomaceae
26	<i>Cleome monophylla</i> L.	Cleomaceae
27	<i>Cleome viscosa</i> L.	Cleomaceae
28	<i>Clitoria ternatea</i> L.	Fabaceae
29	<i>Commelina benghalensis</i> L.	Commelinaceae
30	<i>Crotalaria retusa</i> L.	Fabaceae
31	<i>Crotalaria verrucosa</i> L	Fabaceae
32	<i>Croton bonplandium</i> Baill.	Euphorbiaceae
33	<i>Cyanotis axillaris</i> (L.) D.Don.	Commelinaceae
34	<i>Cyanotis villosa</i> (Spreng.) Schult.	Commelinaceae
35	<i>Cyclea peltata</i> (Lam.) Hook. F & Thoms.	Menispermaceae
36	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae
37	<i>Cyperus articulatus</i> L.	Cyperaceae
38	<i>Cyperus castaneus</i> Willd.	Cyperaceae
39	<i>Cyperus compressus</i> L.	Cyperaceae
40	<i>Cyperus cyperinus</i> (Retz.) Suringar	Cyperaceae

41	<i>Cyperus difformis</i> L.	Cyperaceae
42	<i>Cyperus michelianus</i> (L.) Link. Enum.	Cyperaceae
43	<i>Datura stramonium</i> L.	Apocynaceae
44	<i>Derris trifoliata</i> Lour.	Fabaceae
45	<i>Desmodium triflorum</i> (L.) DC	Fabaceae
46	<i>Echinochloa colonum</i> (L.) Link & Enum	Poaceae
47	<i>Eclipta prostrata</i> (L.) L.	Asteraceae
48	<i>Eichhornia crassipes</i> (Mart.) Solms.	Pontederiaceae
49	<i>Eleusine indica</i> (L.) Gaertn.	Poaceae
50	<i>Eragrostis atrovirens</i> (Desf.) Trin.ex Steud.	Poaceae
51	<i>Eragrostis japonica</i> (Thunb.)	Poaceae
52	<i>Eragrostis tenella</i> (L.) P. Beauv.ex Roem & Schult	Poaceae
53	<i>Eragrostis unioloides</i> (Retz.) Nees ex Steud.	Poaceae
54	<i>Eragrostis viscosa</i> (Retz.) Trin.	Poaceae
55	<i>Fimbristylis aestivalis</i> (Retz.) Vahl. Enum.	Poaceae
56	<i>Fimbristylis dichotoma</i> (L.) Vahl.	Poaceae
57	<i>Fimbristylis dipsacea</i> (Rottb.) Clarke in Hook.f.	Poaceae
58	<i>Fimbristylis miliacea</i> (L.) Vahl.	Poaceae
59	<i>Glinus oppositifolia</i> L.	Molluginaceae
60	<i>Gmelina arborea</i>	Verbenaceae
61	<i>Gomphrena globosa</i> L.	Amaranthaceae
62	<i>Gomphrena serrata</i> L.	Amaranthaceae
63	<i>Hedyotis corymbosa</i> L.	Rubiaceae
64	<i>Hedyotis puberula</i> (G.Don) R.Br.ex Arn.	Rubiaceae
65	<i>Hedyotis travencorica</i> Bedd.	Rubiaceae
66	<i>Heliotropium keralensis</i> Sivar. & Manilal	Boraginaceae
67	<i>Hydrolea zeylanica</i> (L.) Vahl	Hydroleaceae
68	<i>Hygrophila auriculata</i> (Schumach.) Heine.	Acanthaceae
69	<i>Hygrophila schulli</i> (Buch-Ham) M-R&Sm-Almeida	Acanthaceae
70	<i>Hyptis suaveolens</i> (L.) Poit	Lamiaceae
71	<i>Ichnocarpus frutescens</i> (L.) R.Br.	Apocynaceae
72	<i>Indoneesiella echioides</i> (L.) Sreem.	Acanthaceae
73	<i>Ipomea aquatica</i> Forssk.	Convolvulaceae
74	<i>Ipomea biloba</i> Forrsk.	Convolvulaceae
75	<i>Ipomea fistulosa</i> L.	Convolvulaceae
76	<i>Ipomea hederifolia</i> L.	Convolvulaceae
77	<i>Jatropha glandulifera</i> Roxb.	Euphorbiaceae
78	<i>Kyllinga bulbosa</i> P. Beauv.	Cyperaceae
79	<i>Leucas aspera</i> (Willd.) Spreng.	Lamiaceae
80	<i>Lindernia rotundifolia</i> (L.) Mukerjee	Linderniaceae
81	<i>Lindernia sessiliflora</i> (Benth.) Wetts.f.	Linderniaceae
82	<i>Ludwigia adscendens</i> (L.) H.Hara	Onagraceae
83	<i>Ludwigia perennis</i> L.	Onagraceae
84	<i>Marselia quadrifolia</i> L.*	Marseliaceae
85	<i>Merremia tridentata</i> (L.) Hallier f.	Convolvulaceae
86	<i>Mitracarpus verticillatus</i> (Schum.&Thonn.) Vice	Rubiaceae

