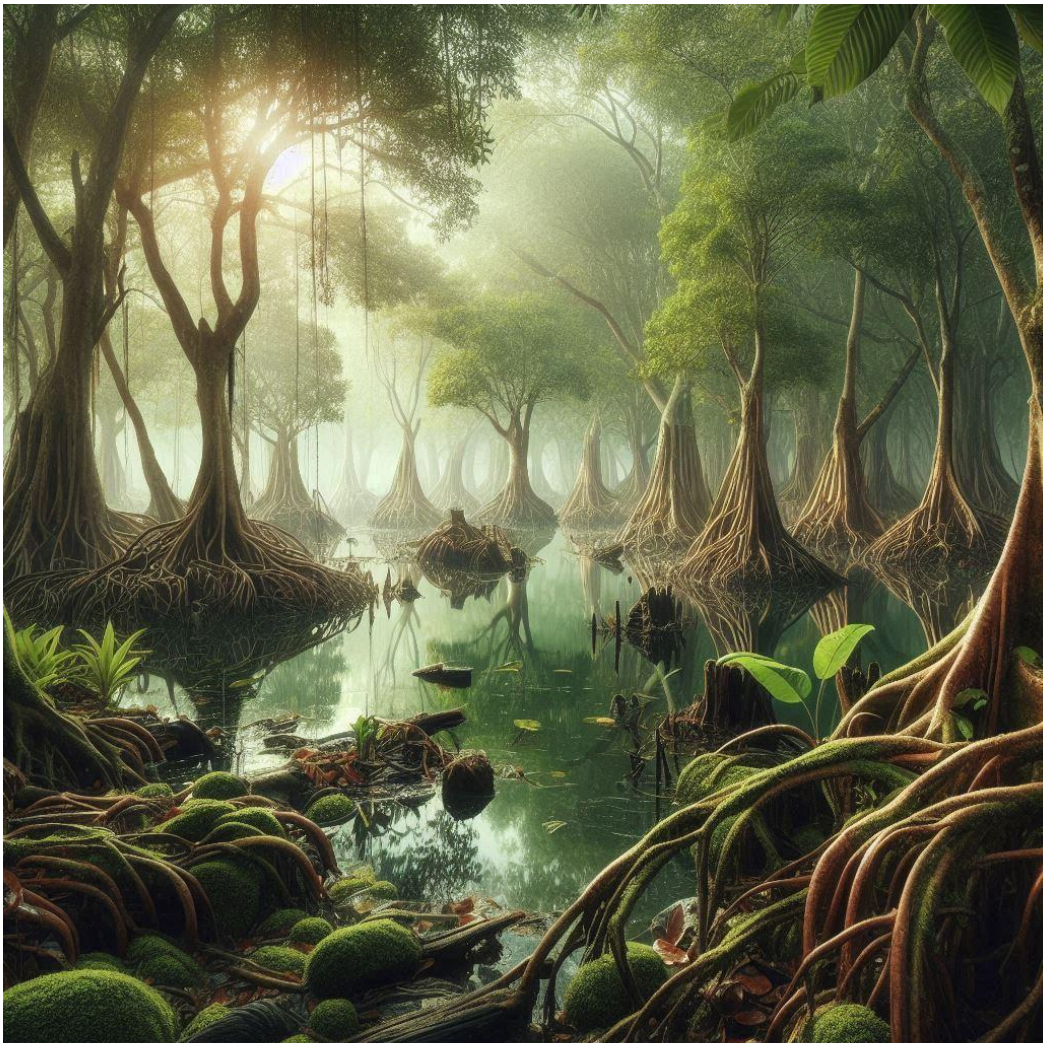
Ecological restoration of Tropical Freshwater Swamp Forests and long-term protection, Central Western Ghats

Final report

Project period May 2024 to September 2025



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1. Introduction

Tropical Freshwater Swamp Forests **(**TFSFs) are unique ecosystems occurring in the valleys and plains of undulating landscapes in the Western Ghats, which provide a suitable microclimate for them. In the Western Ghats, they are tree-covered wetlands within evergreen forests. These swamps shelter some of the last relics of ancient vegetation (Molur et al., 2011, Verghese and Kumar 1997). Within the climax evergreen forests, they occupy poorly drained depressions that often open into a river or rivulet (Gupta et al. 2006). They provide critical ecosystem services and host several endemic and endangered species. Over 20 species are found exclusively in the swamp forests, including some of the paleoendemic species like *Myristica fatua var. magnifica, Gymnacranthera canarica, Vateria indica* and *Dipterocarpus indicus* (Chandran et al. 2010). Large populations of the endangered and endemic primate Lion Tailed Macaque (*Macaca silenus*) and Great Pied Hornbill (*Buceros biornis*) are also found here. Several amphibian species like *Micrixalus kottigeharensis* and *Pseudophilautus amboli* (Bhat and Kaveriappa, 2009; Ramachandran and Joseph, 2000; Ali et al. 2006) are present here. The newly discovered amphibian species *Nyctibatrachus kumbara* is also found in these forests.

However, TFSFs have been fragmented, degraded, or lost through centuries. Water diversion, residues of chemical pesticides and fertilizers, over-exploitation of forest resources, conversion of swamp forests into other land uses, and non-recruitment of obligatory swamp species are the major threats (Ranganathan et al., 2021; Hegde et al., 2018). Hence, it is very essential to take action to halt this degradation and initiate ecological restoration and recovery actions. The TFSFs, once that had been connected to each other, are now fragmented and disconnected, and the consequence of such fragmentation is poorly understood. The gradual shrinking of the core swamp area and the buffer zone is also observed. Monoculture plantations with non-native species have been raised on a massive scale in the catchment area of swamps. Further, the absence of local governance for effective conservation, especially the village forest committees (VFCs), is another cause for concern. In a previous attempt, perhaps for the first time in the Western Ghats, Snehakunja Trust attempted restoration on degraded swamp forests on a participatory basis and conservation efforts have been amplified. Results of this project have been mixed with various degrees of successes and failures. During this period, we were able to bring the strength of shared knowledge between various stakeholders, especially the state Forest Department, Forestry College (Sirsi), state Biodiversity Board, scientists, research organizations, voluntary organizations, and local communities having different stakes in the TFSF for effective conservation. Snehakunja Trust is one of the few organizations known to be involved in research and conservation initiatives on TFSF in the Western Ghats. 110 Myristica swamps were identified and mapped during this CEPF (Critical Ecosystem Partnership Fund) project, in which at least 60 are new.

During the year 2009 – 2010, the Kathlekan, an ecologically important forest was cleared using JCB in an area of about 8 ha in two separate sites. A long contagious stretch of TFSFs was destroyed; still, we could see the swamp at the lower and top side of the destroyed forests. Snehakunja had just initiated the CEPF-funded project on linking the fragmented freshwater swamps in the Uttara Kannada district. While making an inventory on Google Earth images, the team noticed this forest clearance and made an immediate field visit to check the ground realities. We then informed the senior forest officials, who were very responsive and took immediate action to stop the encroachment for further expansion of the arecanut orchard.

1.1 **Conservation Reserves**:

Efforts were made to include the priority FWS in the network of newly declared Conservation Reserves. Proposals for conservation reserves were developed using the multidimensional landscape ecological approach, considering ecological, economic, and social aspects of the landscape. The district of Uttara Kannada was divided into 5x5 km grids, and each grid was assessed with several parameters like the presence of endangered species, priority habitats like TFSFs, IUCN red-listed species, corridor connectivity, etc., followed by economic and social aspects of conservation priority, which were also considered. With all these extensive assessments, four conservation reserves covering 414 sq km have been declared. With this process, the majority of major TFSFs habitats were included in conservation areas. However, many are also left out due to unavoidable situations of tradeoff between the conservation and development priority of landscape. The Snehakunja team was actively involved in declaring the other conservation reserves in the district with the support of the Western Ghats task force, which was executed by the state forest department. They include Bedti, Shalmala, Mundigekere and hornbill conservation reserves in Kali River basins.

Other activities involved aiming for the conservation of TFSFs are:

Community involvement – Swamp conservation committees established, involving representatives from the local community, Village Forest Committees (VFCs), and women's groups. This was to ensure long-term sustainability to the protection and management of the restored swamps. The capacities of the community members were strengthened to engage in restoration activities and participate in the overall forest governance processes.

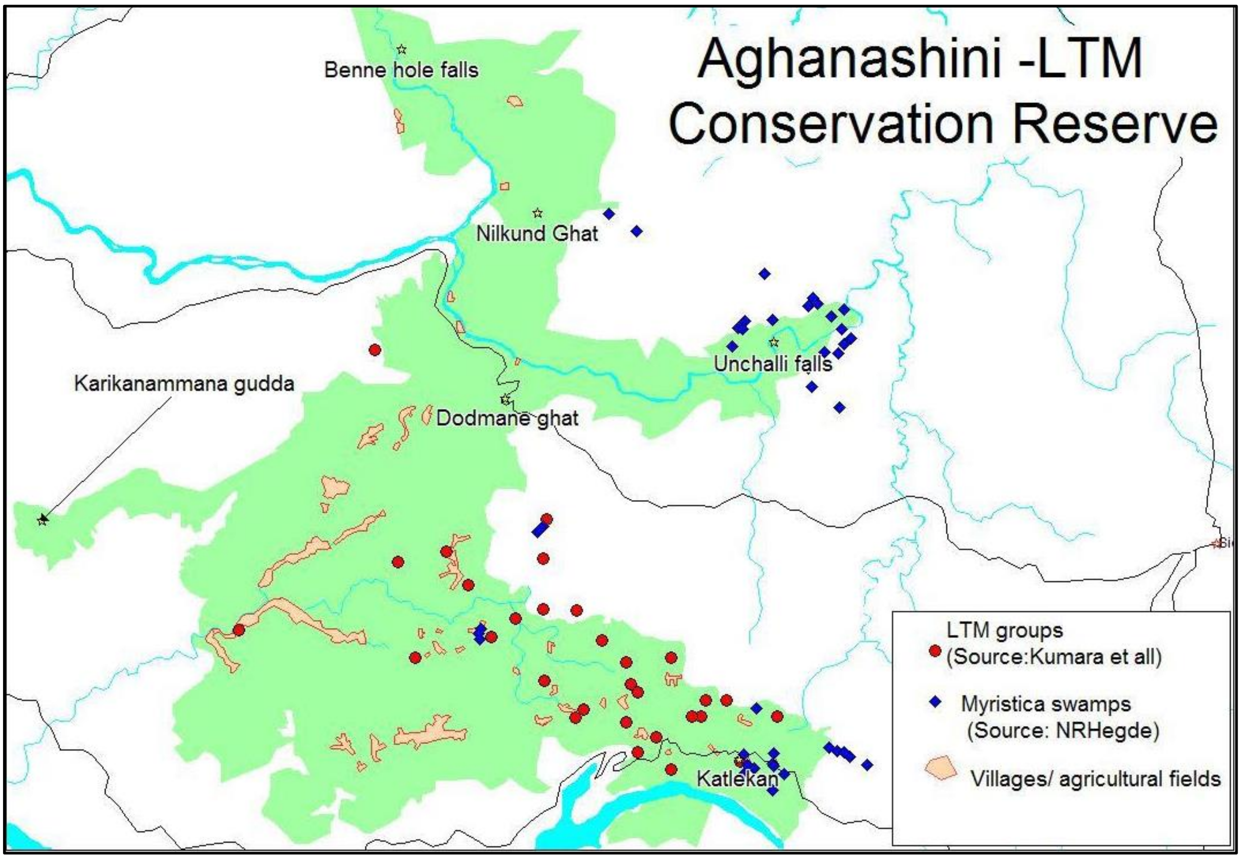


Fig 1. Map of Aghanashini LTM conservation reserve, many TFSFs included in the reserve

Conservation awareness – various workshops, training, and awareness campaigns conducted to amplify conservation awareness. Outreach materials in the form of brochures, handouts, community primers, popular articles, newspaper coverage, and publishing scientific papers in the peer-reviewed journals. Programs on all radios were also broadcast, focusing on the TFSFs.

Policy advocacy – information gathered was regularly shared with the Western Ghats Task Force and the state forest department, and finally the budget allocation has happened for the swamp protection, perhaps for the first time in the state forest department, involving the local village forest committees.

2. Objectives

1. Identifying and upgrading TFSF maps in the Western Ghats region of Karnataka and updating the information for swamps in the Uttara Kannada district for which a mapping exercise has already been done. Swamp categorization using ecological and social parameters and cost-benefit assessment to assess TFSF to be rehabilitated or restored and identify the most optimal lands for purchase to secure them—a comprehensive list of lands for sale, pricing, and possibilities of converting them into TFSF.
2. Participatory ecological restoration of degraded TFSFs in forest department-owned and community-owned lands in Uttara Kannada based on our previous study.
3. To understand the microclimate requirements of obligatory swamp ecosystem species. Develop a methodology for soil treatment protocol for swamps based on soil studies supported by this project.
4. Influence creation and expansion of Myristica specific budget head in the management plans of Karnataka Forest Department.

3.1 Activities and Outputs

5. **Objective 1:** Identifying and upgrading TFSFs maps in the Western Ghats region of Karnataka and updating the information for swamps in the Uttara Kannada district for which a mapping exercise has already been done. Swamp categorization using ecological and social parameters and cost-benefit assessment to assess TFSF to be rehabilitated or restored and identify the most optimal lands for purchase to secure them - comprehensive list of lands for sale, pricing, and possibilities of converting them into TFSF.

Activity 1.1: A comprehensive baseline survey to gather existing data on TFSF, including flora, fauna, and ecological conditions (**Time line: May 2024 to May 2025)**

Activity 1.2: Literature survey for the list of existing swamps in the different districts of Western Ghats of Karnataka apart from Uttara Kannada (**May to June 2024)**

Methods (and Activity 1.2)

- Previous studies, research reports, and restoration efforts were meticulously reviewed. Key sources included documents from the reports prepared by Snehakunja during previous projects, the Department of Forest, the Government of Karnataka, and field reports from the IISC Research Station, Kumta. Approximately 60 such publications were thoroughly reviewed to gather the valuable information.
- The field team comprises people with over 25 years of experience, direct involvement in conservation projects, and long-term ecological monitoring of swamps. Their observations and practical insights were integrated into the baseline dataset.
- All collected information, including research findings, field observations, and expert experiences, was systematically organized and documented. This included creating detailed inventories of plant and animal species, mapping ecological patterns, and highlighting site-specific restoration efforts.
- Consultation of frontline staff of the forest departments and local people of the selected forest regions. Various staff from the Department of Forest, Karnataka, were consulted during the course of project execution as part of the exploration of new swamps and swamp conservation efforts in Uttara Kannada (Sirsi, Siddapur, Yellapur, Kumta, Honnavar Taluks), Shimoga (Sagar, Tirthahalli, and Hosanagara) and Kodagu (Madikeri, Virajpet, Somvarpet taluks), Udupi (Karkala), Dakshina Kannada (Belthangadi), and

Chikmagalur (Sringeri).

Results/output:

Baseline

Planting activities in 2012 and learnings

The area was totally cleared, and land was filled with soil by cutting the edges of the ever-green forests, up to 6 to 7 feet in the middle part of the region, and a trench was made so as to drain the water to make it suitable for establishing the commercial areca orchard. No vegetation was left and as mentioned, the soil layers have been totally altered, and the area must have lost its resilience. In association with the state forest department, Snehakunja planted nearly 4577 plants belonging to 35 species. These seedlings are established by Snehakunja in the nurseries in Torme and planting done in the degraded swamp forests and in adjacent degraded forests. Annexure 5 presents details of the species and their growth patterns.

Here are a few observations based on our understanding of microclimate studies:

We have tried to increase the soil moisture at the restored site by constructing check dams. However, it had a limited impact on improving soil moisture and ‘soil restoration.’ A check dam was constructed to improve the soil moisture. Additionally, an irrigation system was installed using the pipe. However, the soil surface was changed, and there was no organic content in the soil. Barren open soil resulted in the establishment of pioneer species like Macaranga, and few other species. In Myristica swamps, at the driest time of the year, they need a minimum of 35% or more soil moisture, based on our initial observation. We need more data to suggest exact soil moisture for each swamp species. We have already installed microclimate loggers in selected swamps to understand this. (See objective 3)

Our observations and replanting of Gymnacranthera canarica and Myristica fatua var. magnifica

Since we have the planting details for the six sites in Kathlekan, we could not be able to distinguish the number of plants and species that survived exactly in the locations. Now the canopy cover has reached from 0 to nearly 70% in sites 1, 2 and 3. Canopy cover is more than 90% in site 4 and 5. Before planting, we have made a small artificial trench to allow the water to flow in the middle portion of the destroyed sites to allow some natural conditions, especially stagnant water and retention of soil moisture of TFSF. The orchard owner channeled the trench in the border of the entire excavated land and filled it with soil in the middle. We did it in the middle to mimic the swamp by allowing water to flow in the center.

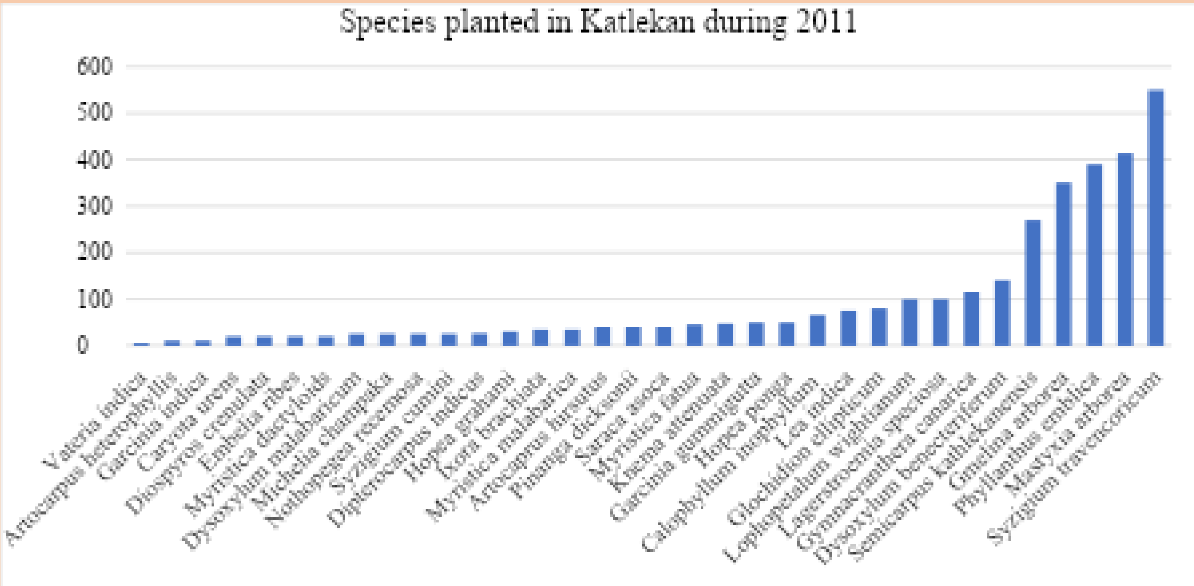


Fig 2: Species planted in Katlekan during 2011

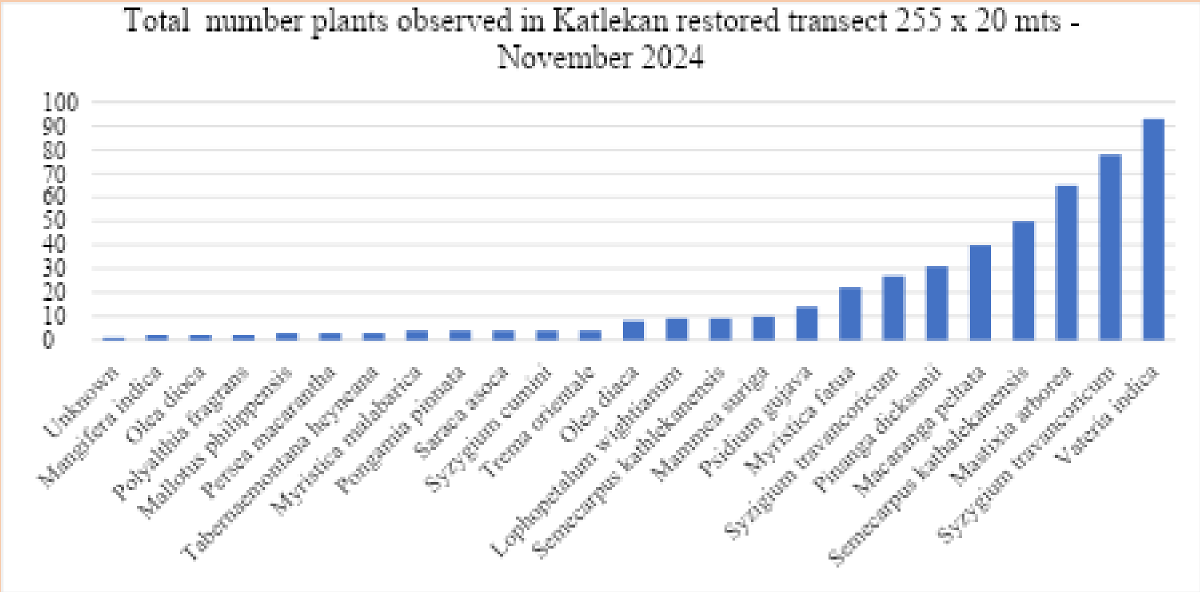


Fig 3: Number of plants observed in 255 mtr transect covering five restored sites of Kathlekan.

Detailed floristic composition studies were conducted in randomly selected swamps by running a line transect of 5 m breadth along the stream course of the selected swamp. The species that are indicators of habitat disturbances and others that are typical to swamps, such as those with specialized modifications for the swampy conditions, are treated as facultative and obligatory species, respectively. To enable the active participation of local villagers, decentralized nurseries were established close to the swamp through community participation for raising typical swamp-specific species as well as swamp-associated species.

Figure 4 indicates all species planted across Katlekan, and Figure 5 indicates the sampled 255 mtr transect across five places in restored swamps of Katlekan. However, this figure clearly indicates that more evergreen species are coming up than actual Myristica swamp species in restored swamps.

- These figures show the trend in succession. Pioneer species like *Macaranga peltata* which were established earlier are now dying, whereas swamp succession species like *Mastixia arborea, Syzigium travancoricum, Pinnanga dicksonii,* are established successfully. Though obligatory swamp species like *Gymnacranthera canarica* and *Myristica fatua* are not successful, there is a clear indication that succession towards more evergreen and later to swamp is possible, with suitable monitoring and management.
- It also indicates that there is a need to study other parameters like soil moisture, soil

nutrients and microbes. We are focusing on understanding these parameters through this project. We hope to complete the data collection this summer, before March.

- This suggests that evergreen species are more successful in establishing themselves. Survival of swamp obligatory species is dependent on soil moisture and soil restoration stages. We were not able to measure the lowest soil moisture in the restored sites as the project started only after June, 2024. We are hoping to measure the lowest soil moisture during March and April, 2025 to understand the soil moisture and survival rate of swamp species.
- Learnings from the previous conservation actions (this should include success and failures in the previous restoration work with data and results of community engagement)
- Active planting of degraded swamps with swamp and associated species was done during the period from 2010 to 2012. Each plant was tagged with a plate displaying a number and date of planting. These plants were observed for two years to document their survival and growth. Results of the belt transects in 5 sites at Kathlekan are presented in Annexure 5. In the completely degraded swamp forest (site 1), evergreen species are coming, and the *Macaranga peltata* trees are dying out. Here the topsoil was removed during 2009-10 to establish an areca nut orchard by a Kerala family who owns a restaurant at Mavingundi near Jog Falls. Obligatory swamp species have survived and new recruitment is happening in sites 4 and 5, where the disturbance was limited to cutting vegetation.

Table 1. Details of swamps in different river catchment areas.