87	<i>Mollugo pentaphylla</i> L.	Molluginaceae
88	<i>Ocimum sanctum</i> L.	Lamiaceae
89	<i>Ocimum tenuiflorum</i> L.	Lamiaceae
90	<i>Oldenlandia auricularia</i> (L.) K.Schum.	Rubiaceae
91	<i>Oldenlandia corymbosa</i> L.	Rubiaceae
92	<i>Oldenlandia diffusa</i> (Willd.) Roxb.	Rubiaceae
93	<i>Oldenlandia travencorica</i> (Bedd) O.Kutze	Rubiaceae
94	<i>Panicum paludosum</i> Roxb.	Poaceae
95	<i>Panicum repens</i> L.	Poaceae
96	<i>Pennisetum polystachyum</i> (L.) Schult	Poaceae
97	<i>Persicaria glabra</i> (Willd.) M.Gómez	Polygonaceae
98	<i>Phyllanthus amarus</i> Schum & Thonn	Phyllanthaceae
99	<i>Physalis angulata</i> L.	Solanaceae
100	<i>Polygonum barbatum</i> L.	Polygonaceae
101	<i>Polygonum glabrum</i> Willd.	Polygonaceae
102	<i>Portulaca oleraceae</i> Linn.	Portulacaceae
103	<i>Pouzolzia indica</i> (L) Gaut.	Urticaceae
104	<i>Rungia laeta</i> Clarke in Hook.f.	Acanthaceae
105	<i>Saccharum spontaneum</i> L.	Poaceae
106	<i>Salvinia molesta</i> D.S.Mitch. *	Salviniaceae
107	<i>Scoparia dulcis</i> L.	Scrophulariaceae
108	<i>Senna tora</i> L. (Roxb.)	Fabaceae
109	<i>Sesamum indicum</i> L.	Pedaliaceae
110	<i>Smithia sensitiva</i> Ait.	Fabaceae
111	<i>Spermacoce verticillata</i> L.	Rubiaceae
112	<i>Sphaeranthus indicus</i> L.	Asteraceae
113	<i>Sphagneticola trilobata</i> (L.) Pruski	Asteraceae
114	<i>Spirodela polyrhiza</i> (L.) Schleid.	Araceae
115	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae
116	<i>Trianthema portulacastrum</i> L.	Aizoaceae
117	<i>Tridax procumbens</i> L.	Asteraceae
118	<i>Typha angustifolia</i> L.	Typhaceae
119	<i>Vetiveria zizanioides</i> (L.) Nashin	Apocynaceae
120	<i>Xanthium indicum</i> Koenig	Asteraceae
<b>Trees</b>		
121	<i>Arenga wightii</i> Griff.	Arecaceae
122	<i>Cinnamomum malabatum</i> (Burm. f.) Blume.	Lauraceae
123	<i>Crateva religiosa</i> G.Forst.	Capparaceae
124	<i>Ficus dalhousiae</i> Miq.	Moraceae
125	<i>Ficus heterophylla</i> L.f.,	Moraceae
127	<i>Mallotus nudiflorus</i> (L.) Kulju & Welzen	Euphorbiaceae
128	<i>Uvaria narum</i> (Dunal) Wall.	Annonaceae

**Table 2. Most speciose Families of plants in the riparian flora along Bharathapuzha**

	Family	Percentage of total species
1	Poaceae	14%
2	Fabaceae	8%
3	Asteraceae	7%
4	Rubiaceae	7%
5	Amaranthaceae	6%
6	Acanthaceae	5%
7	Cyperaceae	5%