	Sharavati	**Bedti**	**Aghanashini**	**Mukti**	**Bilgi**
Total number of swamps	15	22	29	23	18
Total area of swamp (depression part) in Ha	19	13	17	22	18
Number of swamps restored	6	5	0	2	1
Average area of swamp (Ha)	0.755	0.575	0.65	0.757	0.99
Minimum area (Ha)	0.5	0.4	0.1	0.25	0.4
Maximum area (Ha)	2.1	1.5	1.5	2	2

Table 2: List of stakeholders consulted

Sl. No.	Name of the officials	Designations
1.	Ajjayya K A (IFS)	Deputy Conservator of Forest Sirsi
2.	Vasantkumar Reddy (IFS)	Conservator Forest Canara circle, Sirsi
3.	Office of the Deputy Conservator of Forest	Madikeri, Kodagu
4.	Usha Kabber	Range Forest Officer previously Hulekal, Sirsi now Janmane, Sirsi
5.	Shivanad Lingani	Range Forest Office, Hulekal
6.	Subhash Malkhede (IFS)	PCCF wild life, Karnataka state forest division
7.	Ravishankar (IFS)	Deputy Conservator of Forests, Karwar
8.	Jayesh	Assistant Conservator of Forests, Ankola
9.	Pavitra	Assistant Conservator of Forests
10.	Shivaram (IFS)	Deputy Conservator of Forests Karkala wild life Division
11.	Mahesh Devadiga	Range Forest Officer, Kyadgi
12.	Office of the Range Forest Officer Kerekatte	Kerekatte, Chikmagalur
13.	Office of the Range Forest Officer, Amavasye Bayalu	Amavasye Bayalu, Karkala Forest Division
14.	Office of the Range Forest Officer, Belthangady	Belthangady, Dakshina Kannada

Table 3: Other networks established

Sl. No.	Name of contact person	Details
1.	Shivakumar Kodagu and Arun	From Kodagu, assisted in exploration new Elaeocarpus swamps in Kodagu
2.	Abhishek Jain	From Kodagu, assisted in exploration new Elaeocarpus swamps in Kodagu
3.	Subbanna Aneguli-	From Sagara, Shimoga. assisted in exploration

	Vrukshalaksha Andolana-	new TFSFs swamps in Shimoga
4.	Venkatesh Kavalukodlu	A group of medicinal plant growers and conservation enthusiasts, Sagara
5.	B H Raghavendra	
6.	Prakash Manchale	
7.	Bharatiya Sahasa Kendra, Honnemurudu	Honnemurudu, Talgiuppa, Sagara
8.	Mr Rajprasad	Conservation enthusiasts Karkala
9.	Mr Ramprasad and Ramachandra	conservation enthusiasts, proprietor Adavi nursery and retired deputy range forest officer
10.	Community members in Bedti catchment area	Design thinking workshop, 26 members
11.	Community members in Talakeri and Danmavu	Design thinking workshop, 31 members
12.	Parna Western Ghats Producer Company	Bedti river catchment

Literature survey

Myristica swamps are a type of tropical freshwater swamp forest predominantly composed of species in the family *Myristicaceae* (Krishnamoorthy 1960).

The family *Myristicaceae*, within the order *Magnoliales*, includes 18 genera and over 300 species. Of these, four genera—*Horsfieldia, Gymnacranthera, Knema, and Myristica*—and 16 species have been documented in India. The origins of this family, commonly known as nutmeg, are traced to regions like New Guinea and Africa-Madagascar, from where it has gradually spread throughout the tropical regions (Sharma and Armstrong 2013; Swetha et al. 2019).

Myristica species are the most primitive of the flowering plants on earth (Krishnamoorthy 1960). And they have primitive wood anatomy and primitive kind of pollen (Kuhn and Kubitzki, 1993).

They are typically water-tolerant trees with stilt and knee roots helping them stay erect in swampy environments. These unique roots also facilitate gas exchange. Additionally, their thin, moist bark and large leaves allow for rapid shedding of excess water. Most species in the *Myristicaceae* family exhibit similar characteristics; they are shade-tolerant evergreen trees with simple dark-green alternate leaves and contain a pinkish-red resinous sap in their bark

(Krishnamoorthy 1960). In Uttara Kannada first systematic study on swamps was undertaken by Chandran et al. (1999a) primarily from Siddapur taluk.

Identification and distribution

Krishnamoorthy (1960) first recorded Myristica swamps in Travancore, Kerala, in southwest India. These ancient swamp forests are endemic to the Western Ghats below 15.50° N latitude, and a smaller distribution exists in the Andaman and Nicobar Islands (Chandran et al. 1999a; Chandran and Mesta 2001; Nair et al. 2007; Tambat et al. 2007).

Myristica swamps are typically found in valleys and low-lying depressions in the evergreen forests of the Western Ghats and remain inundated with water throughout the year, especially from June through January. Swamp occurrence depends on non-biotic conditions, including valley shape (flat-bottomed or gently sloping) between heavily forested hills, deep soil with porous bedrock allowing for water storage, and slow continual water seepage into the valley throughout the year. Typically, these swamps occur in regions experiencing an average of 3000 mm rainfall per annum (Chandran et al. 1999a; Nair et al. 2007; Keshavachandra and Krishnakumar 2016).

Floral diversity

Studies indicate that at least 79 tree species, 26 shrub species, 27 climbers, and 44 herb species have been identified within and around Myristica swamps, though not all species are specific to these freshwater swamp ecosystems (Bhat and Kaveriappa 2009; Deepamol and Khaleel 2009; Prabhugaonkar et al. 2014). Over 60% of the tree species recorded in these unique habitats belong to the *Myristicaceae* family (Dharmapalan and Asokhan 2013). Among the *Myristicaceae* species found in India, five are present in the Western Ghats, with four of them endemic to this region. These endemic species include *Gymnacranthera canarica* (King), *Myristica fatua* var. *magnifica* (Bedd.) Sinclair, *M. malabarica* (Lam.), and *Knema attenuata* (Hook.f. & Th.) Warb. (Chandran and Mesta 2008).

Among the obligate swamp species, *G. canarica* and *M. fatua* have a widespread distribution across the states of Kerala, Karnataka, Goa, and Maharashtra (Naithani et al. 1997; Chandran et al. 1999b; Nair et al. 2007; Prabhugaonkar et al. 2014; Sreedharan and Indulkar 2018). In 2020, the swamps of Kerala saw the discovery of a new endemic species, *Myristica trobogarii*, described as unique to these habitats (Govind et al. 2020). Another significant tree species, *Syzygium travancoricum* (Gamble), was initially documented in the lowland swamps of Travancore in 1894. Other prominent species found in these swampy areas include *Dipterocarpus indicus* (Bedd.), *Mastixia arborea* (Wight), and *Pinanga dicksonii*

(Krishnamoorthy 1960; Mesta et al. 2008; Bhat and Kaveriappa 2009; Sringeswara et al. 2009; Roby et al. 2014a; Keshavachandra and Krishnakumar 2016).

One recently described and critically endangered species, *Semecarpus kathalekanensis* (Das.), has been documented in the central Western Ghats with a population density of about 11 trees per hectare in swamp areas (Dasappa 2000; Vasudeva et al. 2001; Ravikanth et al. 2004; Bhat and Kaveriappa 2009; Roby et al. 2013). While *S. kathalekanensis* is restricted to the northern Western Ghats of Karnataka and Goa (Prabhugaonkar et al. 2014), *S. travancoricum* is more widely distributed in the swamps of Kerala, Karnataka, and Goa (Bourdillon 1908; Gamble 1935; Chandran et al. 2008, 2010; Prabhugaonkar et al. 2014).

Other notable swamp tree species include *Lophopetalum wightianum* Arn., *Vateria indica* L., *Holigarna beddomei* Hook.f., *Hydnocarpus pentandrus* (Buch.-Ham.) *Xanthophyllum arnottianum* Wight, *Semecarpus auriculata* Bedd., *Kingiodendron pinnatum* (DC.) Harms, *Dipterocarpus bourdillonii* Brandis, and *Litsea travancorica* Gamble, among others (Dharmapalan and Asokhan 2013). These Myristica swamps exhibit significant floristic endemism, with studies identifying 23 tree species endemics to the Western Ghats in these habitats.

In the Andaman and Nicobar Islands, endemic species include *Myristica andamanica*, with *M. fragrans* also present but cultivated in inland evergreen forests (Banik et al. 2017). On North Andaman Island, *Myristica andamanica* is particularly prominent, comprising approximately 15% of the forest cover (Prasad et al. 2009).

Belief systems and swamps

Have studied on impact of traditional conservation practices, where they have realized that sacred swamps have significant diversity (122 plant species from 99 genera and 58 families), stem density (277 individuals/ha), and average basal area (47.57 $m^{2/ha)}$ when compared against the same parameters of non-scared swamps with 83 species from 72 genera and 47 families and stem density of 158 individuals/ha. Further this study also revealed that Sacred swamps have a higher number of endemic species (28%). Regeneration of swampy species is much better in sacred areas. The study concluded that, traditional belief system of treating the swamps as sacred has helped to protect these ecologically important forests. There also exist significant differences in the Shannon index of species diversity of amphibians and birds between sacred and to non-sacred swamps.

Hegde et al. (2020) studied on faith-based approaches for nature conservation through focus group discussions held with indigenous communities on ecological, sociocultural, and economic evaluations of the freshwater swamps with various local groups, through which they proposed faith-based governance as an effective tool and established that sacred swamps as an approach to livelihood preservation and nature conservation.

Traditional laws to be followed in sacred swamps such as i). Entry to the core area only during annual worship/rituals ii). Prohibition of tree, branch and twig cutting in the core area, iii). Prohibition of hunting, gathering and fishing iv). Prohibition of spitting, urinating, and any kind of activity that pollutes the water body while harvesting is allowed only in the buffer zone, and only by the belief group (Hegde et al., 2017).

Hegde et al., (2017) assessed 110 freshwater swamps, of which 11 are sacred swamps. Among the assessed parameters are size and shape, distance to the nearest road, human settlement, and commercial orchard, and population density. The study revealed that sacred swamps in Uttara Kannada significantly smaller, shorter in length, and more compact than non-sacred swamps; they are ecologically diverse with more canopy percentage, and they are near to human settlements, roads (tar and mud) and arecanut orchards.

On the other side, the distance of sacred swamps, human settlements, roads (tar and mud) and arecanut orchards is significantly smaller than that of non-sacred swamps, indicating substantial human pressures against the sacred swamps (Hegde et al., 2017).

Visioning workshops on sacred swamps in the Western Ghats (India) and their role for both freshwater swamp protection and livelihoods (Hegde et al. 2023) highlighted the need for more participatory forest governance, providing space for shared value creation, and also the need for further research on inter-faith nature conservation possibilities, along with innovations on value addition and value chain development for livelihood promotion and protection.

Impacts/threats

The Biodiversity Act of 2002 by the Government of India designates vital biodiversity regions, including Myristica swamps, as Biodiversity Heritage Sites. Despite this, site-specific conservation actions are still needed from the state forest department and the Karnataka State Biodiversity Board, as a majority of these swamps are located in Karnataka (Dudani et al. 2014). Reserve forests, sacred groves, and community conservation areas, where many of these swamp habitats exist, do not provide adequate protection against land conversion. This is especially concerning given the potential for these lands to be drained for hydel projects or repurposed into agricultural fields for crops such as paddy, or plantations for teak and arecanut (Chandran and Mesta 2001; Das et al. 2006; Vijayakumar and Vasudeva 2011).

The swamp ecosystems of the Western Ghats are highly fragmented and isolated today (Das et al. 2006). For instance, Ramesh et al. (1997) documented the existence of remnant Myristica swamps within Reserve Forests adjoining Shendurney Wildlife Sanctuary and Peppara Wildlife

Sanctuary in Kerala's Agasthyamalai region. These swamp patches are now surrounded by eucalyptus and teak plantations, and it is probable that the area of swamp has further declined due to increased plantation activity (Ramesh et al. 1997).

A recent study employing ecological niche modelling tools indicates that swamp-dependent species, such as *Gymnacranthera canarica* and *Myristica fatua* var. *magnifica* could face up to a 7% loss in suitable habitat under projected climate change scenarios (Priti et al. 2016). The partitioning of Myristica swamp forest ecosystems has led to significant habitat fragmentation, resulting in both diminished natural habitats and stable populations, which threatens population viability. Such fragmentation instigates changes in vegetation patterns and increases vulnerability to extinction events (Madhavan and Shaju 2024).

Urbanization, combined with both anthropogenic and natural factors, has divided these swamps into fragmented, remnant patches, which affects functional dynamics by altering their size, shape, and degree of isolation. This fragmentation introduces variability in space and time, thereby impacting the resilience and biodiversity of these unique ecosystems (Madhavan and Shaju). Similar to the floral plateaus (lateritic plateaus) of the northern Western Ghats and the shola-grassland mosaics, Myristica swamps face a significantly higher risk of destruction compared to other evergreen forest types. Freshwater swamps are designated as "ecologically sensitive areas," denoting regions that are biologically rich, unique, valuable, and largely irreplaceable if destroyed. These swamps are unique due to the rare ecological systems they support and the critical services they provide to society. Commonly classified as "unique evergreen regions," many Myristica swamps remain outside India's Protected Area (PA) network, although some swamps in Kerala and Karnataka are situated within protected forest landscapes (Nair et al. 2007).

Research on land use change in Uttara Kannada district demonstrates a substantial decrease in wet evergreen forest cover (including Myristica swamps), declining from 67.73% in 1973 to 32.09% in 2013. This loss is primarily due to human activities, such as converting the land to teak and acacia plantations, among other uses (Ramachandra et al. 2016). Studies in Uttara Kannada also reveal that 17 out of 51 monitored swamps are under threat of extinction due to conversion to agricultural use. This issue is particularly severe in the Sirsi and Honnavar divisions, where swamps have been drained for horticultural expansion (Ramachandra et al. 2016).

The diversion of water resources for plantation irrigation and construction of check dams has severely impacted certain Myristica swamps. These swamp-dwelling trees, which have adapted to survive in perennially flowing waters, are at risk due to these changes in water availability

(Tambat et al. 2012). Draining swamps has negative consequences for ecosystem balance and hampers the regeneration of specialized swamp species. Chandran and Mesta (2008) found that draining swamps results in higher surface water runoff, causing floods and erosion downstream during monsoon seasons and leaving dry streambeds during the rest of the year. Reduced soil water absorption and retention also lead to declining soil quality, which impacts surrounding agriculture (Chandran and Mesta 2008).

The excessive exploitation of swamp ecosystems, particularly through the collection of non-timber forest products (NTFP) and medicinal plants, has further degraded the remaining Myristica swamps (Hegde et al. 2017). *Myristica fragrans* is widely cultivated for its seeds and mace, used in spices and traditional medicine (Bose et al. 2008; Arumugam et al. 2019). Essential oils derived from *M. fragrans*, such as myristic acid and myristicin (a narcotic), also have economic significance (Banik et al. 2017).

In addition to culinary uses, mace from *M. fragrans* serves as a dye source, and species such as *M. malabarica*, *M. andamanica*, and *M. beddomei* are valued in traditional medicines (Zachariah et al. 2008; Arunachalam and Subhashini 2011; Manjunatha et al. 2011; Swetha et al. 2019). Historically, these species were harvested for timber, once used in the matchbox industry (Bose et al. 2008). Seeds of *G. canarica* are also commonly utilized in making soaps and candles (CSIR 1956; Banik et al. 2017)

Elaeocarpus swamps

The genus Elaeocarpus belongs to the family of Elaeocarpaceae with a worldwide distributed species population of around 360. Among them, 25 species belonging to Elaeocarpus genus have been categorized as vulnerable, endangered and critically endangered by the International Union for Conservation of Nature (IUCN) (Soorangkattan et al, 2021).

The genus *Elaeocarpus* is primarily found in tropical and warm regions of the Old World, with the exception of Africa. Globally, this genus comprises approximately 350 species (Mabberley 2008). India hosts 33 species of *Elaeocarpus*, of which 10 are endemic (Murthi 1993). Notably, around 80% of these endemic species are concentrated in the Western Ghats, including four that are steno-endemics: *Elaeocarpus blascoi* Weibel, *E. gaussenii* Weibel, *E. recurvatus* Corner, and *E. venustus* Bedd.

Elaeocarpus venustus Bedd. is a steno-endemic and endangered species that is restricted to the Agastyamalai Biosphere Reserve (Irwin et al. 2013). *E. venustus*, first collected and described by Beddome in 1872 from Muthukuzhivayal, *E. venustus* remains highly localized in its distribution, restricted to a few swampy areas within this reserve.

Previously assessed by Nayar and Sastry (1990) for the first time by *Elaeocarpus venustus* Bedd.

And it was regarded as one among the vulnerable categories by IUCN and considered as endangered by the Red Data Book.

Elaeocarpus venustus has most recently been assessed for The IUCN Red List of Threatened Species in 2021. *Elaeocarpus venustus* is listed as Critically Endangered under criteria B1ab (iii,v) (Gole, 2021). *Elaeocarpus venustus* is a medium-sized tree narrowly restricted to Agasthyamalai Biosphere Reserve. It grows in high altitude swamps of Southern Western Ghats and shows ecological adaptations for surviving in seasonally flooded freshwater swamp habitats (Gole, 2021). It is presently known only as a single location and has an area of occupancy (AOO) of 24 km^2 and an extent of occurrence (EOO) of 59.8 km^2. The area is included within Kalakad Mundanthurai Tiger Reserve, but landscape level changes by dams, private plantations, and construction of roads are leading to habitat fragmentation and decline in habitat quality. It is assessed here as Critically Endangered (Gole, 2021). *Elaeocarpus venustus* is a narrow endemic tree species restricted to the Southern Western Ghats. It occurs in Chimunji, Muthukuzhivayal, Upper Kodayar and nearby areas of Kalakkad Mundanthurai Tiger Reserve (a part of Agasthyamalai Biosphere Reserve) in Tamilnadu state, India (Gole, 2021). *Elaeocarpus venustus* is a steno-endemic and Critically Endangered tree species of the Agasthyamalai Biosphere Reserve, southern Western Ghats, India (Ramasubbu et al., 2024).

Irwin et al. (2013) investigates the ecology, population status, regeneration, and threats facing *Elaeocarpus venustus* Bedd., a rare and endangered tree species endemic to the Agasthiyamalai Biosphere Reserve in the southern Western Ghats, India. Using GPS and ArcGIS software, they mapped eight highly fragmented population sites of *E. venustus* covering about 9 hectares in Kanyakumari District, each separated by 3–8 km and limited to elevations of 1250–1500 meters in swampy areas. Further the distribution pattern of *Elaeocarpus* species across India is also outlined, with a notable concentration in the Western Ghats, where 16 species occur, including 8 endemics. Ganesan (2002) classified *E. venustus* swamps into three types: (1) Open swamps bordered by *E. venustus*, (2) Swamps with monospecific stand of *E. venustus*, and (3) Mosaics of primary forest vegetation and swampy vegetation.

Irwin et al. (2013) reported a total of 181 saplings across the region, with 180 confined to a single site, indicating poor regeneration across most areas. Approximately 64% of the recorded stems were mature, but the limited number of saplings points to low seed germination and poor seedling establishment, especially in disturbed habitats.

Irwin et al. (2013) reported association of *Elaeocarpus venustus*, its swamp habitat with species such as *Aglaia bourdillonii*, *Calophyllum austroindicum*, and *Myristica dactyloides*, among others. This limited distribution and low regeneration rate highlight the conservation urgency for

E. venustus, especially in light of anthropogenic impacts that continue to fragment its habitat. Natural regeneration of *Elaeocarpus* is not viable due to intrinsic factors like low fruit set, low seed viability, prolonged seed dormancy (up to 2 years), hard seed coat, and poor seed dispersal ability (Baruah et al. 2018; Khan et al. 2005).

Conservation efforts

Efforts are being made at the local level to conserve and restore these ecosystems, particularly in Kerala and Karnataka. Some swamps in these regions are part of community conservation initiatives, such as sacred groves and reserve forests, which aim to protect these habitats from further degradation. However, the success of these efforts is contingent on better coordination between government agencies, local communities, and conservation organizations (Chandran and Mesta 2001).

Activity 1.3: Identification of unexplored swamps using RS&GIS – (May 2024 to April 2025)

Methods

Exploring new swamps involved various approaches. One key strategy involves extensive field expeditions combined with close consultation and interaction with local communities. We attempted modelling to predict potential TFSFs by analysing their ideal conditions. This includes factors such as geography, elevation, hydrology, vegetation patterns, and land use types. By integrating diverse datasets with remotely sensed data, we aim to predict and identify promising sites more effectively.

We tried to prepare exploratory maps of swamps based on existing information. We have used bioclimatic data from freely available data sources, like the Worldclim data source. (https://www.worldclim.org/data/bioclim.html). The predictive map was prepared using Maxent software. Geo coordinates of already documented locations of Myristica swamps were used along with the bioclimatic data extracted from the Worldclim web page. We determined the minimum and maximum temperature as well as the amount of rainfall. The R package dismo was used for developing maps.

For Myristica swamps were predicted in lower elevation forests across the Karnataka Western Ghats.

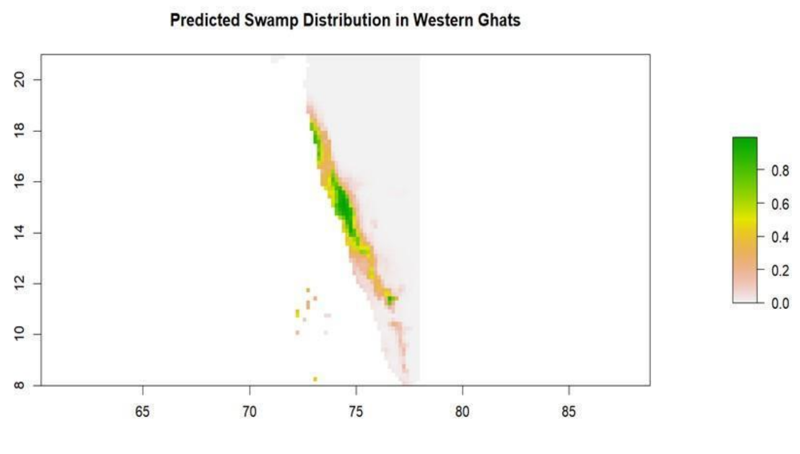


Fig 4: Predictive distribution of Myristica swamps across the Western Ghats; map

prepared using Maxent and R code.

For preparing predictive maps for the Elaeocarpus swamp area also we have used the data from our data of existing Elaeocarpus locations.

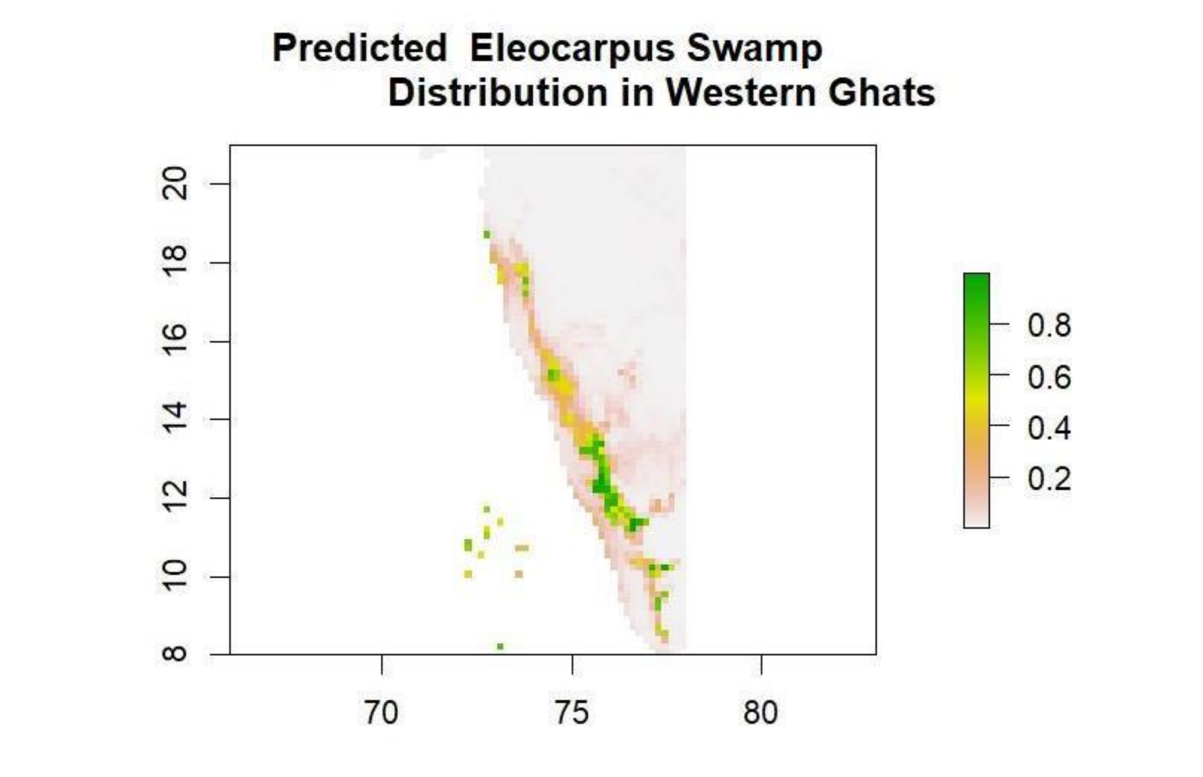
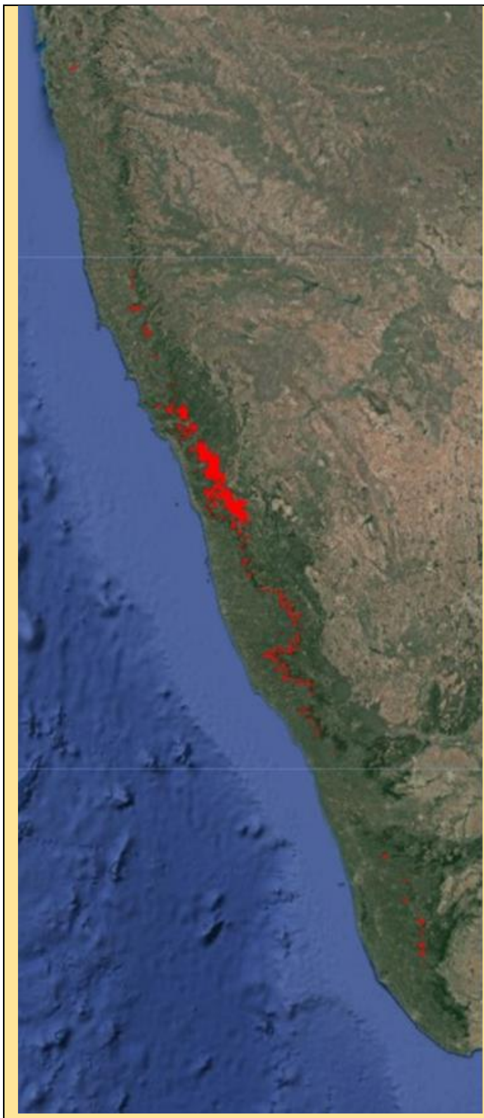


Fig 5: *Elaeocarpus* is predicted to occur at places around Chikmagalur, Coorg district. Though there is one grid in Uttara Kannada district that predicts the location for E*laeoca*rpus swamps, our initial survey did not find any information about *Elaeocarpus* species in the location.