**Table 3. Invasive plants in the riparian zone of Bharathapuzha**

No	Binomial	Family	Habit
1	<i>Aeschynomene americana</i>	Fabaceae	Herb
2	<i>Ageratum conyzoides (L.) L.</i>	Asteraceae	Herb
3	<i>Alternanthera tenella Moq.in</i>	Amaranthaceae	Herb
4	<i>Calotropis gigantea (L.) R.</i>	Apocynaceae	Shrub
5	<i>Cassia tora L.</i>	Fabaceae	Herb
6	<i>Chromolaena odorata (L.)</i>	Asteraceae	Herb
7	<i>Cleome monophylla L.</i>	Cleomaceae	Herb
8	<i>Cleome viscosa L.</i>	Cleomaceae	Herb
9	<i>Crotalaria retusa L.</i>	Fabaceae	Herb
10	<i>Croton bonplandium Baill.</i>	Euphorbiaceae	Herb
11	<i>Cyperus difformis L.</i>	Cyperaceae	Herb
12	<i>Echinochloa colonum (L.)</i>	Poaceae	Herb
13	<i>Eclipta prostrata (L.) L.</i>	Asteraceae	Herb
14	<i>Eichhornia crassipes (Mart.)</i>	Pontederiaceae	Herb
15	<i>Gomphrena serrata L.</i>	Amaranthaceae	Herb
16	<i>Hyptis suaveolens (L.) Poit</i>	Lamiaceae	Herb
17	<i>Ipomea hederifolia L.</i>	Convolvulaceae	Herb
18	<i>Ludwigia perennis L</i>	Onagraceae	Herb
19	<i>Physalis angulata L.</i>	Solanaceae	Herb
20	<i>Saccharum spontaneum L.</i>	Poaceae	Herb
21	<i>Salvinia molesta D.S.Mitch.*</i>	Salviniaceae	Herb
22	<i>Scoparia dulcis L.</i>	Scrophulariaceae	Herb
23	<i>Senna tora L. (Roxb.)</i>	Fabaceae	Herb
24	<i>Synedrella nodiflora (L.)</i>	Asteraceae	Herb
25	<i>Tridax procumbens L.</i>	Asteraceae	Herb
26	<i>Typha angustifolia L.</i>	Typhaceae	Herb
27	<i>Xanthium indicum Koenig</i>	Asteraceae	Herb

**Findings from the study:**

- Preliminary survey of the flora along the banks of Bharathapuzha reveals the plant diversity of the riparian vegetation.
- The vegetation is predominantly herbaceous, with 93% of the species studied being herbs or small shrubs (Fig. 2). Among them 14% of Poaceae members or grasses and 5% of Cyperaceae members or sedges (Fig. 1).
- The study being done in the month of April the river had dried up and the banks were exposed. The sandy substratum favours the growth of grasses and several invasive elements. The predominance of species like *Saccharum spontaneum* is a very familiar sight along the river banks in the dry season.
- These herbaceous and grass species gets dried during summer season and they increase the risk of fire and make the riverine ecosystem fire prone.
- The frequent occurrence of fire along the river banks is likely to alter the vegetation profile of the area because, the invasive species have better fire-germination response than the native species and can drive the invasion process. So the frequent fire of these grass beds affect the biodiversity of the riparian ecosystem.
- The main reasons for fire is when this grassland are
  1. Fire caused by cooking food by local people / tourist visiting the area for leisure purpose.
  2. Fire spreading from adjacent agricultural field
  3. Dumping and burning of waste near river banks
- The long -term effect of regular fire in these regions becomes significant because 21%of the vegetation are non-native species (Fig.

3). On an average 2-5 hectares of grass lands are burned annually because of various reasons mentioned.

- Several check dams have been constructed along the river for the purpose of irrigation. They no doubt serve as source of water during the dry season but they alter the course of the river and this can have a detrimental effect on the biodiversity. Where the check dam is built the volume of water upstream is very high and the banks are not exposed. But downstream the river shrivels into trickles and the area of exposed river bed is large. Such alteration of the course of water in the river can change the sedimentation pattern and also the quality of water. Studies have shown that the dams across the river have contributed to the deterioration of the river by reducing the quantity and quality of water and altering the course of the river and by reducing its biodiversity.
- Only 4% of the land is retaining natural vegetation and the majority of land along the river is utilised for mixed tree crop raising, coconut plantation, paddy and other crops.
- Around 16% of the land remains barren. Natural vegetation retained is seen as patches without much continuity.
- The riparian zone of Bharathapuzha is reported to be home to 140 species of birds, 65% of which are resident and the rest are migratory. The breeding season of most of these birds falls in the months of October to January and hence the exploration during the month of April does not help in their enumeration.
- The alteration of the substratum character of the river bed is known to affect the fish population as some fishes of the families Balitoridae, Cobitidae and Nemacheilidae require pebbles and gravel in their microhabitats for breeding.