The Google Earth Engine is also used to make a possible distribution map of Myristica swamps. Rainfall, altitude, and temperatures were used for making this map using Google Earth Engine. Data was used from freely available sources like the USGS webpage.

We have also utilized several additional modelling approaches. However, with the existing open-source data, the prediction seems to be coarser.



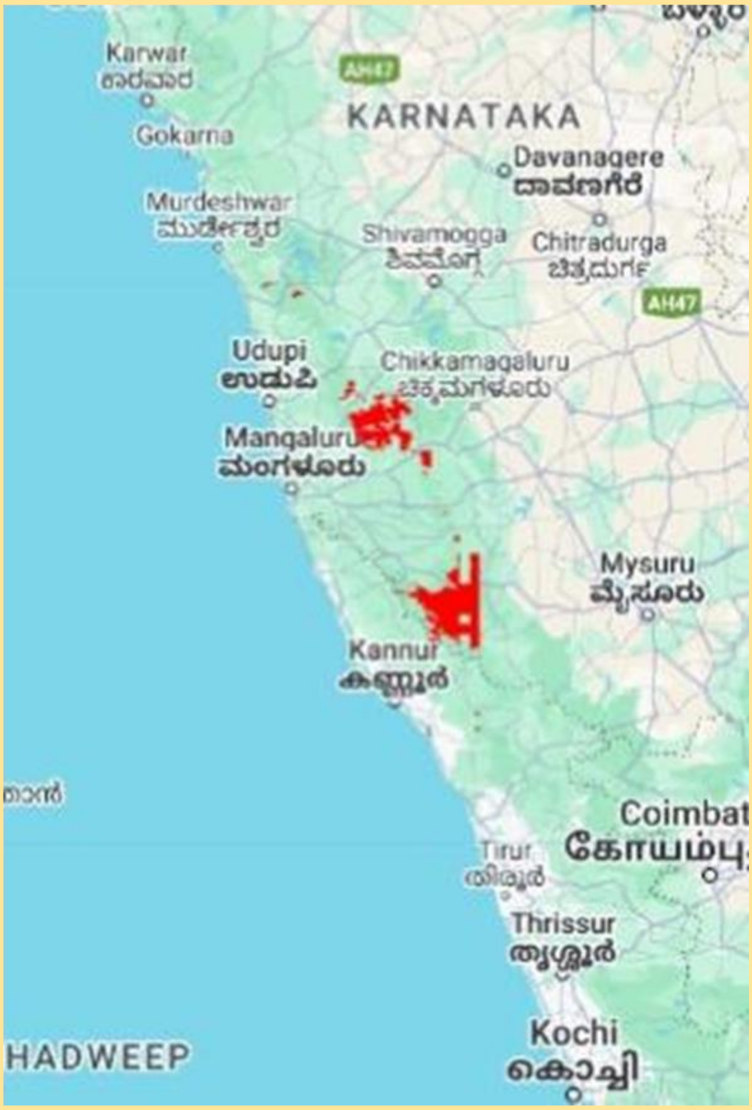


Fig 6 and 7: Possible distribution of Myristica swamps and *Eleocarpus* swamps map prepared using GE.

The above figure (4 to 7) shows the newly identified Myristica swamps across the Western Ghats of Karnataka.

Although these predictive maps suggest possible locations, we require additional field data regarding the actual prerequisites of the swamps, such as microclimate data. Furthermore, there is a need to include hydrological features like catchment areas and flow data in the model for better results.

Although our current efforts are in the early stages, we are experimenting with multiple approaches to refine our prediction models. We remain committed to developing robust and We expect reliable methodologies to emerge in the near future, which will ensure significant advancements in the identification and conservation of swamp ecosystems.

We have consulted Dr Girish Pujar, senior scientist at NRSC and ISRO and Pradeep G, expert in remote sensing, in this regard.

Results/Outputs:

Eleven swamps in Uttara Kannada, seven in Kodagu, eight in Shivamogga, and two each in Dakshin Kannada, Udupi and Chikmagalur, totalling thirty-two new swamps, were identified and mapped. Garmin handheld GPS (eTrex 10) was used for recording the geocoordinates. Names, geocoordinates, area, and forest range details are provided in Annexure 1a, 1b, 1c, 1d, 1e, and 1f.

District-wise TFSF maps were provided in the following maps, which are also updated in Figures 8a and b, 9, 10 and 11.

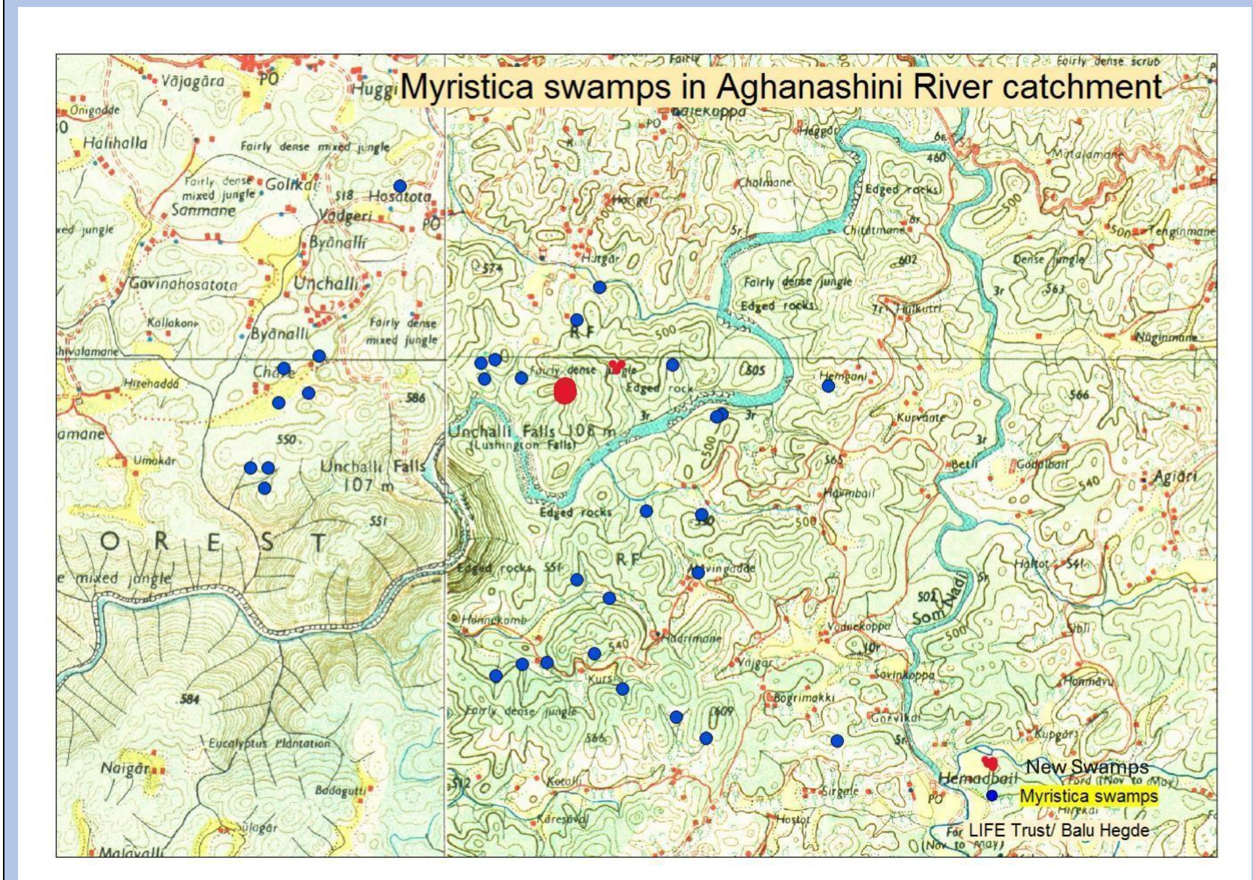


Fig 8a: New Myristica swamps in Aghanashini catchment.

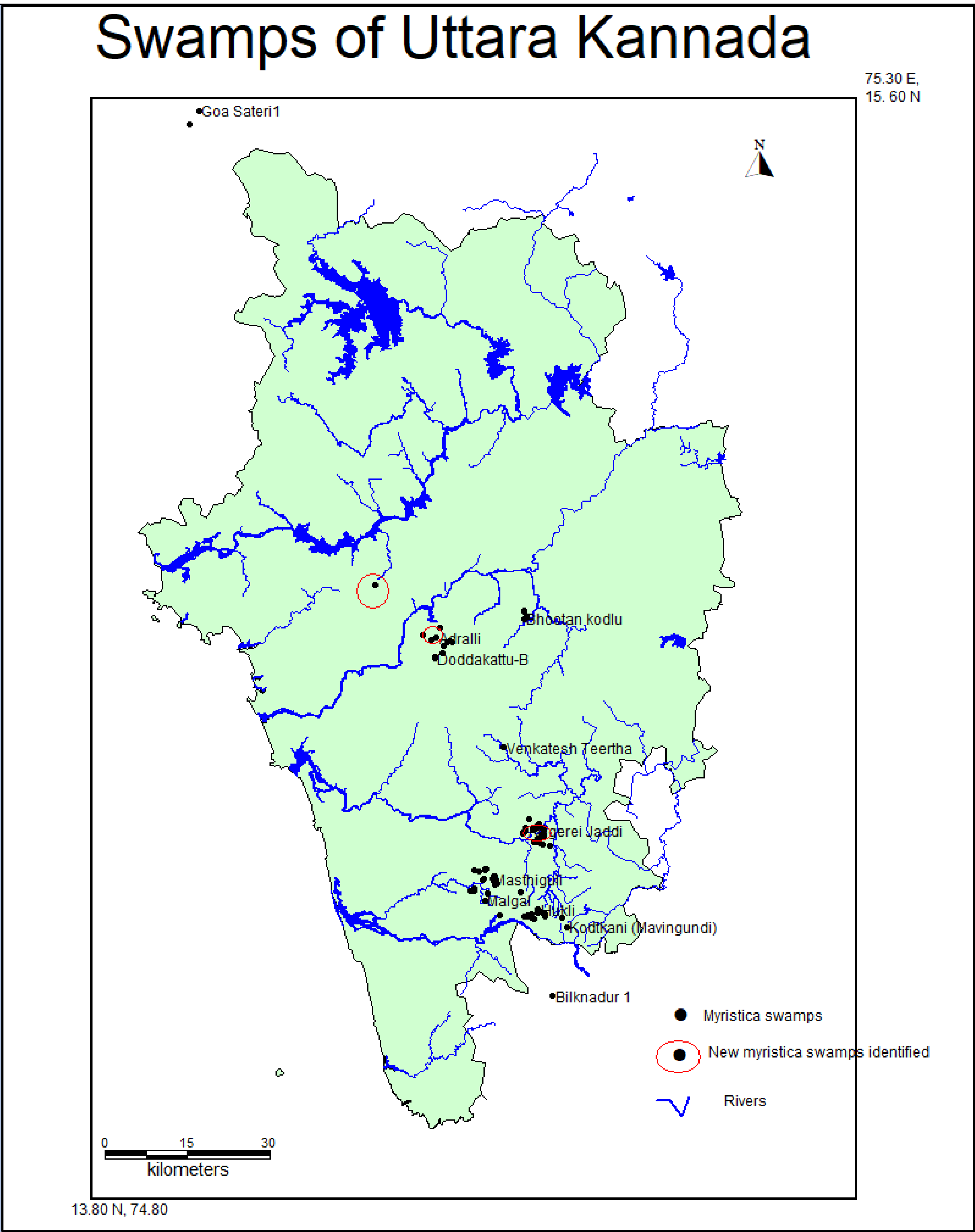


Figure 8b: Map showing all Myristica swamps, including the new ones

New swamp areas were marked in red circles. Detailed maps of the new TFSFs are shown as separate catchment maps.

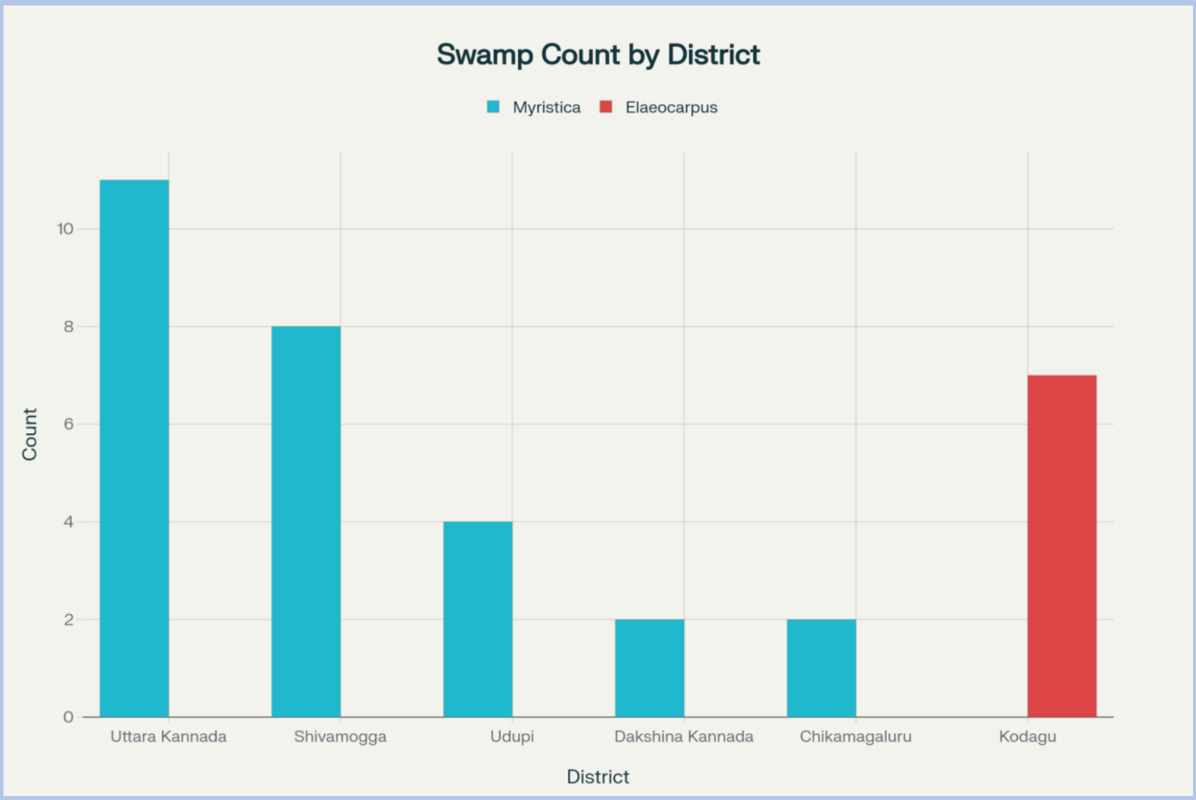


Fig. 9 Distribution of Myristica and Elaeocarpus swamps across districts

A bar chart comparing swamp distribution reveals that the majority of newly explored Myristica swamps are concentrated in Uttara Kannada (11), followed by Shivamogga (8), with smaller numbers in Udupi (4), Dakshina Kannada (2), and Chikamagaluru (2); meanwhile, all Elaeocarpus swamps (7 in total) are found exclusively in Kodagu. This highlights the geographical preference and ecological separation between these two swamp types, with Myristica favoring the coastal and upland districts and Elaeocarpus restricted to Kodagu. The highest count of Myristica swamps is in Uttara Kannada (11), indicating a potentially richer habitat. It's also a result of our more extensive exploration efforts here in Uttara Kannada.

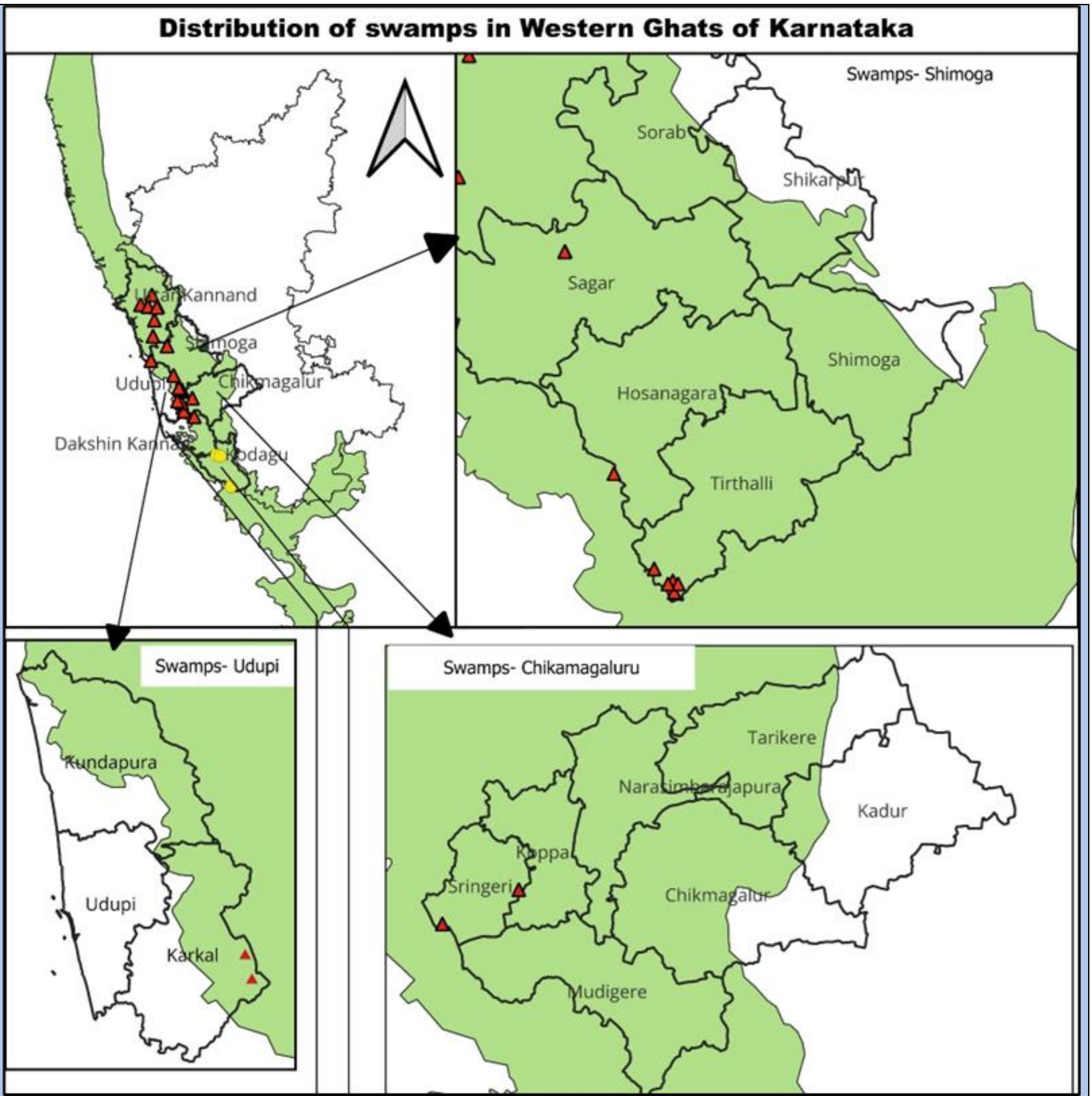


Fig 10a: Distribution of swamp across different districts (Shimoga, Udupi, Chikamagaluru) of Western Ghats

*****Red-filled triangles indicate the new swamp identified

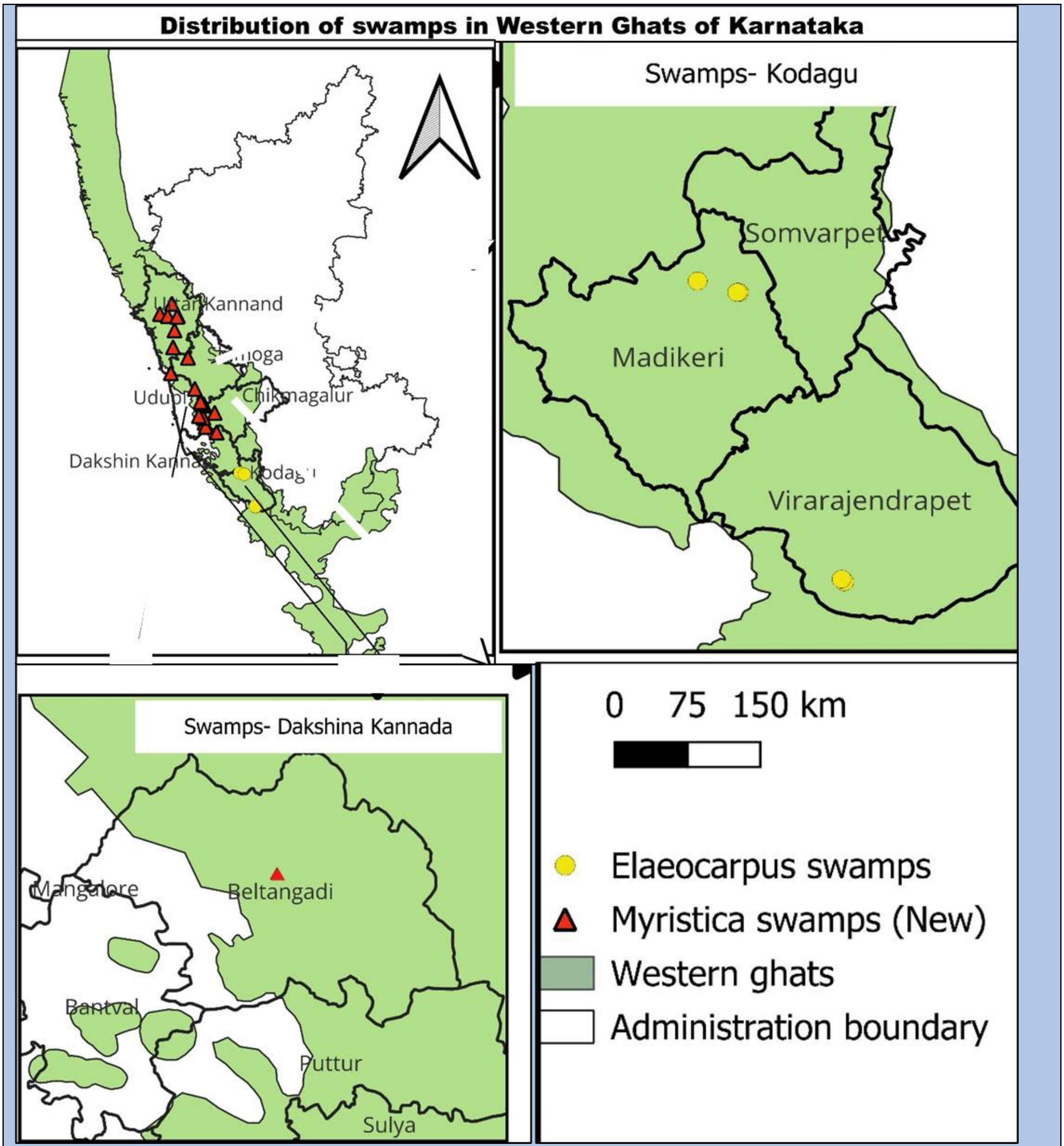


Fig 10b: Distribution of swamp across different districts (Shimoga, Udupi, Chikamagaluru) of Western Ghats