**Recommendation:**

Based on the result of the preliminary survey of the natural vegetation along the banks of Bharathapuzha river in Palakkad district, the following priorities have been identified.

1. To protect the riparian vegetation from fire and to reduce degradation and restrict the spread of invasive species, Steps can be taken to increase the population of native species as a means of river bank stabilising / undertaking enrichment planting in the riparian ecosystem. Local task groups or village level committees can be formed to achieve this.
2. Ensure free and natural flow of water along the river, thereby increase the moisture regime and reduce the threat of fire.
3. Since a major part of the riparian zone is cultivated, efforts must be made to ensure sustainable agriculture practices that replenish the water table and cause least environmental degradation. Slash / agricultural waste burning can be discouraged among farmers in liaison with Agricultural department.
4. Capacity building of various stake holders influencing the riparian ecosystem. They should be sensitized by giving proper awareness regarding importance of riparian vegetation and harmful effects of fire.

## **ACTION PLAN**

From the output from the preliminary study, it documented the existing biodiversity along the banks of Bharathapuzha river. The further cause of action proposed is

- i. Setting up a multidisciplinary team**
- ii. Survey and demarcation**
- iii. Preparation of site-specific restoration plan by expert team**
- iv. Plan implementation and execution of restoration measures with the help of line departments.**
- v. Monitoring to review timely progress, effectiveness of the projects and maintenance**
- vi. Community involvement and people's participation**

### **1. SETTING UP A MULTIDISCIPLINARY TEAM**

- A total of 60 km stretches of river from lakidi perur village to Anakkaraka village area is taken up for the study.
- A village level / block level committee including members from Revenue, Forest, Agriculture, Police, irrigation, LSGD, Soil conservation, a technical expert from a scientific institute and members from kerala state biodiversity board can be formed at village level.
- This committee can visit the river banks in each village level block and plan restoration activities based on the guidelines formulated in this plan.

- The role of various departments are
  - Revenue- execution of this plan. The total study area of the Bharathapuzha river flowing through revenue area.
  - Forest- preparation of plan and technical advice / monitoring in planting activities
  - Agriculture- will advise on the matters on agricultural practises on adopted in the area.
  - Irrigation – technical advice on watershed aspects
  - Police – Protection of riparian vegetation
  - LSGD- for pooling man power by participatory method like MGNREGS programmes
  - Soil conservation -technical advice on soil and moisture conservation measures
  - Expert from Scientific institutes- technical advice
  - Kerala state biodiversity board- technical advice through Biodiversity management committees

**2. SURVEY AND DEMARKATION OF AREA AND COLLECTION OF BASELINE DATA**

The survey and GIS mapping of the area will provide clear cut information about the land available with the government for actual implementation of Master plan. This includes data collection of survey records, demographic, and socioeconomic ecological aspects. Land Survey records will help in identifying actual extent of land available with government.

Mapping the area and fixing the boundary of the river bank using GIS is critical to initiate the site preparation activities. This will help to calculate the total time and manpower required for site preparation activities.

Demographic information (population, density etc.) will help to analyse the number of people directly or indirectly depending upon this particular river ecosystem.

The village level map and base line data need be prepared with the help of survey and revenue departments which can be utilized for preparing village level site specific plan.

**PROJECT LOCATION**

The specific sites for intervention and prioritized location for specific treatment can be identified after field visit and recommendation of block level committee.

**List of villages through which Bharathapuzha river flowing taken for implementation of Master Plan**

- |                       |                      |
|-----------------------|----------------------|
| 1. Anakkara           | 7. Pattambi          |
| 2. Parudur            | 8. Ongallur -II      |
| 3. Pattithara         | 9. Shornur-II        |
| 4. Thrithala          | 10. Vaniyamkulam -II |
| 5. Thirumittikode I   | 11. Ottappalam -I    |
| 6. Muthuthala         |                      |
| 12. Lakkidi -perur -I |                      |



Google earth map of study area

**3. PREPARATION OF SITE-SPECIFIC RESTORATION PLAN BY EXPERT TEAM**

The expert committee with representation from all line department will visit the river banks of 12 village level block and plan restoration activities based on the guidelines formulated in this plan. They will collect data from the field based on the draft performa and prepare a detailed report based on that.