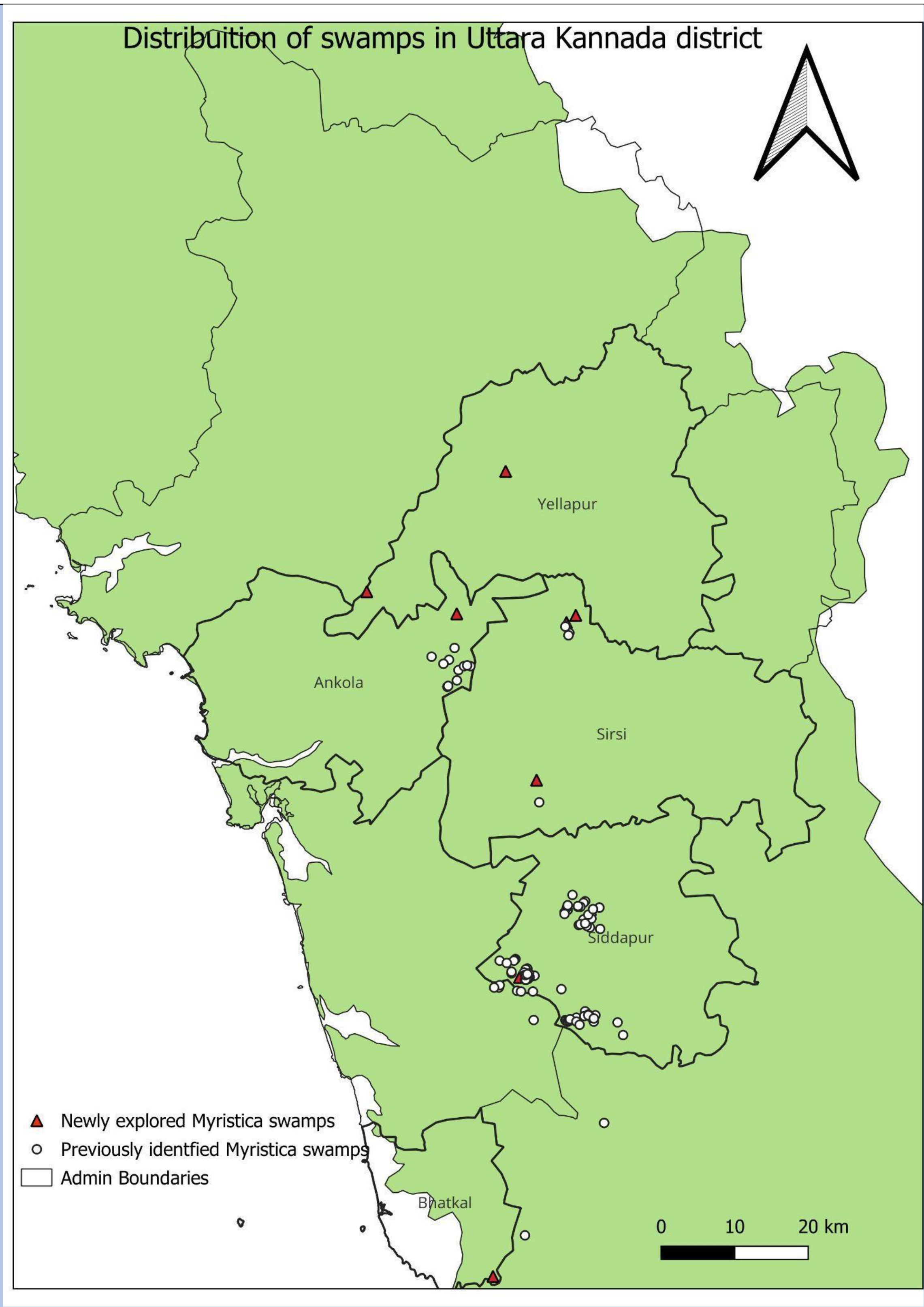


Fig. 11. Distribution of tropical freshwater swamps in Uttara Kannada district

Activity 1.4 – Conducting ecological surveys to assess the biodiversity, vegetation, and hydrological features of the swamps **(May 2024 to April 2025).**

Activity 1.5 - Analysis of social parameters by engaging local communities in participatory assessments to understand their dependence

Activity 1.6 - Swamp categorization based on various parameters

(These activities are clubbed, because of interlinkage between them also to avoid duplication and overlap of the information.)

Results/Outputs

- We compiled a comprehensive species checklist after conducting an extensive ecological assessment of thirty-two different swamp sites and analysing previously gathered data. This checklist details the diversity of swamp species observed across the study areas. The data has been organized to highlight various categories of species, including obligatory swamp species, associated species, and evergreen species.

Species diversity in Uttara Kannada, Shivamogga, Udupi, Chikamagaluru, Dakshina Kannada and Kodagu

- Annexure 2a presents the species checklist for the Uttara Kannada region, along with a detailed breakdown of obligatory swamp species, associated species, and evergreen species. Annexure 2b presents the corresponding list of species for the Kodagu region, which includes the same categories.

Growth data and additional measurements

- In addition to the species list, growth data such as girth and height measurements were systematically recorded in the 32 swamp sites. This growth data offers advantageous information regarding the health and development of the species across different sites. The complete set of species checklists, along with the growth data, can be accessed in Annexures 2b and 5, providing a detailed view of the diversity and development of the swamp species in these regions.

- The following figures show the growth, basal area, diversity indices, and species richness in all the plots.

- These plots also provide information about similarities and differences among the swamps across the landscapes.

Analysis of different vegetation parameters

Area sampled in each swamp sites

The swamp sites sampled show a considerable range in area, from just 500 sq. m. in the smallest Katlekan restored swamps to 10,800 sq. m. for Torme, with an average of 2631.03 sq. m. across the 29 sites and a total surveyed area of 76,300 sq. m.

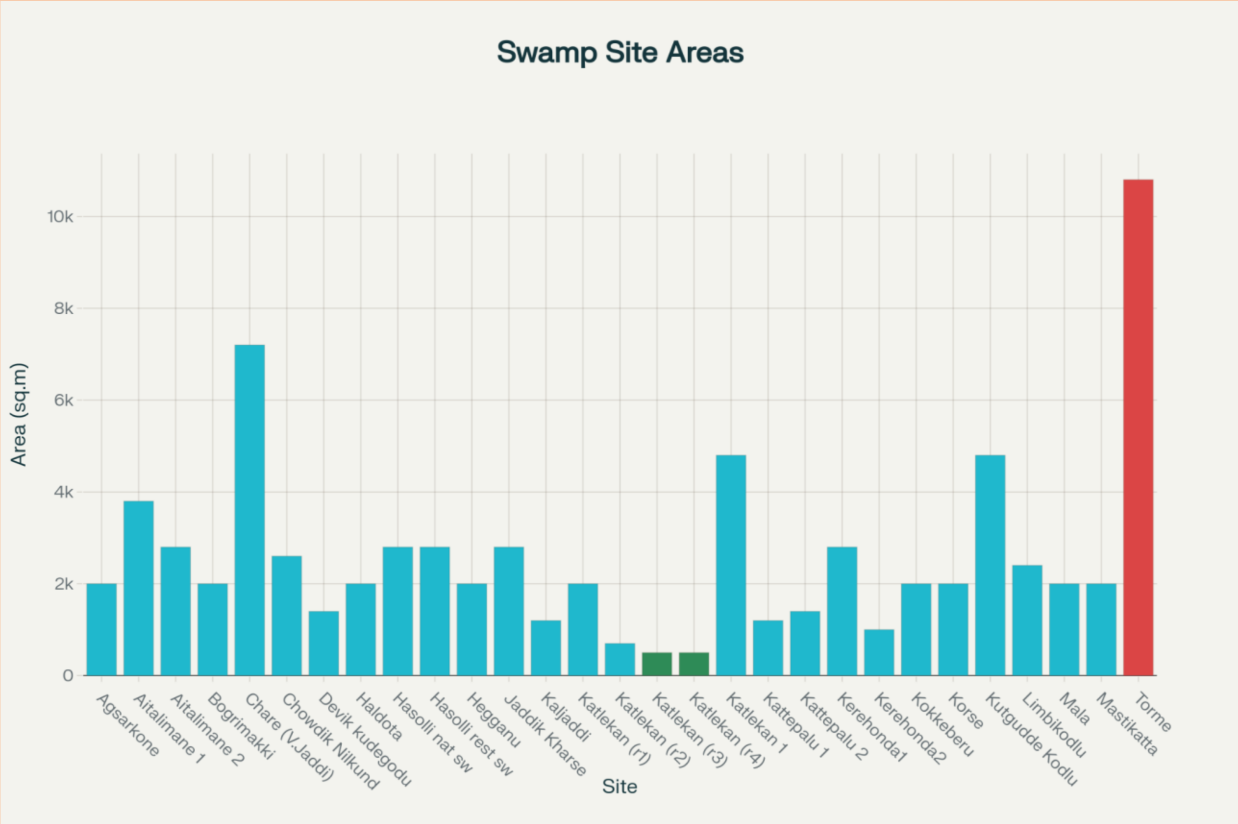


Fig 12a. Bar chart of sampled area (sq. m.) by swamp site

- The largest area sampled is at Torme (10,800 sq. m.), significantly above average and standing out as an outlier.
- The smallest sites are Katlekan (restored 3 and 4), each with only 500 sq. m., representing the minimal scale of selected restoration plots.
- Most swamp sites (such as Bogrimakki, Hegganu, Kokkeberu, Mala, and Mastikatta) cluster around 2,000 sq. m., suggesting a standardization in plot size for sampling purposes.

Density of plants

Plant density across swamp sites averages 1521 plants/ha, with the total for all sites combined reaching 44,107 individuals. This indicates that these swamps are, on average, highly dense ecosystems compared to many other tropical forest types. The highest density is recorded in the Hasolli natural swamp (3550 plants/ha), showing vigorous natural regeneration and structural maturity. Similarly, Katlekan 1 (2310 plants/ha) and Kerehonda 1 (3261 plants/ha) represent highly crowded stands. On the other extreme, very sparse densities are seen in Torme (167 plants/ha) and Kutgudde Kodlu (290 plants/ha), suggesting either smaller swamp fragments or degraded systems (Fig. 12).

Interestingly, several restored swamps (Katlekan restored 2–4) show high densities (1986–2420 plants/ha), which suggests that plantation or regeneration efforts have successfully established individuals. However, without corresponding basal area and biomass growth, these sites may represent younger, thinner stems, not yet ecologically comparable to natural swamps. Thus, while the average density across sites is high, density alone does not reflect ecosystem maturity or function — it must be interpreted in conjunction with structural parameters.

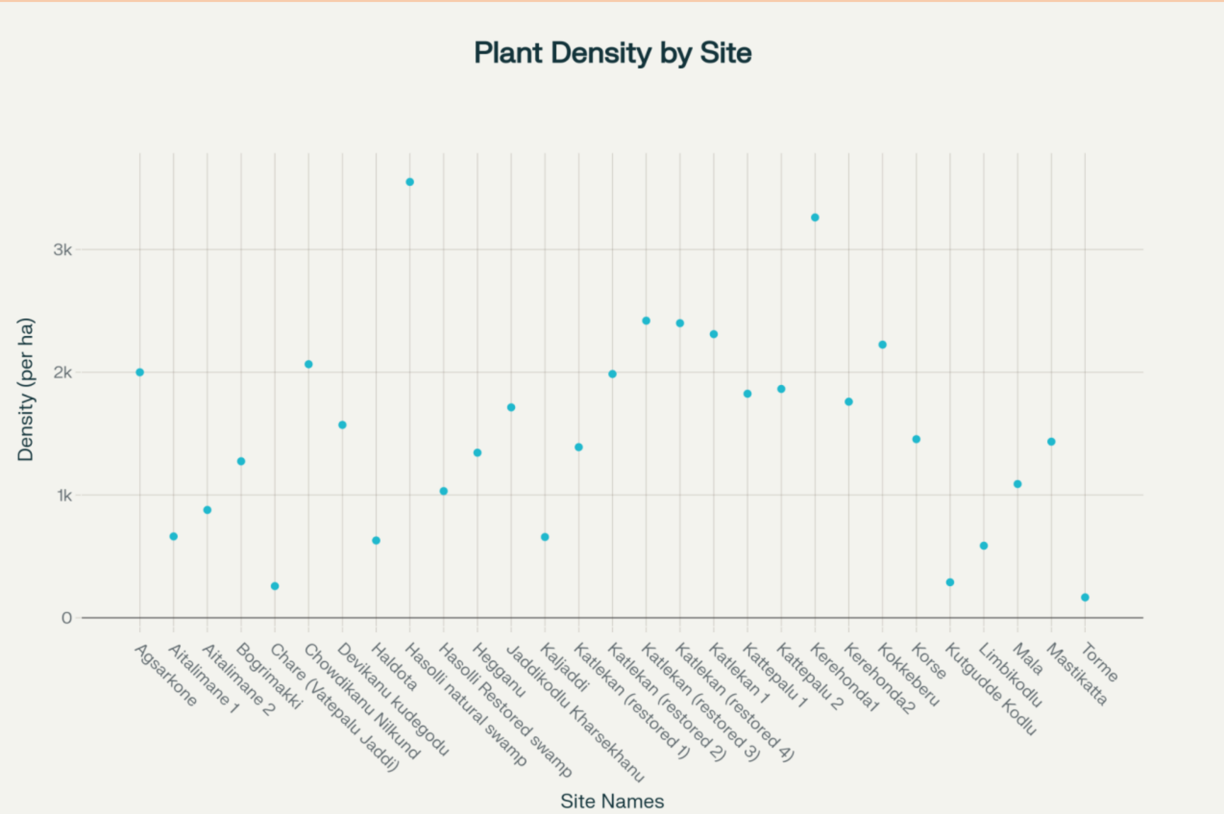


Fig 12b. Variation in plant density per hectare across different swamp sites

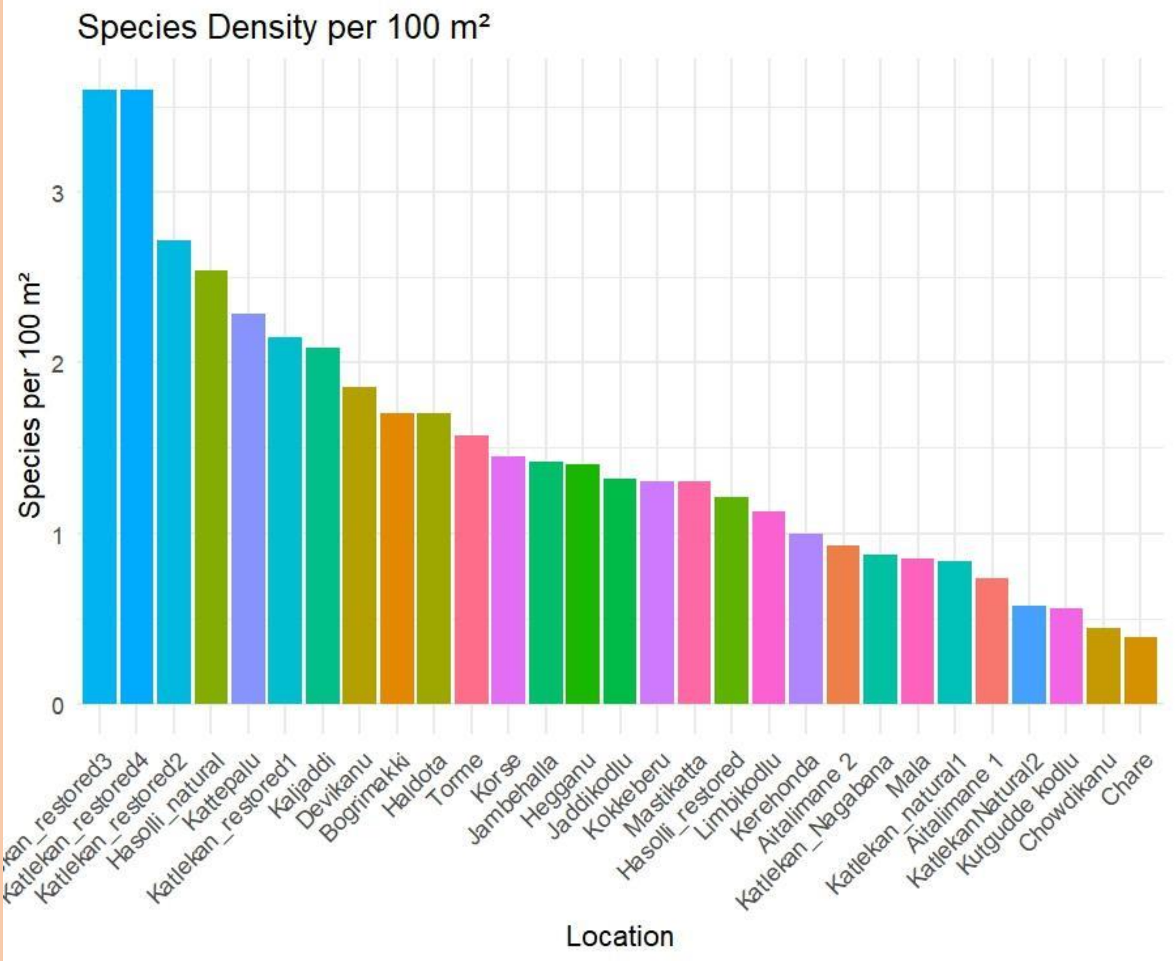


Fig 13. Species density per 100 square meter area in different swamp sites

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Basal Area (m²): (expressed for site)

The average basal area (Fig. 14) across all sites is 153 m², with a total of 4447 m² summed over all swamps. This value reflects an overall structurally significant set of ecosystems, but the variation among sites is striking. Natural swamps have higher basal areas than restored sites, with Hasolli natural swamp exhibiting an exceptional 868.4 m² and Katlekan 1 following with 559.6 m², both indicative of highly mature, old-growth swamp systems. These sites act as the structural backbone of swamp biodiversity and carbon storage.

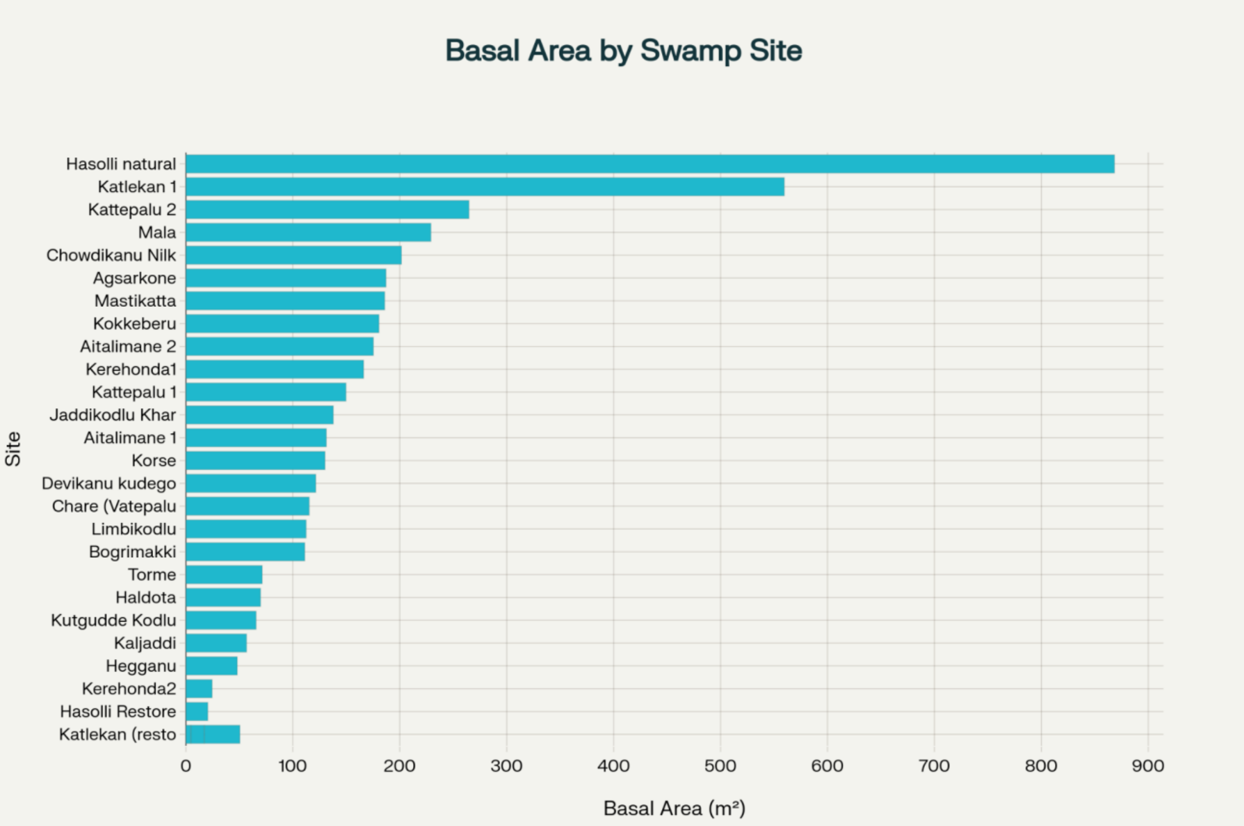

Fig 14a. Total basal area (sq. m.) of different swamps

The average basal area across all sites was 152.91 sq. m., and the total for all sites combined is 4434.25 sq. m. In contrast, restored sites exhibit very low basal area despite high densities. For instance, Katlekan restored 2 has 1986 plants/ha but only 4.7 m^2 basal area, while Katlekan restored 3 and 4 are similarly underdeveloped (12–13 m^2). Even Hasolli restored swamp, though moderately dense (1032 plants/ha), has only 20.5 m^2 basal area. This reinforces that restored swamps, although numerically well-stocked, consist mostly of juvenile trees that have not yet contributed significant girth or canopy structure. The contrast between the average (153 m^2/ha) and extreme values (868.4 vs. <5 m^2) underscores the ecological maturity gap between natural and restored sites.

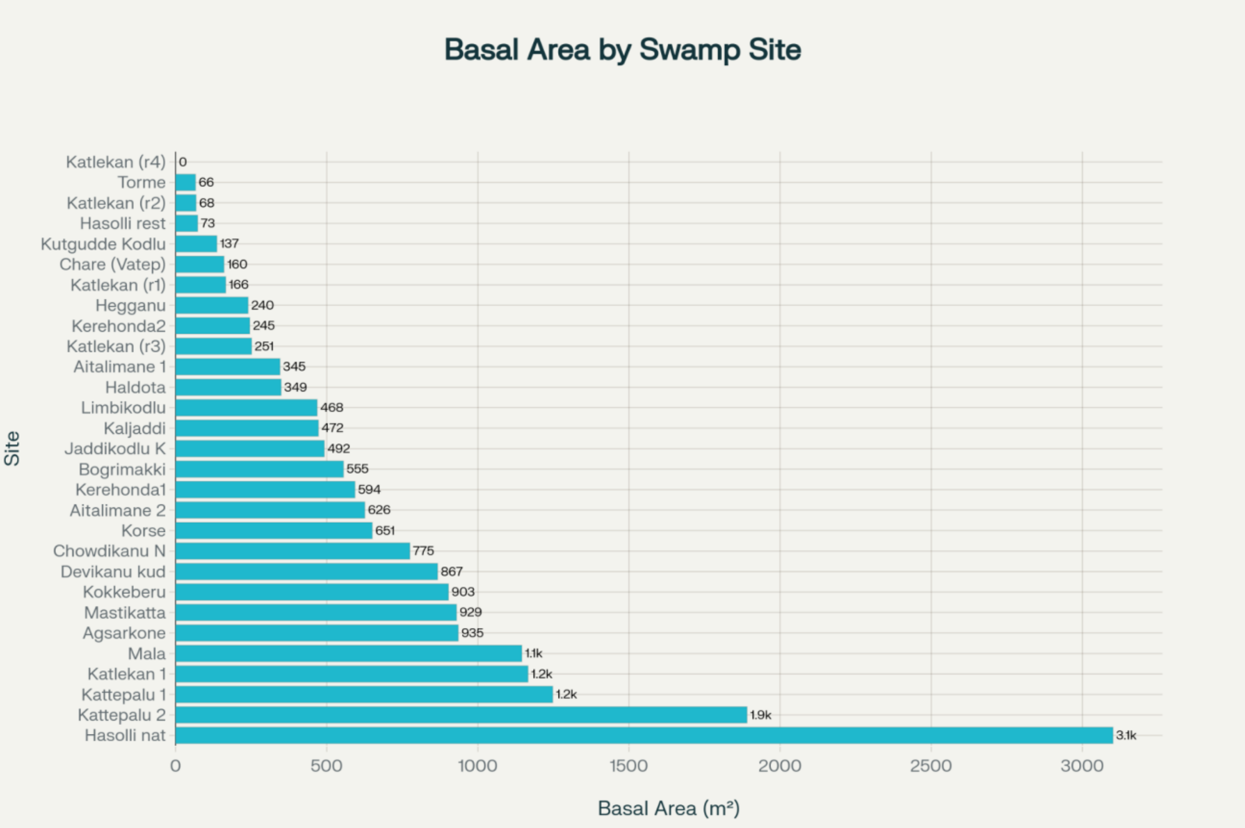

Fig 14b. Horizontal bar chart showing basal area per ha (sq. m.) for different swamp sites.