1. Riverbank stabilization methods
2. Site selection for planting
3. Species selection based on zonation of river bank
4. Cost of planting and protection measures.
5. Detailed site-specific plan will be prepared for each village level block.

**Block level Restoration cum conservation Plan - ..... block**

[Template] [Prepared along with block map]

Block Name	
Area	
General description	
Vegetation Status	Good/ Average/ Poor
Major vegetation Type /	
Major observations	
Threat Status	High/ Medium / Low
Action plan / Recommendations	

### BIODIVERSITY ENRICHMENT PLANTING

Planting of trees, shrubs, herbs or grasses along the riverbank is a vegetative method of stabilization referred to as **riverbank bio-stabilization** whereby the root system hold the soil in place and reduce the impact of water flow. It is basically refer to the use of live and dead herbaceous and woody plant materials in combination with natural and synthetic support materials for slope stabilization, erosion reduction, and vegetative establishment.

In simple terms, **riverbank bio-stabilization** uses plants and sometimes inert material to increase the strength and structure of the riverbank. Vegetation appears more complex to work with but it also offers unique benefits. Vegetation as a live material can be self-sustaining under suitable conditions, it can adapt to temporal changes in topography, it provides habitat for other species, provides food sources for other species, and can prevent the warming of river flow temperature by overbank shading.

For designing and planning of riverbank stabilization process we had divided the riverbank into three zones based on the width of riverbank, water level and vegetation characteristics. A figure illustrating an idealized depiction of these zones, as well as a brief description of each, is provided below.



Riparian vegetation zones in an ideal riverbank

- **Lower Zone** is adjacent to river having low to medium water level. This zone is usually water saturated throughout the year. The species seen in this zone have the ability to survive prolonged inundation and are flexible enough to withstand high velocity water current. Grasses and shrubs tolerant to continuous inundation can survive in this zone.
- **Middle zone** is having medium to high water level. This zone is usually saturated 3-4 months in a year. This zone includes some tree, palm or bamboo species along with grasses and shrubs tolerant to occasional water inundation.
- **Upper zone**- In the zone above the high water level and rarely to nil water saturation. Trees, palms or bamboos are seen with or without shrubs.

Not all streams will exhibit all of these zones. Topographic and edaphic conditions will change along and across the riverbank.

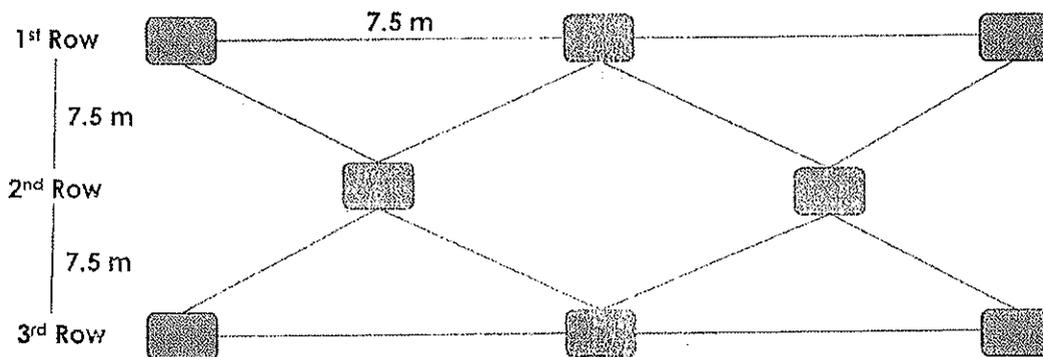
### **SITE PREPARATION**

The level of site preparation needed will depend on the specific goals and objectives of the project, riparian species to be used, zonation of river bank and condition of the site. Site preparation is critical for plant survival and growth and may include removal of invasive species or other vegetation, grading, exposing soil, draining, irrigating, or adding fertilizer and other soil amendments.