The chart (Fig 14b) shows basal area per hectare, reflecting biomass density rather than absolute total. Hasolli natural swamp stands out with 3101.351 sq. m. per ha, over 60% higher than the next densest site, Kattepalu 2 (1890.396 sq. m. per ha), evidencing extremely dense tree cover and old and relatively undisturbed growth. Average basal area per hectare across sites is 652.41 sq. m., with a total of 18919.85 sq. m. The restored sites, especially Katlekan (restored 4), remain at the bottom of the density scale.

Comparing these results with the earlier sampled area data, it's clear that the largest areas do not always have the highest basal area or density. Sites with medium areas can have very high biomass concentrations, while large sampled areas can be comparatively sparse. Mature and naturally occurring swamps are more structurally developed, whereas restored and newly managed sites lag behind both in total basal area and density

Total Biomass (tonnes per site)

Average biomass across sites is 1.77 tonnes per swamp, with a combined total of 51 tonnes for all sites. Biomass integrates density and basal area into a measure of stored carbon and ecosystem productivity. Here again, natural swamps are disproportionately important. Hasolli natural swamp holds 10.66 tonnes, and Katlekan 1 stores 6.51 tonnes, together contributing one-third of the total swamp biomass. These figures make them critical carbon reservoirs, emphasizing their conservation value.

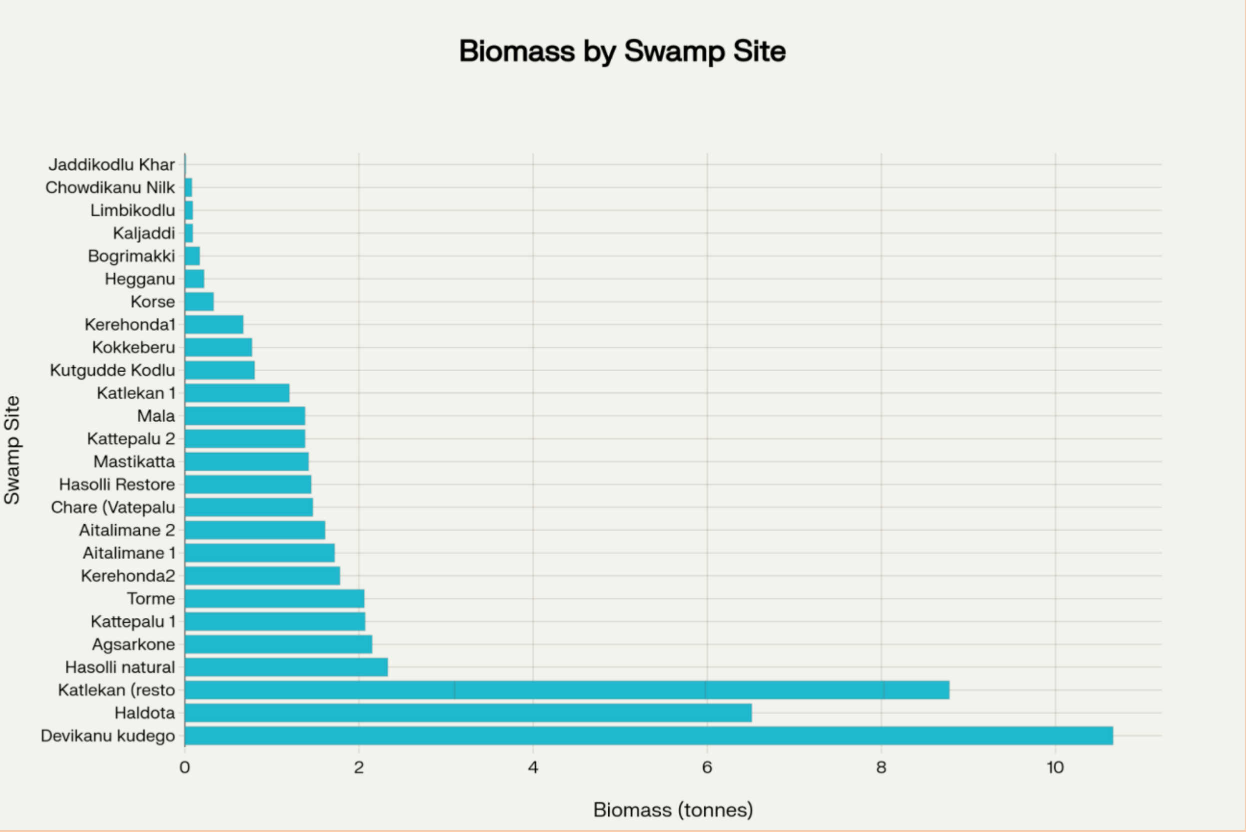

Fig. 14c. Total biomass (tonnes) by swamp site

The chart (14c) displays the total biomass (in tonnes) for each swamp site. Restored swamps, on the other hand, contribute almost negligibly to total biomass. Sites like Katlekan restored 2–4, holding less than 0.1 tonnes each, despite their high densities. Even Hasolli Restored swamp, with over 1000 individuals, stores just 0.08 tonnes, highlighting the carbon accumulation is regained after restoration. Some intermediate sites, such as Kattepalu 2 (3.10 tonnes) and Mala (2.88 tonnes), are doing relatively better, suggesting naturally regenerating younger swamps that are progressing toward maturity may be less disturbed in recent years and the area of swamp (and sampled area) also matters in total biomass accumulation.

Biomass per hectare (in tonnes per hectare) shows (Fig 14d) a wide range in biomass density among the swamp sites.

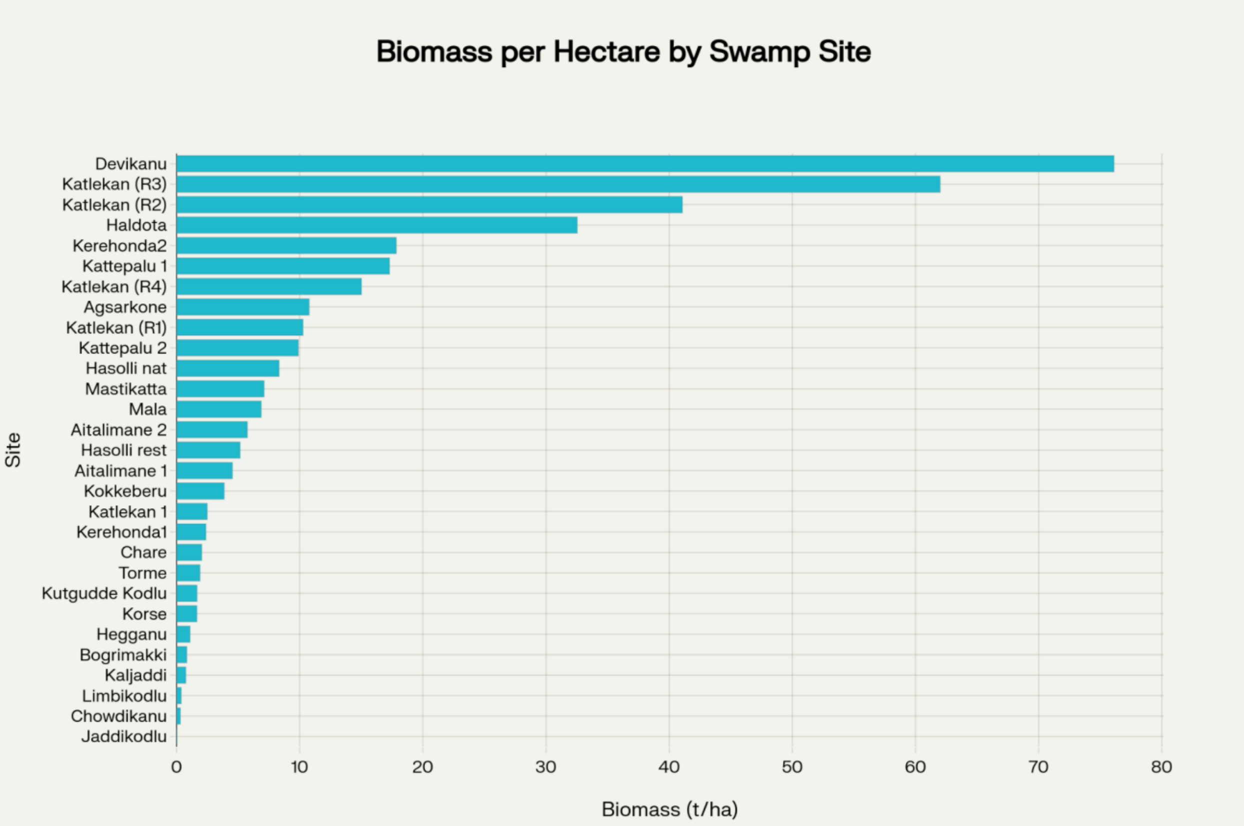

Fig 14d. Biomass per hectare (tonnes per hectare) by swamp site

The highest biomass density is found at Devikanu kudegodu (76.12 t/ha), followed by Katlekan (restored 3) (62 t/ha) and Katlekan (restored 2) (41.07 t/ha). These values indicate highly productive or well-vegetated areas per unit of land. The lowest biomass density is seen at Jaddikodlu Kharsekhanu (0.04 t/ha), suggesting very sparse biomass in that area. This also suggests that there has either been considerable degradation; however, higher density (1714 plants per ha.) suggests the presence of a significant proportion of young plants, which might have emerged after decades of degradation and anthropogenic disturbances. The average biomass density across all sites is 12.07 t/ha, with a total of 349.94 t for the sampled plots.

Old-growth sites like Hasolli and Katlekan 1 are disproportionately important, both for biodiversity and carbon, and they should be prioritized for protection. Restored swamps show encouraging density but remain in early successional stages, which underscores the need for long-term monitoring and adaptive management to ensure they develop into structurally and functionally comparable systems.

Diversity Patterns:

The number of species varies widely. Hasolli natural swamp stands out with the highest diversity

(62 species), highlighting its ecological richness. Katlekan (restored 1) and Kerehonda 1, which also exhibit significant species counts (43 and 48, respectively), follow closely behind. Sites like Katlekan (restored 4), Kattepalu 1, and Mala have the lowest species numbers (17 each), suggesting comparatively lower biodiversity.

Restored swamps like Hasolli Restored and the Katlekan plots (restored sites) have moderate species numbers, but natural swamps (Hasolli natural, Kerehonda1) often have both higher density and biodiversity

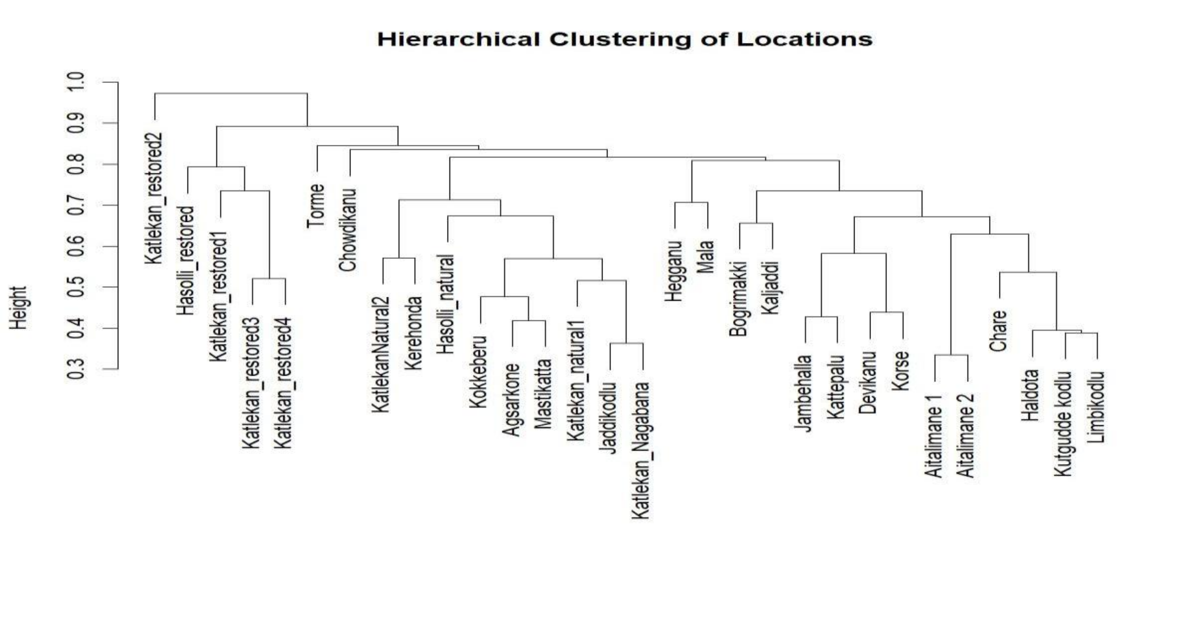

Fig 15. Hierarchical clustering of different swamp sites derived from Simpson diversity index.

Species richness varies widely, from as low as 17 species in sites such as Mala, Katlekan restored 4, and Kattepalu 1, to as high as 62 species in the Hasolli Restored swamp. Similarly, Mala and Katlepalu 1 also show poor diversity metrics, indicating that certain restored or naturally stressed sites might still be at an early successional stage or facing environmental constraints that restrict recovery.

The natural swamps present a slightly different picture. They generally display moderate richness (25–37 species) and Shannon indices between 2.2 and 2.8, reflecting stable but not maximally diverse systems. This could be due to natural dominance patterns where certain swamp-adapted species regulate the composition, ensuring long-term stability but limiting evenness. For example, sites like Jaddikodlu (37 species, H = 2.22) and Bogrimakki (34 species, H = 2.79) are typical of such stable yet moderately diverse natural swamps. Interestingly, some smaller natural sites such as Kaljaddi, though having only 25 species, exhibit a relatively high Shannon index (2.75), suggesting that the species present are well-balanced in their abundances.

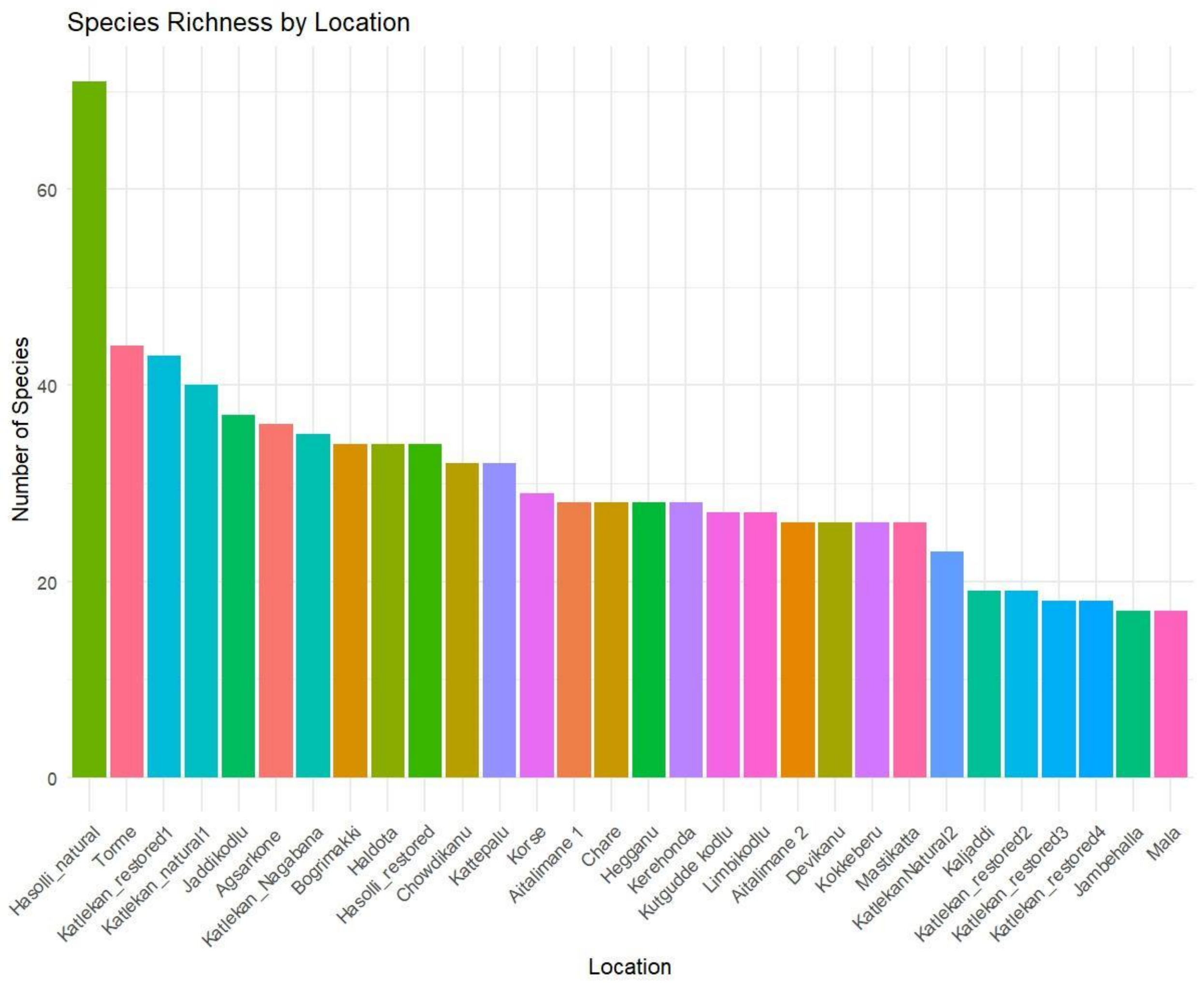

Fig 16. Number of species (species richness) in different swamp sites

Vegetation in restored sites:

Hasolli Restored swamp stands out with the highest richness (62 species), a very high Shannon diversity index (3.19), and the lowest Simpson dominance value (0.0013), reflecting both a wide variety of species and an even distribution of individuals among them. Similarly, Katlekan restored 1 also demonstrates strong recovery, with 43 species and the highest Shannon index (3.20), indicating a balanced and resilient community (Fig. 16).

In contrast, not all restored sites have been equally successful. Katlekan restored 2, for example, has a low richness (19 species), the lowest Shannon index (1.60), and the highest Simpson value (0.0175), showing that a few species dominate the community. This suggests that factors such as the number of species planted during restoration, hydrological conditions, soil fertility, or ongoing disturbances could be limiting factors in these sites, which need to be considered while interpreting the data.

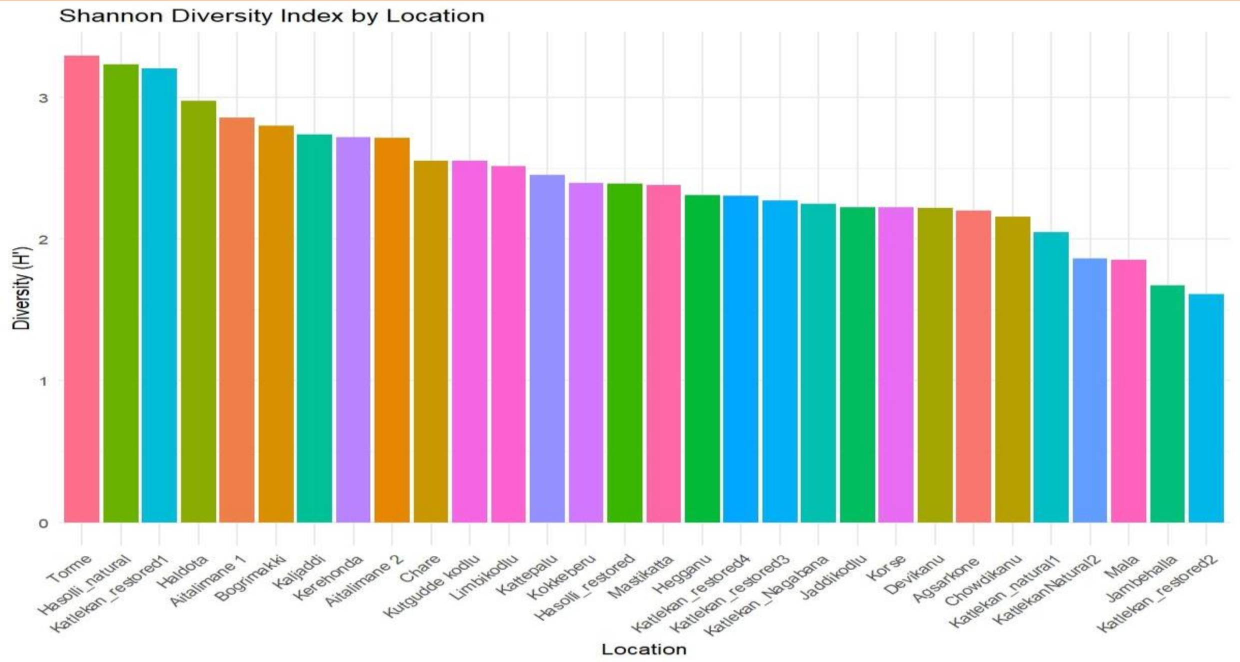

Fig 17. Shannon diversity index for different swamp sites

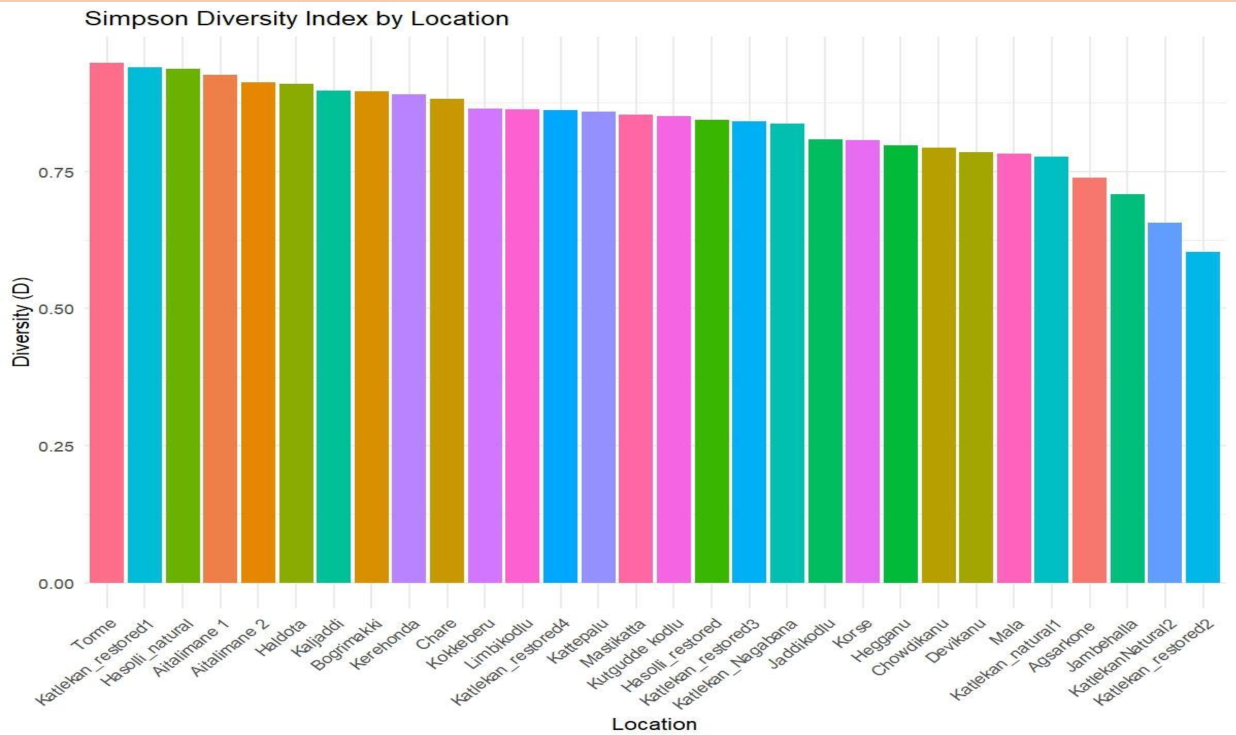

Fig 18. Simpson index for different swamp sites

Shannon Diversity Index (H)

- The Shannon index (Fig. 17) measures both species richness (number of species) and evenness (how evenly individuals are distributed among species). Higher H values indicate greater diversity and more balanced species distribution.
- In the data, Katlekan (restored 1) has the highest Shannon index (3.20), indicating a diverse and evenly distributed community, possibly because of the greater number of native species planted during restoration and their even distribution.
- Sites like Maryanakodlu (2.87) and Aitalimane (2.71) also show high Shannon diversity, suggesting healthy ecosystems with a good mix of species. Conversely, Kattepalu 1 has the lowest Shannon index (1.67), implying less diversity and dominance by a few species, potentially due to environmental stress or habitat degradation.
- Intermediate values in sites like Melina Honda (2.41) reflect substantial diversity but may indicate some dominance or uneven species distribution. i.e., dominance of Myristica fatua observed here.