1. **Selective area cleaning:** - The field should be cleared for planting and clearing the site can be done only at specific points where planting is planned. Well rooted trees, grasses, bamboos, aquatic plants and other plants already present in river banks can be retained.

**2. Alignment and Spacing:** -The spacing of the pits can be at 5 - 7.5 m in a triangular pattern. The ideal time for such activity is February – March.

- Pits dug at a spacing of 7.5 m in a triangular pattern is advised for most trees,
- 5.0 m in a triangular pattern for most shrubs
- 2.0 m in a triangular pattern is recommended for herbs and grasses.



**3. Pitting:** - The next step is to dig pits of specified size for planting. Based on the species used pit size may differ. Spacing between pits will depend upon the species used and zone of work.

- Trees and bamboos require more space so that a pit size of 50 x 50 x 50 cm<sup>3</sup> can be used for planting trees.
- Smalldigs with crow bars is advisable for herbs and grasses so as to minimize soil disturbances.

### **SELECTION OF SUITABLE SPECIES**

The selection of suitable plant species and species combinations for bio stabilization measures must be based on careful vegetation surveys and different zones by village level expert team.

Many species grow quickest in the open although others prefer shade, so one must carefully assess site conditions to understand which are most appropriate before deciding which species and types are to be used for the bio-restoration activities.

. The use of appropriately sized plant stock is also a key consideration.

Plant selection should be done based on following characteristics

- Select indigenous species
- Suitable for climatic and edaphic conditions of the site
- Good root anchoring capacity
- High tolerance to adverse conditions like salinity, drought, waterlogging etc.
- High growth rate
- Multiple uses (food, timber, fodder, NWFPs etc.)
- High regeneration and coppicing power

**The list of species suitable for each zone**

**LOWER ZONE**

SR NO	SPECIES	FAMILY	HABITAT
1.	<i>Oclandra setigia gamble</i>	poaceae	Shrub
2.	<i>Ochlandra raizada and chatterje</i>	Poaceae	Shrub
3.	<i>Ochlandrabeddomiigamble</i>	poaceae	Shrub
4.	<i>Oclandra travancoria</i>	poaceae	Shrub
5.	<i>Ochlandra scriptoria</i>	poaceae	Shrub
6.	<i>Ochlandra wightii</i>	poaceae	Shrub
7.	<i>Panicum repens</i>	Poaceae	Herb
8.	<i>Pennisetum pedicellatum</i>	Poaceae	Herb
9.	<i>Saccharaam arundinaceum</i>	poaceae	Herb
10.	<i>Vetivera zizanoids</i>	poaceae	Herb
11.	<i>Saccharum spontaneum</i>	Poaceae	Subshrub
12.	<i>Pandanus spp.</i>	Pandanaceae	Shrub
13.	<i>Cryptocoryne spp</i>	Araceae	Herb
14.	<i>Lagenandra toxicaria</i>	Araceae	Herb

**MIDDLE ZONE**

SR NO	SPECIES	FAMILY	HABITAT
1.	<i>Buteo monosperma</i>		Tree
2.	<i>Calotropus gigantia</i>	Apocynaceae	Shrub
3.	<i>Cinnamomum verum</i>	Lauraceae	Tree
4.	<i>Derris scandens</i>	Fabaceae	Climber
5.	<i>Ficus hetrophylla</i>	Moraceae	Shrub
6.	<i>Gliricida sepeium</i>	Fabaceae	Tree
7.	<i>Glycosmis pentaphylla</i>	Rutaceae	Shrub

8.	<i>Homonoia riparia</i>	Euphorbiaceae	Shrub
9.	<i>Helicterus isora</i>	Sterculiaceae	shrub
10.	<i>Hydnocarpuz pentandra</i>	Flacourtiaceae	Tree
11.	<i>Lawsonia inermis</i>	Lithraceae	Shrub
12.	<i>Macaranga indica</i>	Euphorbiaceae	Tree
13.	<i>Pongamia pinnata</i>	Fabaceae	tree
14.	<i>Ricinus communis</i>	Euphorbiaceae	Shrub
15.	<i>Syzygium cumini</i>	Myrtaceae	Tree
16.	<i>Syzygium occidentale</i>	Myrtaceae	Shrub
17.	<i>Senna tora</i>	Fabaceae	shrub
18.	<i>Terminalia catappa</i>	Combretaceae	Tree
19.	<i>Wrightia tinctoria</i>	Apocynaceae	Tree
20.	Bamboo species		