Simpson Diversity Index

- The Simpson index measures (Fig. 18) the probability that two randomly selected individuals belong to different species. Lower values of the Simpson index indicate higher diversity, as more species are represented evenly.
- Katlekan 1 has the lowest Simpson index (0.0017), correlating with high species richness and Shannon diversity, signalling exceptional diversity with minimal dominance by a few species
- Melina Honda, despite high richness and H, has a slightly higher Simpson index (0.0028), indicating some species dominance but still high diversity overall.
- Sites like Kaljaddi show higher Simpson values (0.0146), corresponding with lower density and possible dominance by fewer species, confirming lower biodiversity uniformity.

When viewed at the site scale, it can be said that natural swamps far exceed the restored swamps in terms of structural development/biomass and carbon storage. While restored swamps often show high plant densities, they are structurally immature, with low basal area and biomass contributions. This indicates that swamp restoration success cannot be judged in terms of numbers alone — true functional recovery requires decades for trees to accumulate girth and wood volume.

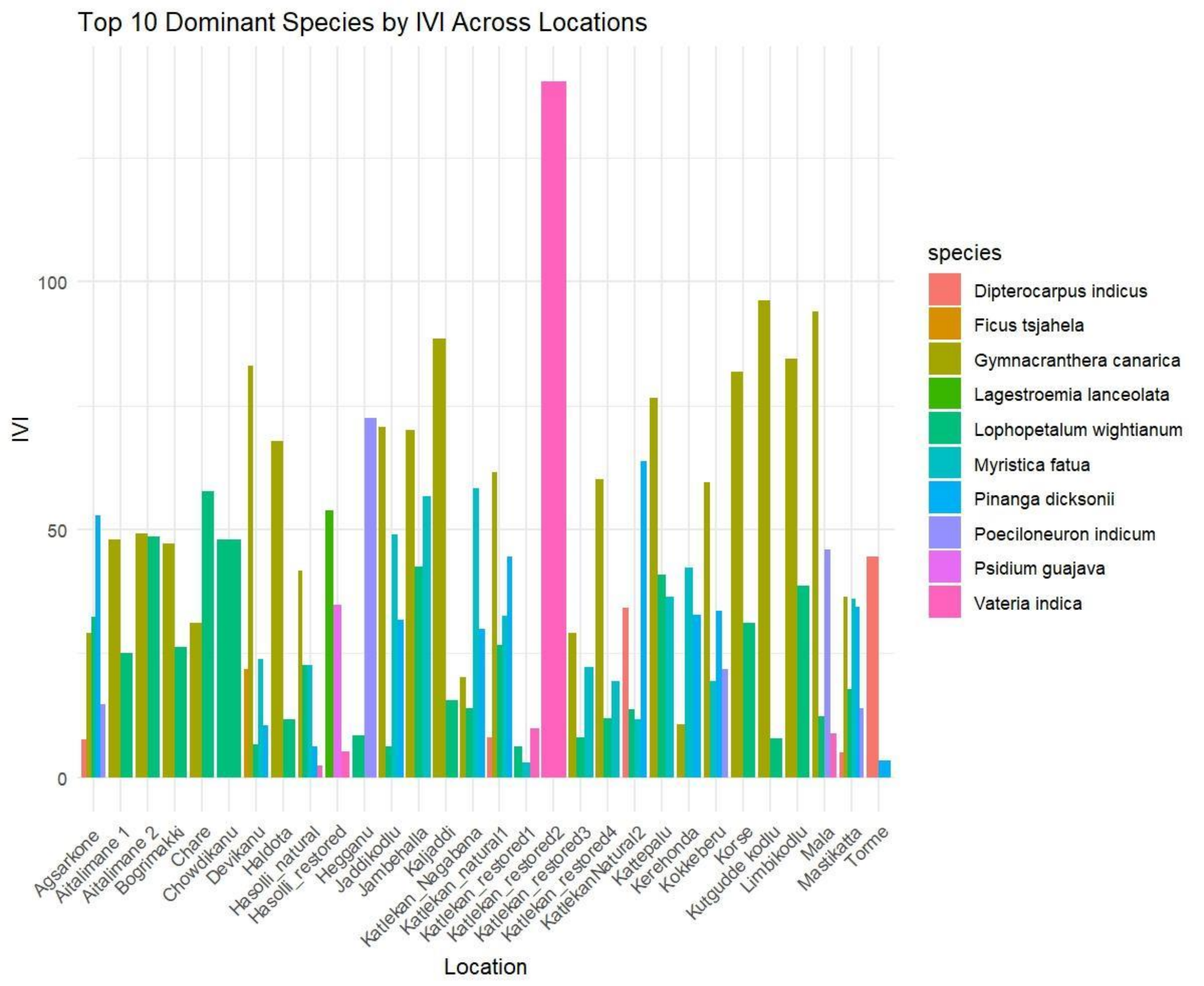

Fig 19. Importance value index (IVI) of different species in various swamp sites

Current status of swamps

Threats to newly identified swamps and in general to the TFSF visited are listed as below

- Gradual expansion of agricultural land—areca orchards in Utara Kannada and Shivamogga, coffee estates in Kodagu.
- Water diversion from the TFSFs for household needs and for agriculture is a common practice which will have a negative impact on TFSFs especially in peak summer season. Clearing the vegetation in the catchment region (both forest and Betta land) and collecting biomass are observed.
- Construction of roads near and adjacent to the TFSFs by cutting them is another major threat noticed in TFSFs.
- Killing of steno endemic species like *Elaeocarpus venustus* for establishing/expanding the coffee estates and even for materials used in building constructions.

Categorization of Swamps:

Swamps are diverse and complex ecosystems. To truly understand them, we cannot look at them from just one angle. Instead, we need to bring together different layers of information—geography, ecology, and even human connections. This multi-parameter approach allows us, more holistic understanding of swamp ecosystems, highlighting their location, type, status, and degradation level, while also providing guidance for future conservation actions. So, the following parameters were used for their classification.

1. Geographical parameters

Swamp classification first considers spatial and physical features:

- **Administrative boundaries:** Classification at the district allows understanding of their geographical distribution and dynamics and dominance. Swamps were mapped to identify whether they occur as clustered groups in valleys or as scattered, isolated patches across the Western Ghats.
- **Basins and drainage:** Swamps are grouped based on ultimate drainage - whether they fall into west-flowing rivers (Arabian Sea) or east-flowing rivers (Bay of Bengal).
- **River catchment:** Each swamp is assigned to a specific catchment (e.g., Aghanashini, Bedti, Sharavathi, Kali, Mukti), which provides ecological meaning by linking them to hydrological systems.
- **Area and size:** Swamps are further classified by extent (large, medium, small), since area often correlates with species diversity, ecological integrity, and resilience.
- **Altitude:** Elevational gradients are considered, as swamps show distinct ecological variation at lowland valleys, mid-elevation slopes, and escarpment zones.

2) Ecological parameters

Ecological parameters help in assessing the biological richness and structural attributes of swamps. These include:

- **Swamp Type:** Swamps were further classified into Myristica-dominated swamps, Elaeocarpus swamps, or mixed swamps, depending on their dominant tree species.
- **Species Richness:** The number of species present in a swamp, which reflects overall biodiversity value.
- **Density:** Plant density was calculated to understand population structure and regeneration potential.

- **Biomass and Basal Area:** These parameters provide insights into productivity, ecological stability, and the swamp's role in carbon storage.
- **Species Dominance:** The identification of dominant tree species, such as *Myristica fatua* or *Gymnacranthera canarica*, gives each swamp its ecological identity.

Swamp classification based on geographical parameters:

1) Based on geographic occurrence

The swamps can be classified geographically using two major parameters: their administrative distribution (districts) and their hydrological setting (drainage basins).

2) Based on administration boundaries

Across the Western Ghats, *Myristica swamps* are the most widespread, occurring in the districts of Uttara Kannada, Shimoga, Udupi, Dakshina Kannada, and Chikmagalur. Uttara Kannada holds the largest concentration, with numerous swamps clustered along river valleys such as the Kali, Bedti, and Aghanashini. Shimoga supports both pure *Myristica swamps* and mixed *Myristica–Elaeocarpus swamps*, reflecting its transitional location between coastal and inland river systems.

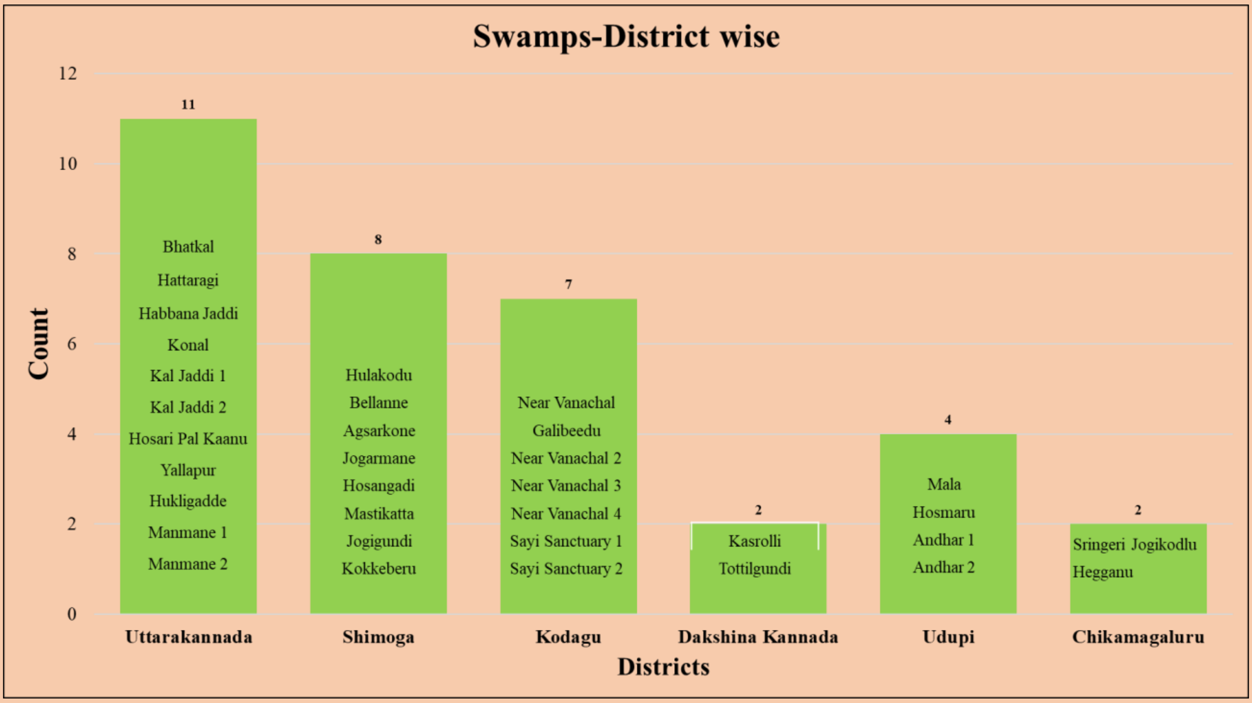

Fig 20. District-wise classification of newly identified swamps

Udupi and Dakshina Kannada also contain a few isolated Myristica swamps, while Chikmagalur has limited representation, mostly near Sringeri. In contrast, *Elaeocarpus swamps* are largely restricted to Kodagu (Coorg), with examples like Sayi Sanctuary and the Vanachal sites, highlighting their localized occurrence.

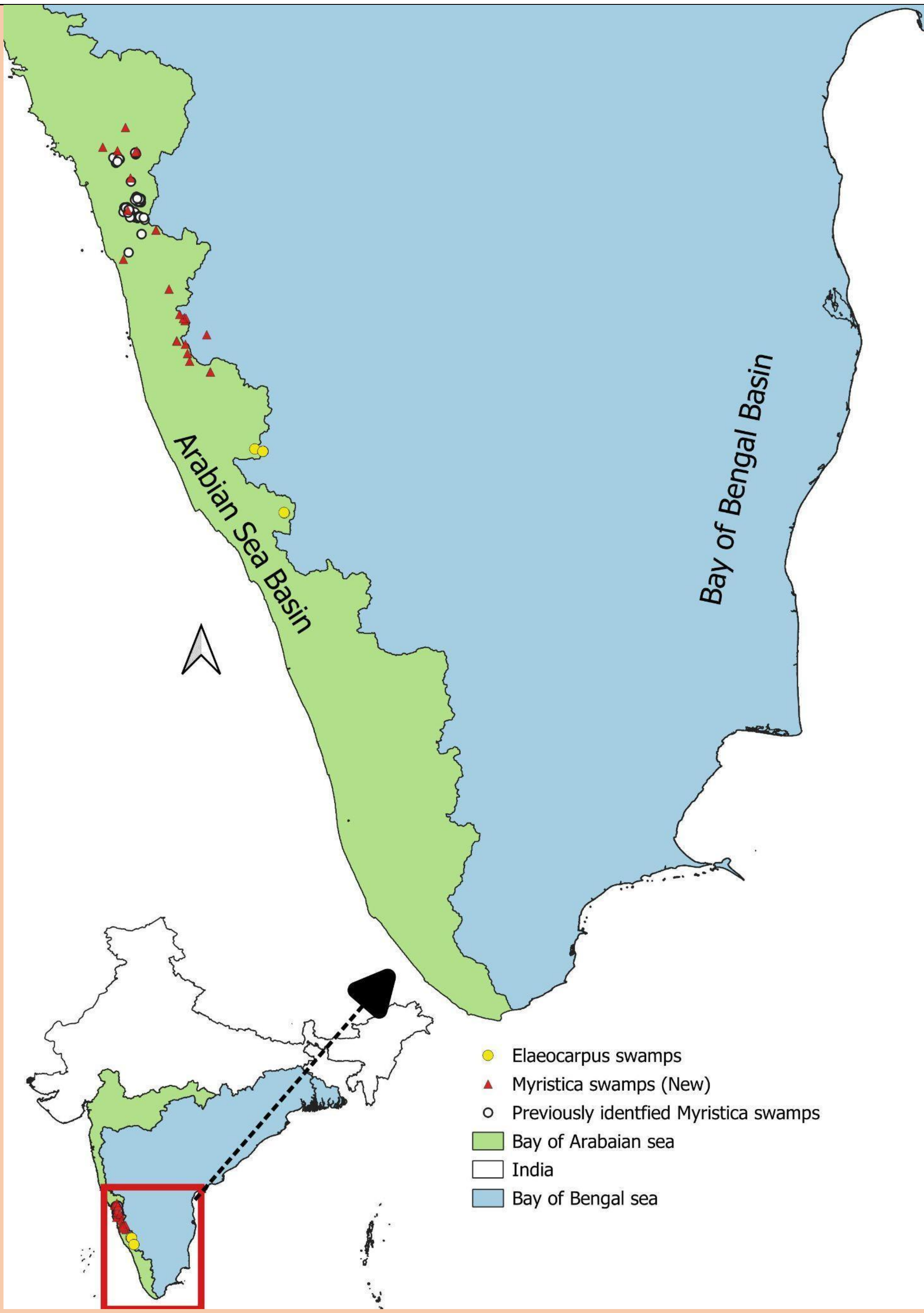

Fig 21. Swamp classification based on geographical occurrence, i.e., Arabian sea basin and Bay of Bengal basin based on the ultimate drainage basin

When looking at the drainage basin/coastal geography (bay-wise distribution), the swamps align with two major drainage basins: the Arabian Sea basin and the Bay of Bengal basin. Swamps in the Arabian Sea basin dominate in Uttara Kannada, Dakshina Kannada, Udupi, and western parts of Shimoga and Kodagu. These are primarily *Myristica* swamps, with *Elaeocarpus* swamps appearing in Kodagu. The Bay of Bengal basin, by contrast, hosts swamps in eastern Shimoga, Kodagu, and Chikmagalur. These are associated with east-flowing rivers such as the Tunga and Cauvery systems, and here both Myristica and Elaeocarpus swamps are found.

Generally, Myristica swamps dominate the swamps in the Arabian Sea drainage, which are associated with short, high-rainfall coastal rivers. In contrast, the swamps in the Bay of Bengal drainage can include both Myristica and Elaeocarpus species, although Elaeocarpus swamps are more often found to be a bit dominant in this basin.

Swamp categorization river catchment-wise

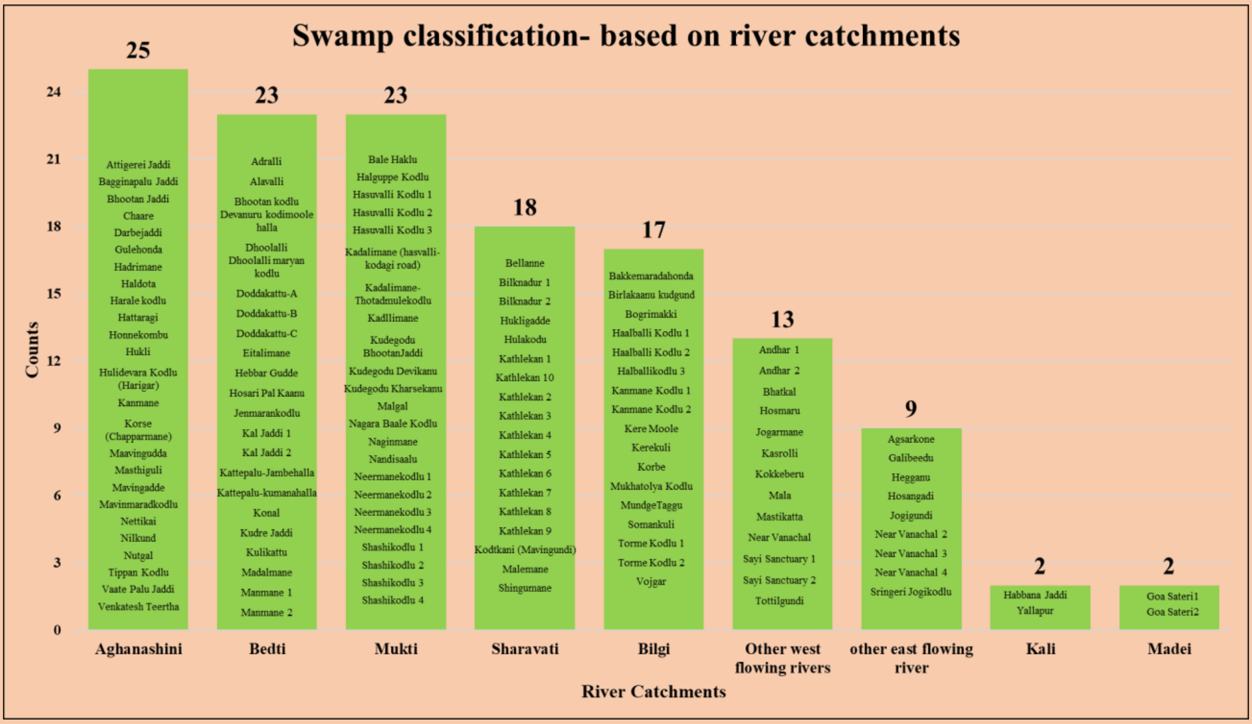

Fig 22. Distribution of swamp sites across river catchment

Categorization of newly explored swamps using different parameters

1) **Based on the area of the swamp**

   Swamp categorization has been done based on area of the sites, into three main size groups: Small (<2500 sq. m.), Medium (2500 to 7000 sq. m.), and Large (>7500 sq. m.).

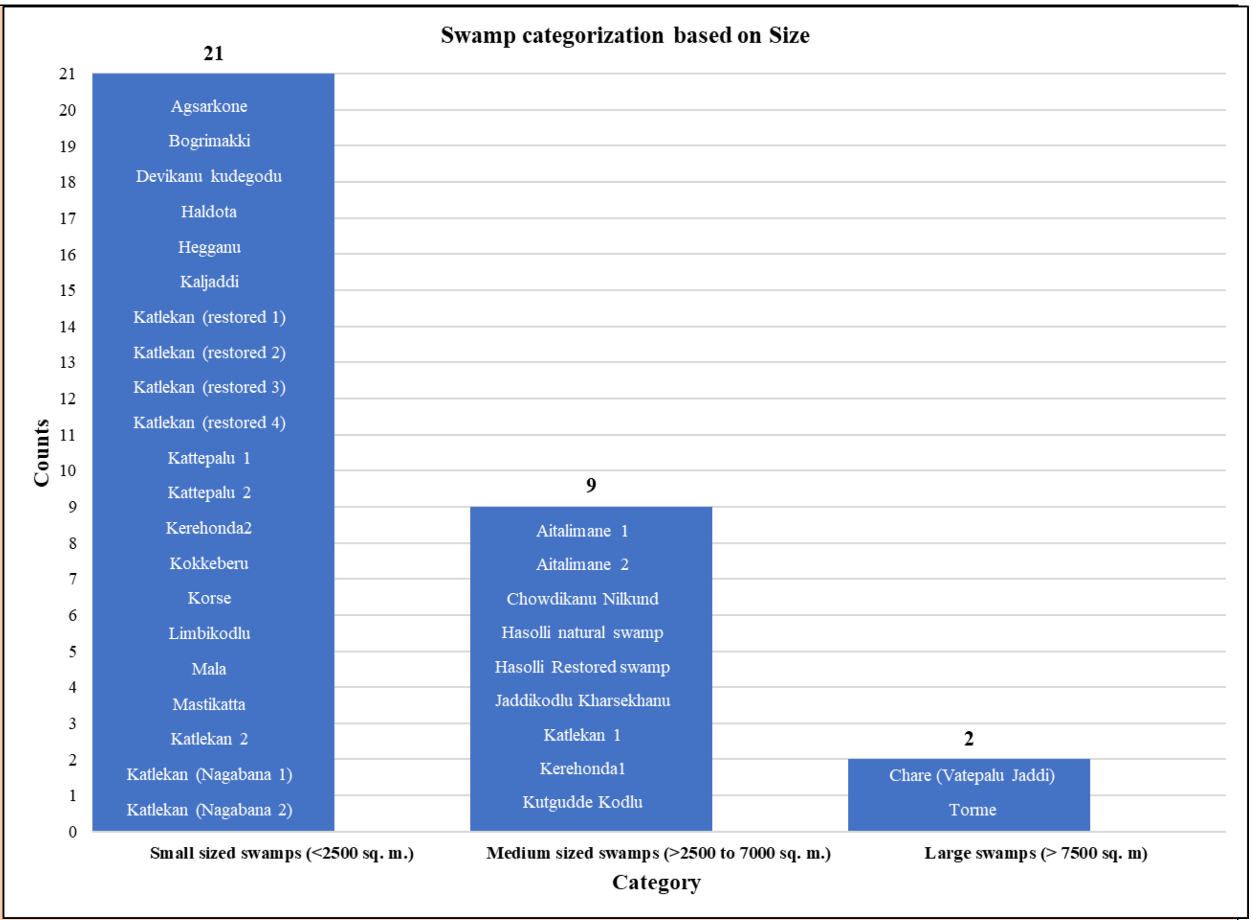

Fig 23. Number of swamp sites in each size category (Small, Medium, Large)

The data (Fig. 20) indicates that small-sized swamps (<2500 sq. m.) dominate the landscape, with 21 swamps falling into this category. This suggests that most swamp ecosystems in the region are relatively degraded, fragmented, (encroached) and occur as small habitat patches. Medium-sized swamps (2500–7000 sq. m.) are less common, with only 9 recorded, while large swamps (>7500 sq. m.) are rare, represented by just 2 sites.

Swamp classification using vegetation parameters based on swamp types

Based on swamp types the newly identified/explored swamps can be broadly categorized into

- **Myristica swamps** (dominant, especially in Uttara Kannada, Shimoga, and Sharavathi).
- **Elaeocarpus swamps** (restricted mainly to Kodagu and parts of Shimoga).
- **Mixed Myristica–Elaeocarpus swamps** (e.g., Mastikatta, Kokkeberu), which highlight ecological transitions and species overlap.