**UPPER ZONE**

SR NO	SPECIES	FAMILY	HABITAT
1.	<i>Albizia lebbeck</i>	Fabaceae	Tree
2.	<i>Aporosa cardiosperma</i>	Euphorbiaceae	Tree
3.	<i>Areca catechu</i>	Arecaceae	Tree
4.	<i>Baccaurea courtallensis (wight)</i>	Euphorbiaceae	Tree
5.	<i>Barringtonia acutangula L</i>	Lecythidaceae	Tree
6.	<i>Briedelia retusa.L</i>	Euphorbiaceae	Tree
7.	<i>Caesalpinia sappan. L</i>	Fabaceae	Tree
8.	<i>Carallia brachiata</i>	Rhizophoraceae	Tree
9.	<i>Casuarina equisetifolia</i>	Casuarinaceae	Tree
10.	<i>Cocos nuscifera</i>	Arecaceae	Tree
11.	<i>Crataeva magna</i>	Capparaceae	Tree

12.	<i>Cinnamomum riparium</i>	Lauraceae	Tree
13.	<i>Dragea volubilis</i>	Asclepidaceae	Tree
14.	<i>Ficus recemosa</i>	Moraceae	Tree
15.	<i>Garcinia gummi gutta.</i>	Clusiaceae	Tree
16.	<i>Humboldtia vahliana</i>	Fabaceae	Tree
17.	<i>Hibiscus tiliaceus</i>	Malvaceae	Tree
18.	<i>Madhuca nerifolia</i>	Sapotaceae	Tree
19.	<i>Mallotus aureopanctatus</i>	Euphorbiaceae	Tree
20.	<i>Mangifera Indica</i>	Anacardiaceae	Tree
21.	<i>Tabernaemontana alternifolia</i>	Apocynaceae	Tree
22.	<i>Tamarindus Indica</i>	Fabaceae	Tree
23.	<i>Thespesia populnea</i>	Malvaceae	Tree
24.	<i>Trema orientalis</i>	Ulmaceae	Tree
25.	<i>Lagerstroemia speciosa</i>	Lythraceae	Tree

### PLANTING IN SITE

Planting plans help accelerate the establishment and helps to ensure that the appropriate species are included. It also reduces the exposure period to erosion.

Re-vegetation consists of selecting the appropriate plant species for the management area and introducing them in a manner which promotes successful establishment. This includes watering until the plant is established, appropriately locating plants on banks and terraces so the water table will be accessible to the plant roots, and selecting appropriate species to match site conditions.

The seedlings can be raised in localized nursery. Casualty replacement should be done to maintain the continuity of the riparian vegetation.

**PROTECTION, MAINTENANCE AND AFTERCARE**

The success of this riparian planting and other silviculture treatments depends on periodic maintenance (watering, invasive removal, protection from predators) until vegetation becomes well established. Considerable maintenance in the first 5 years after planting is needed, which may include staking, weeding, manuring, and replacing dead plants / casualties, irrigation, and additional invasive species removal.

In addition, the protection of plantings from cattle, goats, and other herbivores is often necessary to limit damage and mortality of plantings and improve growth of trees and other plantings. Continuous monitoring is necessary to evaluate its growth performance and check the growth of weeds and other plants around the seedling. Care should be taken to avoid the attack of insects and pests and occurrence of diseases.

These guidelines as such or with some modifications can be applied in each block after a detailed site study.

1. Fire Gang: A committee should be formulated at village level with the help of NGO's to protect the banks from fire and activities that damage the riparian habitat like cutting trees, waste dumping etc. A fire gang with 5-10 man mazdoors can be employed during fire season after assessing the threat status of fire in every village level / block level committee.
2. Protection can be given to such areas by regular patrolling by forest or police department staff.
3. Local NGO's help can be taken for getting information regarding the illegal activities such as waste dumping, tree cutting, setting fire etc.
4. Surveillance cameras can be set up at strategic locations to prevent activities of anti-social elements.

## **PUBLICITY AND AWARENESS**

Publicity is a very essential part of the fire control. Since the fire is a manmade phenomenon, creating awareness is the best tool for its control.

The various methods proposed for the publicity is as follows:

1. Pamphlets / posters/Banners etc. urging people about the importance of riverine ecosystem its ecosystem services, dangers of wild fires to ecosystem etc.
2. Awareness can be given to public regarding the importance of riparian habitat and foraging and breeding grounds of birds and wildlife.
3. Awareness classes, film shows, quiz competitions etc. in schools and colleges of locality can also be planned.
4. Mike publicity in the local area.
5. Display boards can be setting up in specific location

## **REJUVENATION OF STREAMS / RAINWATER RECHARGE**

Rejuvenation of streams and rainwater recharge activities can be undertaken in 12 identified villages along the catchment areas of the river, so that the minimum flow of water for ecological function is maintained and exposure of river basin during summer is avoided.

## **GREEN PROTOCOL**

Green protocol can be implemented in these areas so that drains and discharges of polluting water both solid and liquid to river during summer can be addressed. A separate guideline for waste disposal can be formulated by the block level committee.

**SYNERGY WITH SIMILAR ACTIVITIES FOR PROTECTION OF BHARATHAPUZHA RIVER**

Similar master plans which aim the protection of Bharathappuzha river can be identified and combined for focused result.

**4. IMPLEMENTATION / EXECUTION OF WORK.**

This master Plan can be implemented by preparing 12 village level site specific plan under the plan fund of LSGD department and execution under the guidelines of expert committee.

- The work can be carried clubbing with MGNREGS activities in Palakkad district.
- Detailed estimates can be prepared based on Forest Schedule rate / MGNREGS data
- This can also be clubbed with several exiting planting programmes like Haritha keralam Mission etc.
- The seedlings can be procured from Social Forestry wing of Forest department, so that the cost of planting can be minimized.

**5. MONITORING TO REVIEW TIMELY PROGRESS, EFFECTIVENESS OF THE PROJECTS AND MAINTENANCE**

For the systematic implementation of proper monitoring and evaluation is highly essential. A monitoring committee at District level may be formed under the chairmanship of District collector. This committee ensured time bound plan formulation by conducting regular meetings, provided administrative sanction for site specific plan, final approval of execution plan for future implementation.

**Frame Work**

Chairman – District collector, Palakkad

Members \_

Divisional Forest Officer, Palakkad

Sub collector, ottappalam

District coordinator, Kerala state biodiversity board

Members from Kerala Forest Research Institute

Director of Panchayat, Palakkad

DYSP shornur

Tahsildar Ottappalam

Tahsildar Pattambi

Secretary, PattambiMunicipality

Secretary, ShornurMunicipality

Secretary, OttappalamMunicipality

**PROJECT PERIOD PROPOSED**

The project is proposed to be executed in a phased manner from 2021-22 to 2026-27, because many of the activities proposed are time taking and different department collective initiative needed. It will also help in proper planning and execution of master plan, so that the works can be implemented in a time bound manner.

**2021-2022:**detailed survey and demarcation of area, engaging protection Mazdoors

**2022-2023:**Eco restoration / enrichment planting, fire protection activities.

**2023-2024:**maintenance of plantation, fencing, Sign boards etc

**2024-2025:** maintenance of plantation, fire protection activities

**2025-2026:** maintenance of plantation, fire protection activities

**2026-2027:** maintenance of plantation, fire protection activities

**PROJECT COST**

The project cost can be met with the plan fund of implementing agency. Estimated project can be reduced by procuring seedlings from Social Forestry wing of Forest department, Keral Forest Research institute etc, and implementing the planting activities by clubbing with MGNREGS activities and Haritha Keralam programmes.

**Estimated Project Cost**

<b>Sl no</b>	<b>Particulars</b>	<b>Rs. In lakhs</b>
1	Survey and demarcation	1.0
2	Enrichment planting Total estimated area available for planting 40hactare and maintenance upto 5 years 40x 1 =40lakh	40.00
3	Engaging Man mazdoors for fire protection at fire sensitive locations January to may 12 x 5MMx 15000x4	36.00
4	Printing publicity materials	2.0
5	Cost of display boards 5nos x 5000 x 12 blocks	3.0
	<b>Required project cost</b>	<b>82.00</b>

36

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## **6. COMMUNITY INVOLVEMENT AND PEOPLE'S PARTICIPATION**

The people participation is ensured in this restoration plan for ensuring better result and arrest further degradation. The NCC, SPC, Nature clubs of neighbouring Schools, NGO,s working in field of biodiversity conservation and river protection can be incorporated into the filed level implementation of site specific plans.



Divisional Forest Officer

Palakkad