2) Swamp categorization based on species richness

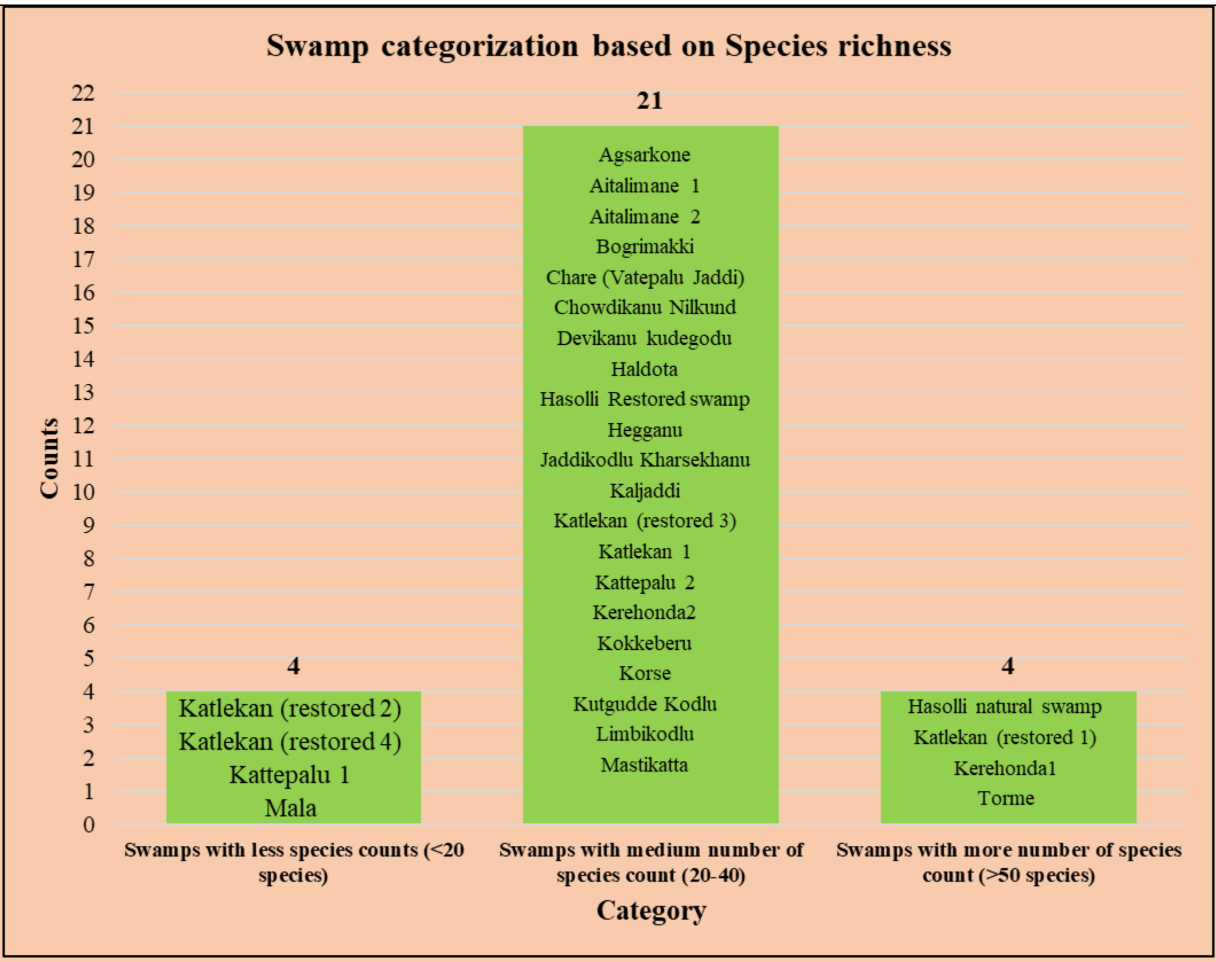

Fig 24. Swamp categorization based on species richness

The Fig. 24 shows swamp sites grouped by their species richness into three categories: low species count (<20 species), medium species count (25–50 species), and high species count (>50 species). The swamps categorized by species richness reveal important ecological distinctions. data shows that the majority of the swamps fall into the medium diversity category, with 21 swamps hosting between 20–40 species. In contrast, only 4 swamps have low species richness with fewer than 20 species, suggesting either higher levels of disturbance, habitat degradation, or naturally poor species composition in those sites. On the other hand, another 4 swamps stand out for their exceptionally high species richness, each supporting more than 50 species. Overall, the distribution highlights a predominance of medium-diversity swamps.

- Swamps with less than 20 species like Katlekan (restored 2), Katlekan (restored 4), Kattepalu 1, and Mala signify ecosystems with low biodiversity. These may be younger restoration sites or locations with environmental constraints limiting species colonization, indicating early successional stages or habitat stress.
- Swamps with a medium species count (25-50 species), such as Agsarkone, Aitalimane 1 & 2, Hasolli Restored swamp, Chowdikanu Nilkund, and Mastikatta reflect moderately

diverse ecosystems. These swamps may be in transitional ecological phases or have conditions allowing stable but not maximal species richness. They serve as important areas for biodiversity but may be vulnerable to habitat changes.

- Swamps with more than 50 species including Hasolli natural swamp, Katlekan (restored 1), Kerehonda1, and Torme represent highly diverse, complex ecosystems with mature habitats supporting a wide range of plant and possibly animal species. These swamps are biodiversity hotspots crucial for conservation efforts and ecological resilience.

Site-specific actions and restoration plans need to be developed in order to increase the diversity in the swamp sites with low species diversity in future.

3) Swamp categorization based on density of plants/ha.

The categorization of swamps based on plant density per hectare (Fig. 22) shows a clear variation in vegetation abundance across different swamp sites. A small number of swamps, only three in total, fall into the lowest density category (<500 plants/ha), represented by Chare (Vatepalu Jaddi), Kutgudde Kodlu, and Torme. These sites may reflect degraded conditions or naturally low plant recruitment, making them more vulnerable to ecological stress. Slightly better conditions are observed in the 500–1000 plants/ha category, which includes five swamps such as Aitalimane 1, Aitalimane 2, Haldota, Kaljaddi, and Limbikodlu. While these swamps have higher densities than the lowest group, they still remain relatively poor in terms of plant abundance.

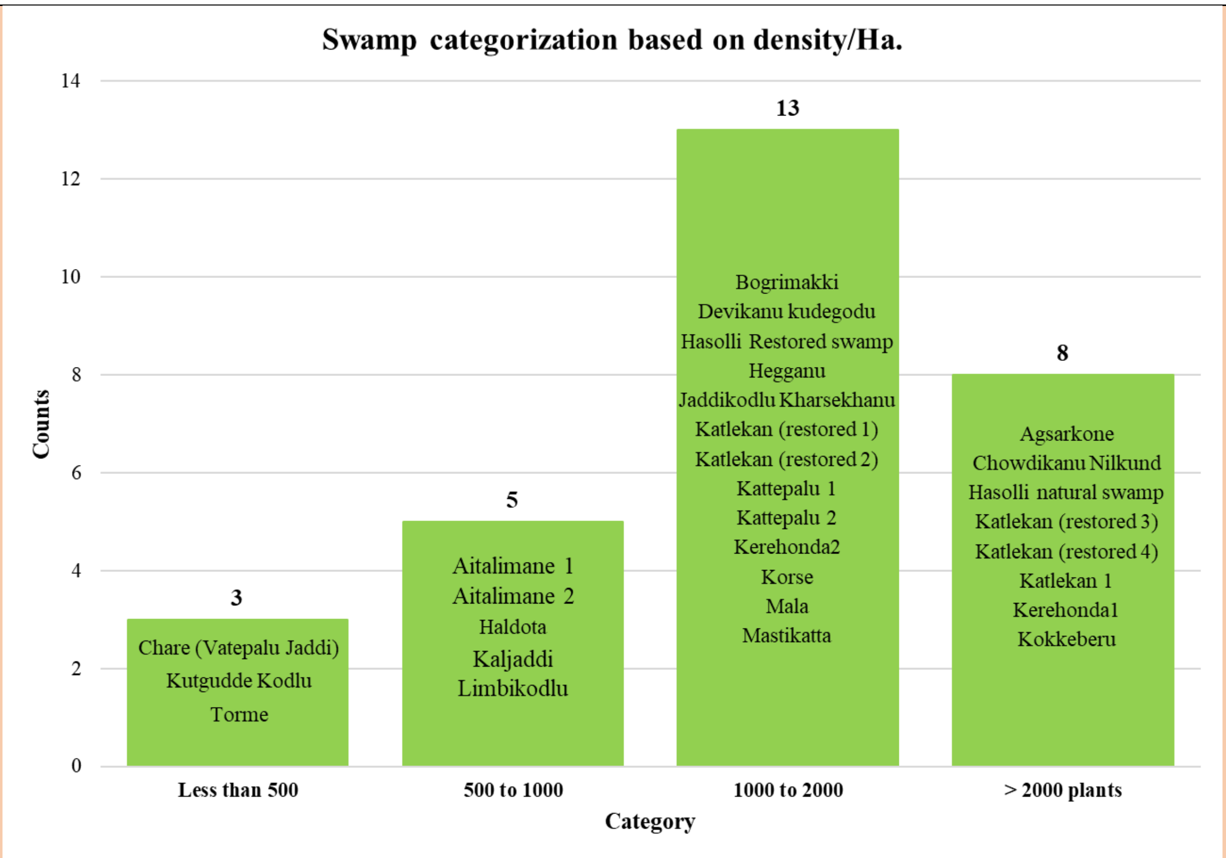

Fig 25. Swamp categorization based on the density of plants/ha.

The largest share of swamps, 13 in total, are concentrated in the 1000–2000 plants/ha category. This includes sites like Bogrimakki, Devikanu Kudegodu, Hasolli Restored swamp, and multiple Katlekan and Kattepalu swamps. The dominance of this category suggests that most swamps in the region maintain a moderate level of plant density, which may support stable ecological processes and a reasonably diverse species composition. At the higher end of the spectrum, eight swamps fall in the >2000 plants/ha category, including Agsarkone, Chowdikanu Nilkund, Hasolli Natural swamp, and restored Katlekan sites. These high-density swamps are ecologically significant, as they represent either well-preserved natural sites or successful restoration outcomes, offering higher structural complexity and resilience.

4) Swamp categorization based on basal area:

The categorization of swamps based on basal area per hectare (Fig. 26) reveals considerable variation in forest structure across sites. A small group of swamps, only three in total, such as Hasolli Restored swamp, Katlekan (restored 2), and Torme, fall into the lowest category (<100 sq. m./ha), indicating sparse tree cover and possibly representing either degraded or early successional stages.

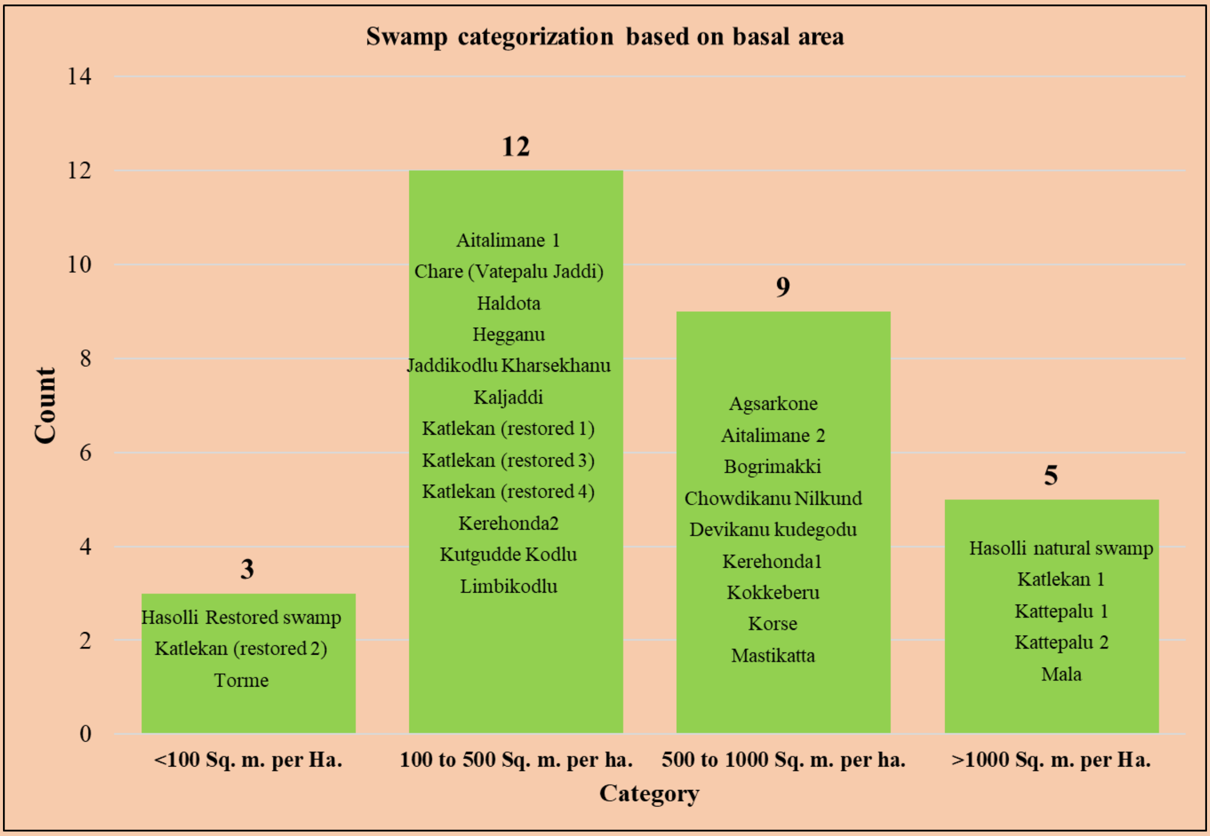

Fig 26a. Swamp categorization based on basal area

The majority of swamps, 12 sites, are concentrated in the 100–500 sq. m./ha category, including Aitalimane 1, Chare (Vatepalu Jaddi), Haldota, Hegganu, and others. This suggests that many swamps maintain moderate basal area, reflecting stable but not highly dense forest conditions.

A significant number, nine swamps, fall into the 500–1000 sq. m./ha range, including Agsarkone, Bogrimakki, Chowdikanu Nilkund, and Kokkeberu. These sites indicate higher tree density and biomass, contributing more strongly to ecosystem functions such as carbon storage and microclimate regulation. At the upper extreme, only five swamps exceed 1000 sq. m./ha, including Hasolli Natural swamp, Katlekan 1, and Kattepalu sites.

Overall, the data shows a gradient where most swamps cluster within the moderate basal area categories (100–1000 sq. m./ha), while fewer sites occur at the extremes of very low or very high basal area.

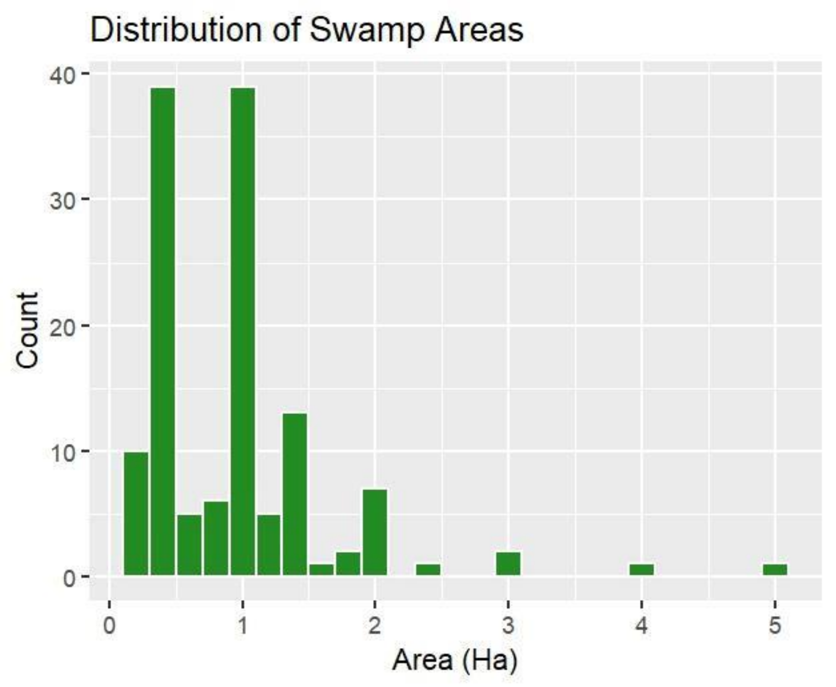

Fig 26b. Distribution of TFSFs areas

The bar chart titled "Distribution of Swamp Areas" illustrates the frequency distribution of swamp sizes across a given landscape, measured in hectares. It reveals a pronounced skew toward smaller swamp patches, with the highest counts concentrated in the 0 to 1 hectare range—two bars peaking near 40 occurrences. As area increases, the frequency of swamp sites declines sharply, indicating that larger swamp habitats (2 to 5 hectares) are comparatively rare. This pattern suggests a fragmented wetland mosaic, where microhabitats dominate the ecological terrain. Such a distribution has significant implications for conservation planning, as smaller swamps may be more vulnerable to edge effects, land-use pressures, and hydrological disruptions, yet collectively contribute to biodiversity and microclimatic stability. Understanding this size-based distribution is essential for designing scalable interventions, prioritizing connectivity, and tailoring outreach strategies to protect these underrepresented wetland fragments.

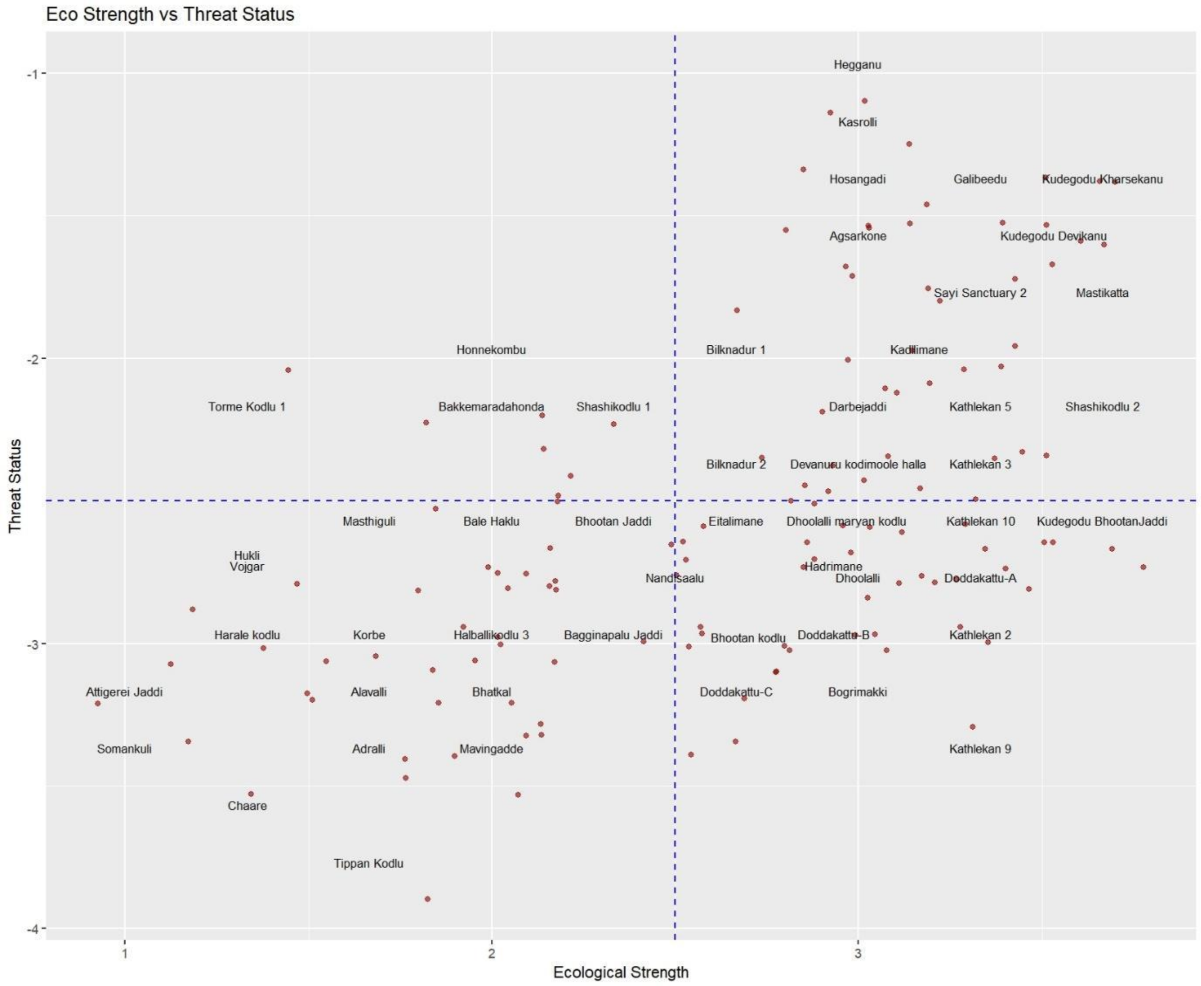

Fig. 26c. TFSFs categorization for entire TFSFs

The scatter plot titled "Eco Strength vs Threat Status" offers a compelling visual framework for evaluating conservation priorities across ecological sites. By plotting ecological strength on the x-axis and threat status on the y-axis, and encoding area (in hectares) through the size of each circular marker, the visualization enables a multidimensional assessment of each location. The intersecting dashed blue lines divide the graph into four quadrants, each representing a distinct ecological scenario: high strength–high threat zones signal urgent conservation needs; high strength–low threat areas suggest resilient ecosystems; low strength–high threat sites may benefit from restoration efforts; and low strength–low threat zones are candidates for long-term monitoring. This quadrant-based logic facilitates rapid categorization and strategic planning.

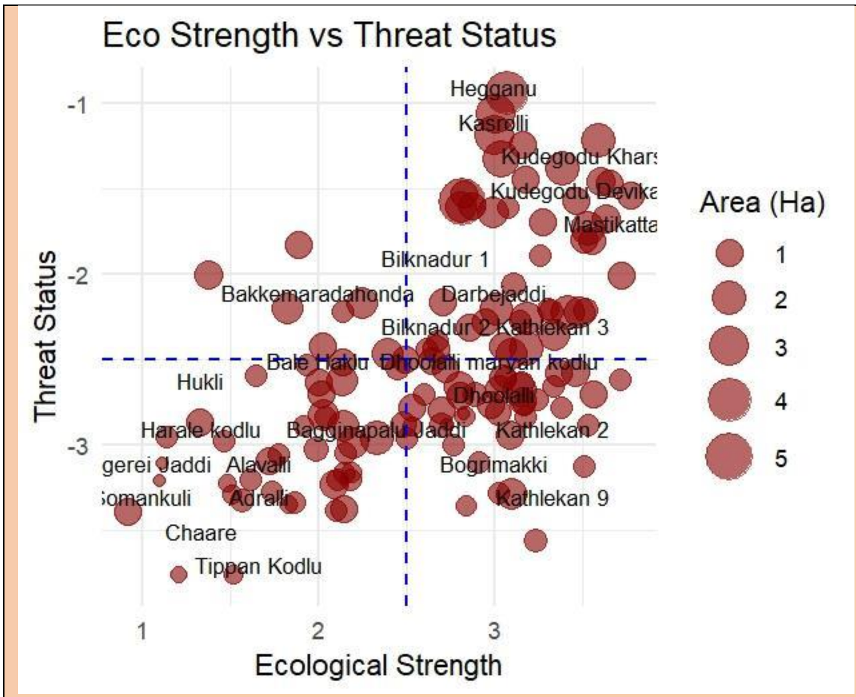

Fig 26d. TFSFs categorization with proportionate areas

Beyond its analytical utility, the plot serves as an effective communication tool for outreach and policy engagement. Its intuitive structure and scalable symbols make it accessible to diverse audiences, including local communities, officials, and interdisciplinary collaborators. For researchers and conservation communicators like Balachandra, the format lends itself to further adaptation—such as integrating regional scripts, QR-linked site profiles, and culturally resonant iconography—to enhance ecological storytelling and community resonance. As a synthesis of ecological data, spatial scale, and threat dynamics, this visualization exemplifies how scientific insight can be translated into actionable and inclusive conservation narratives.

Activity 1.9 – Preparing a list of swamps and surrounding areas with possibilities of expansion of the swamp areas **(November 2024 - March 2025)**.

Activity 1.10 – Listing of possible sites for land purchase and their cost-benefit assessments. **(November 2024- March 2025)**

Approach:

Land securing - list of land, survey numbers, geocoordinates, area, owner, price and prioritization

Criteria used for land prioritized for securing are the area of the land, distance from the TFSF, connectivity with larger forests and protected areas, existing forest species in the land, suitability for restoration, land price, and potential of species recovery (RET and endemics). In which one site selected in Katlekan was under Forest Right Act (FRA Act, 2006) claims. There are 80000 cases in the Uttara Kannada district, Karnataka, under FRA. Most of these farmers have cultivated small patches of forest lands for several years. They have filed the application for regularization of their land under FRA. However, claims have been declined due to insufficient documents or encroachments after 1978. However, the CAMPA guidelines do not offer provisions for compensating such lands. There is a need to add provisions to provide compensation in such conditions. The forest department cannot evacuate or compensate them because they have less than three acres of land (the Government of Karnataka took the decision to evacuate farmers who encroached on more than three acres of forest land). They have neither any legal documents to get any benefits from governments nor to sell the land to others. There were a few farmers who wanted to sell this land and buy it with legal documents.

Results/Outputs

After considering several criteria and cost benefits, 17 sites accounting for 28 acres have been listed under land securing (Annexure 3).

Objective 2. Participatory ecological restoration of degraded TFSFs, newly secured land, catchment area and buffer zones

Activity 2.1 – Seed collection and raising of 10000 saplings of obligatory and associated swamp species (June 2024 to June 2025)

Approach:

Calendar for seed collection

A seed collection plan was developed, as many swamp species produce seeds only during specific seasons. A collection plan ensures seeds are gathered at the optimal time. Specifically for the species that are rare or endangered, planning is crucial to collect seeds when they are available to avoid missing or running short of propagule materials for their multiplication in the nursery. The table below provides information on the availability of seeds for different swamp species.

Species	Category	Mode of propagation	Season for Seed/wildling collection
Gymnacranthera canarica	Obligatory	Seed	June to September
Myristica fatua	Obligatory	Seed	June to September
Mastyxia arborea	Facultative	Wildlings	June to August
Myristica malabarica	Obligatory	Seed	June to August
Lophopetalum wightianum	Facultative	Seed	September to October
Knema attenuata	Facultative	Seed	August to October
Canarium strictum	Facultative	Seed	June to September.
Arenga wightii	Facultative	Seed	June to August

Nature of seeds of different species of swamp

Understanding the nature of seeds—whether they are recalcitrant or non-recalcitrant—is crucial for assessing their viability and determining the optimum time for sowing. This knowledge also guides the implementation of appropriate germination treatments. For instance, identifying the seed type offers information regarding its dormancy characteristics, longevity, and the need for specific interventions to break dormancy.

Such information is valuable in standardizing germination techniques, which helps maximize germination rates and minimize the collection of excess seeds. Ensuring a higher germination percentage reduces the need to collect many seeds to meet the required number of saplings for restoration efforts. In turn, this promotes the natural recruitment of swamp species, protecting their populations and preserving ecological equilibrium.

The table below indicates the nature of seeds of different species, which was gathered based on our previous experiences and documented for future references.

Sl. No	Species	Seed type
1	*Gymnacranthera canarica*	Recalcitrant
2	*Myristica fatua* var. *magnifica*	Recalcitrant
3	*Mastixia arborea*	Recalcitrant
4	*Cinnamomum malabatrum*	Non-recalcitrant
5	*Myristica malabarica*	Recalcitrant

6	*Dipterocarpus indicus*	Recalcitrant
7	*Bombax ceiba*	Non-recalcitrant
8	*Lophopetalum wightianum*	Non-recalcitrant
9	*Mangifera indica*	Recalcitrant
10	*Artocarpus heterophyllus*	Non-recalcitrant

1. ***Gymnacranthera canarica***

Seed collection and germination techniques for *Gymnacranthera canarica*:

During the fruiting season, mature seeds were carefully collected from healthy *Gymnacranthera canarica* trees. Fallen seeds were collected from the ground, ensuring selection of fully ripe fruits with well-developed seeds.

These collected seeds were kept in gunny bags and kept in flowing water to ensure leaching out of germination of inhibitory compounds (so that it mimics natural swampy conditions) for a week and then spread over a sand bed and covered with a polythene sheet to provide congenial moisture and temperature to attain an optimum germination percentage.

Propagation techniques for *Myristica malabarica* and *Myristica fatua*:

During the fruiting season, mature seeds were collected from *Myristica fatua* trees. Fruits will fall when they are fully ripe and begin to split open to reveal the seeds inside. They are then collected. Care was taken to handle the seeds delicately to avoid damage. These seeds were soaked in water for several hours or overnight to soften the seed coat. Seed propagation involved sowing soaked seeds in a nursery bed of well-draining soil and sand mix at an appropriate depth. Consistent moisture levels, indirect light, and warmth were provided to support germination.

3. *Mastixia arborea*

Mature seeds were collected from *Mastixia arborea* trees. Scarified or stratified seeds were sown in well-draining potting mix or nursery beds at a suitable depth to initiate germination.

4. *Cinnamomum malabatrum* (Malabar cinnamon):

Seeds are collected from mature fruits and soaked in water for 24 hours to soften the seed coat. They are then sown in well-drained soil trays or pots filled with a mixture of compost and sand. Germination occurred within 2-3 weeks. Seedlings are transplanted into polybags at the

4-6 leaf stage.

Collection of wildlings

Thumb rule for collection of wildlings

When collecting wildlings for restoration or conservation purposes, it is essential to minimize the disturbance to natural recruitment processes in the ecosystem. One commonly referenced guideline is a "rule of thumb" proposed by Hoag in 1994. Hoag (1994) proposed One guideline suggests collecting or digging no more than 1 ft^2 (0.09 m^2) of plant material from a 4 ft^2 (0.4 m^2) area.

This rule suggests that collectors should only harvest a portion of the available wildlings, ensuring that a significant number remain in their natural habitat to sustain the species' natural regeneration cycle.

While following the above guideline, several additional criteria were also taken into account when collecting the wildlings, as outlined below.

- **Selective collection:**

Collect wildlings only from areas where populations are healthy and abundant. Avoid collecting from areas with low population densities or where species are already under stress.

- **Limited collection:**

Limit the number of wildlings collected from any single location to prevent overharvesting and maintain genetic diversity within natural populations. A general rule of thumb is to collect no more than 10% of the total population from a given area.

- **Avoid damage to parent plants:**

When digging out wildlings, take care to minimize damage to the parent plants and surrounding vegetation. Use appropriate tools and techniques to extract wildlings without causing harm.

Wildling preparation and nursery raising:

Upon collection, wildlings were carefully dug out from the soil, ensuring minimal damage to their roots. They were then transported to the nursery with their root systems intact. In the nursery, wildlings were planted in containers filled with a suitable potting mix, which typically consisted of a combination of soil, sand, and organic matter.

Results/Outputs

The total number of species raised in the nursery is 21, seven are TFSF obligatory species, others are associated and evergreen species. Seeds procured from Kathlekan, Nilkund, Dharbejaddi, Aitalimane, Dholalli, Torme and Kudegod. The total number of plants in the nursery is 9950.

Activity 2.2. Swamp-level action plans in association with state forest department, VFCs, scientists from IISc and the College of of forestry (August 2024 to September 2024)

Catchment area assessment

The following methodology was applied to map a small micro catchment area with the primary aim of identifying and earmarking sites for restoration efforts. This approach utilized contour maps, field observations, Google Earth Pro elevation profiles, and satellite imagery to delineate and assess the catchment area accurately.

Data used

- **Contour maps**: A topographic map with 10-meter contour intervals was prepared using SRTM DEM data in Qgis and used as a primary reference for identifying ridgelines, peaks, and other elevation-based features within the micro catchment area.
- **Satellite imagery**: High-resolution satellite imagery was used to provide a clear, current view of land cover, vegetation, and water features within the study area.
- **Google Earth Pro:** The ruler tool and elevation profile functionality in Google Earth Pro were employed to validate flow directions, measure distances, and gain insights into elevation changes throughout the catchment.

Identification of High Points and Ridgelines

- **Contour analysis**: Key high points, including ridgelines and peaks, were identified using contour maps as natural boundaries of the catchment area.
- **Tracing ridgelines**: Ridgelines were traced along the highest continuous contours, establishing natural watershed divides to separate flow directions within the catchment area.

Determining flow directions

- **Field observations**: Experienced insights gathered during field visits were leveraged to understand natural flow patterns. Observations of soil moisture, vegetation types, and visible water pathways were considered in interpreting flow directions across the landscape.

- **Google Earth Pro Elevation Profiles**: Using the elevation profile tool, flow paths were visually confirmed by simulating potential water flow directions from high points toward the core of the catchment area.
- **Ruler tool**: The ruler tool was used to verify distances and refine the estimated boundaries, ensuring consistency with observed terrain features and flow paths

Selection of restoration sites:

Open canopy areas identification: Open canopy regions within the catchment, particularly near the core swamp area, were identified as restoration sites based on satellite imagery. Specific polygons were drawn around these open canopy zones, prioritizing areas that would benefit most from restoration to support water retention and ecological health near the core swamp.

Final validation

- The mapped polygons and boundary lines were reviewed against field observations, contour maps, and satellite imagery for accuracy.
- The finalized map included clearly marked polygons for the catchment boundary and designated restoration sites, with notes explaining the rationale for site selection.
- Contacts and network building including college of forestry Sirsi and Ponnampet, NCBS, Coorg, Shivamogga, Chikmagaluru, Village Forest Committees, Vruksha Laksha Andolan Sagar, Bharateeya Sahasa Samanvaya Kendra Honnemaradu.
- Contacts were developed near Shringeri for Elaeocarpus Swamps. Loggers are also installed in the same.
- Village-level action plans were made in Torme, Chaare, Kudegodu and Jambe Halla. These are based on discussions with the key informants in and around the swamp forests.

Results/Outputs

Fig 27. Micro catchment area (30 ha.) and sites potential for restoration (7 ha.) near Kudegodu Kharsekanu

Fig 28. Micro catchment area (58 ha.) and sites potential for restoration (14.7 ha.) near Kudegodu Kharsekanu

Similarly, the prioritized swamp sites will be mapped for micro catchment areas, sites potential for restoration within the identified catchment area as the project progresses.

Village-level action plans in Torme, Chaare, Kudegodu and Jambe Halla

Action plan for swamps:
Torme Swamp:
Torme is a hamlet in the village of Kudgund, Siddapur Taluk, Uttara Kannada, Karnataka. Two swamps in Torme Kodlu and another in Mukha Tolya Kodlu are present in the forests close to the hamlet. Ten households, having a population of nearly 52 people, use the water from the above-mentioned swamps. Apart from domestic use and cattle, the swamp's water is being used to irrigate 30 acres of land. We have discussed with the local people installing solenoid valves with timers. STHIL company will provide such devices to ensure efficient use of water in the peak summer during nighttime. As of now, diverted water from the swamp forests will flow continuously in the households even during the night time when there is no usage. The tap will not work because of natural water flow and higher pressure. Now we decided to install solenoid valves on a pilot basis to test the efficiency and acceptability.

Almost twenty years ago, the family constructed a mud road near the swamp, clearing the forest to reach Nandan Tota, an areca nut orchard. While improving his farm through earthing up and adding soil the family has damaged adjacent swamp forests and four Dipterocarpus trees were killed in the process.

We could only inform the local forest department officials to take necessary action to halt such damages in the future. In case they stop further expansion or reclaim the encroached part we could consider planting Dipterocarpus indicus.

Catchment area treatment—Hejani Gudda, Bare Gudda, Rakshas Gudda, Godkallu Bare, and Kabballi are hilltops with grassland. Here grassland restoration can be undertaken by planting native grass species. Next to this grassland, within these hilltops, planting of Ficus species and hardy plant species could be considered.

Grassland restoration could be undertaken during the monsoon period; however, we need to do further work to understand the species and plan the restoration. Planting of Ficus could be done on a priority during the coming monsoon.

Swamp catchment areas with degraded forest patches are – Kabbbin Haklu Gudda (5 acres), Jenumane Kumbri (40 acres), Torme Bena (15 acres), Banatada Kallu Vaare (12 acres), Kabna Haklu Pagaru (3 acres).

This may not be possible immediately; we need to discuss this with local forest officials and require more evergreen species for planting. In fact, we have visited most of these areas and have a fair understanding of the landscape features. It is ideal to include local village forest committees in the planting of these sites along with the forest department.

Near Sanisara 2 acres of forest land have been encroached and clear-felled for almost two decades now. Recently the farmer has been trying to expand the encroached land by clearing the adjacent forests.

Kattin Moole, with an area of 1.5 acres, has the potential to be restored into TFSFs. It is a wetland with few large trees of *Lophopetalum wightianum*, *Knema attenuata,* and *Lagerstromea lanceolata*.

Our team needs to visit this site to evaluate the potential for restoration. However, in the past, local people had a good understanding of how to establish the swamp nursery and contribute to the restoration efforts. This approach may assist us in restoring the previously mentioned land.

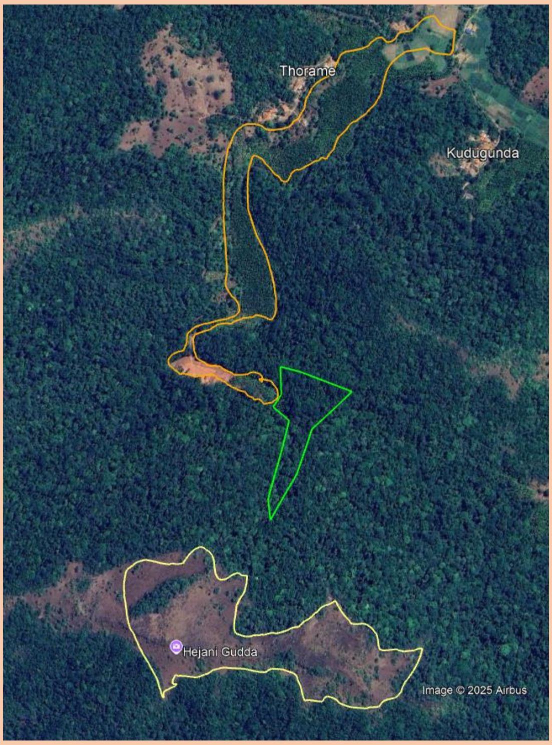

Figure 29: ***Torme swamp, green polygon—swamp, light yellow—grassland, Dark Yellow: Agriculture land***

Water is continuously drawn from the swamp throughout the day. Since it is a gravity-based system, there is no tap to stop the flow of water from the swamp. Water is being wasted during the night. We planned to install a solenoid valve at the water source. This will help in retaining the water back at the swamp area during the night.

Action plan Kudegodu

Kudegodu village, Siddapur taluk, Uttara Kannada. Sirsi Forest Division is home to several swamps: Kharsekanu, Kudegodu Devikanu, Huklagadde, Melina Honda, Neeramane Kodlu, Jaddikodlu and Sodlekodlu. All these swamps were identified and mapped by the Snehakunja team in the previous CEPF-supported project. The THT project period led to the discovery of

Hukligadde swamp. Based on our previous experience and observations of topography, habitat characteristics, similar micro- and macro-climatic conditions, and its proximity to other swamps, it is predicted that Hukligadde swamp historically consisted of Myristica species. Some farmers in this region have said that this Hukligadde swamp earlier had several Gymnocranthera canarica and Myristica fatua plants. Still there are debris of large fell stems and stumps indicating presence of swamp species till previous recent years

However, a portion of the swamp was converted into an arecanut plantation a few decades ago, approximately 20–30 years, based on the estimated age of the arecanut trees. Additionally, some areas appear to have been converted more recently, as indicated by the presence of young arecanut seedlings.

The pristine Kharsekhanu Kudegodu swamp has also been degraded, with parts of the swamp converted into arecanut plantations. The length of the swamp from its origin is 510 meters. However, approximately 300–350 meters of this stretch, along both sides of the stream, has been converted into arecanut plantations. The total area of the swamp is 1.5 acres. To prevent flood damage and soil erosion in the arecanut plantations during heavy rains, the edges of the stream have been reinforced with rocks.

At the end of the arecanut plantation, swamp species such as *Gymnacranthera* canarica and *Myristica fatua* are still present, clearly indicating that the swamp has been historically degraded. The flatter, more accessible areas, which were likely considered ideal for conversion, have been turned into arecanut orchards. The total length of the remaining intact but discontinuous swamp is 510 meters. This swamp system feeds approximately 34 acres of land downstream, which includes both arecanut plantations and paddy fields.

However, Devikanu, a sacred swamp, is being protected, which is in the vicinity of a settlement and areca orchards.

An interview with Sadanand Hegde, a farmer residing just below the Kharsekanu swamp, revealed that recent construction efforts—specifically the building of a mobile network tower at the top of the swamp (just above the starting point of the core swamp area)—have caused significant soil erosion. The excavation activities and soil dumping at the top led to runoff during heavy rains, resulting in large amounts of soil being washed down along the swamp. This has made the water in the downstream households unusable for domestic purposes. Hegde also expressed concern that this may have serious long-term impacts on the swamp ecosystem.

The Kharshekhanu swamp has been found to hold cultural significance. As said by Sadanand

Hegde, it is associated with local deities Boota and Chowdi, and is worshipped once a month on the day of Amavasya (the no-moon day).

Other swamps in this cluster include Neeramane Kodlu and Sodlekodlu. Neeramane Kodlu consists of members of the Myristicaceae family and can be classified as a Myristica swamp. It has two streams, designated as Neeramane Kodlu 1A and Neeramane Kodlu 1B, which originate from different sources. Neeramane Kodlu 1A appears to be the primary swamp, with Neeramane Kodlu 1B joining it downstream. Neeramane Kodlu 1A extends for approximately 240 meters, while Neeramane Kodlu 1B runs for about 125 meters before merging with 1A. Another swamp Sodlekodlu Kodlu has very few numbers of trees from the Myristica species (historically it might have degraded); it is dominated with Arenga wightii populations. The swamp ecosystem ends at the starting point of the arecanut plantation.

Melinahonda swamp has a larger area, characterized by a flatter terrain, greater diversity, and a wider spatial distribution of swamp species. This swamp is formed by the confluence of three streams, which is the primary reason for its relatively larger size. Additionally, another swamp joins this system a few meters downstream. The fourth swamp has an exceptionally steep slope, which is uncommon. Swamps with such steep slopes are typically dominated by Myristica fatua.

Together, these three swamps feed approximately 57 acres of farmland. Narrower areas with steep slopes on both sides are considered ideal for arecanut plantations, while wider, relatively flatter areas along the stream or downstream zones, especially at lower elevations, are generally used for paddy cultivation. Eleven households depend on these swamps for daily water consumption and irrigation of orchards and paddy fields.

Actions needed

Catchment area treatment

The catchment area of these three swamps together forms an area of 350 acres. This creates a significant opportunity for catchment area treatment.

The places within the catchment area are Nagin Mane (1 acre), Hoklagadde Betta (25 acres), and Halegubbi Betta (11 acres).

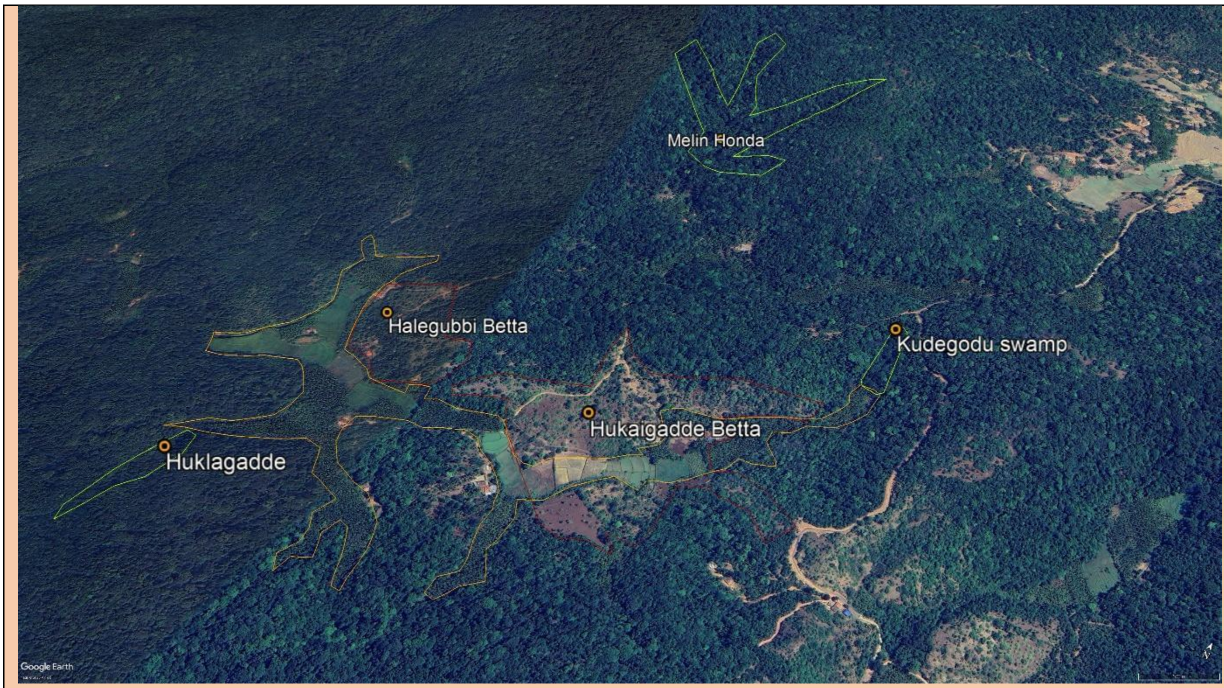

Fig. 30. Action Plan—Kudegodu Kharsekanu cluster

Kudegodu Devikanu swamp cluster

The "Kudegodu Devikanu" swamp is considered sacred, and rituals are regularly conducted at the site. A small structure dedicated to Lord Devi is located at the edge of the swamp, adjacent to the road. The swamp is characterized by a relatively wide stream but supports only a few obligate swamp species. The area has been fragmented by a tarred road, and an arecanut plantation that occupies the land on the opposite side of the road.

Despite its current degraded condition, Kudegodu Devikanu remains a sacred swamp. Downstream, Sasitota 1 (a Myristica swamp) and Sasikodlu also join the same stream, which later merges with Sasihalla—a larger stream that supports Myristicaceae species. This interconnected system forms what we refer to as the "Kudegodu Devikanu Swamp Cluster", an important unit for our documentation, ecological monitoring, and future conservation planning.

The Kudegodu stream travels approximately 0.75 km before joining the Sasihalla stream. Along this stretch, notable Myristicaceae species such as Gymnacranthera canarica and Myristica fatua are present. Their occurrence suggests that the arecanut plantations in the intermediate zones have likely resulted in significant loss of Myristica swamp habitats.

Before merging with Sasihalla, the Sasitota 1 swamp, rich in Myristica species, extends for about 110 meters and ends near the arecanut plantation, although the stream itself continues to flow and joins Sasihalla. Sasikodlu (or Sasitota 2) is another stream that joins this Sasihalla. The Sasihalla stream then flows for approximately 1 km toward Dasuru village, having

Myristica species throughout its path.

There are five households located along these swamp streams, relying on them for both domestic water needs and agricultural irrigation. The agricultural land use primarily includes arecanut plantations, often intercropped with banana, cocoa, cardamom, black pepper, and other spice crops. The swamp system sustains approximately 11 acres of agricultural land during the winter and summer seasons.

Conservation action and restoration potential

The Kudegodu Devikanu swamp has a small catchment area with an open canopy and sparse vegetation. The swamp's catchment includes degraded grasslands and deciduous forest patches, which are critical to its hydrology and ecological integrity. Two major open areas have been identified:

- Devalagudda / Devikanu Gudda: 4 hectares
- Shale Gudda: 6.2 hectares

Both areas have significantly reduced vegetation cover, and restoration efforts targeting these catchments could greatly benefit the swamp ecosystem and water retention capacity.

Suresh Hegde, the owner of the arecanut plantations near Sasitota 1, Sasikodlu, and Sasihalla, has expressed willingness to sell his land, which creates an opportunity for habitat restoration. The land parcels include:

- Arecanut plantations: Survey Nos. 6, 7, 8, and 10, totalling 4.5 acres
- Associated Betta land (forest/hilly land): Survey Nos. 2, 9, and 120, totalling 33 acres
- Sasikodlu (also referred to as Sasitota 2) lacks Myristica species but shows favourable ecological conditions for future restoration or creation of new Myristica swamps.

This makes the Kudegodu Swamp Cluster a potential site for a pilot project aimed at restoring and conserving Myristica swamp ecosystems.

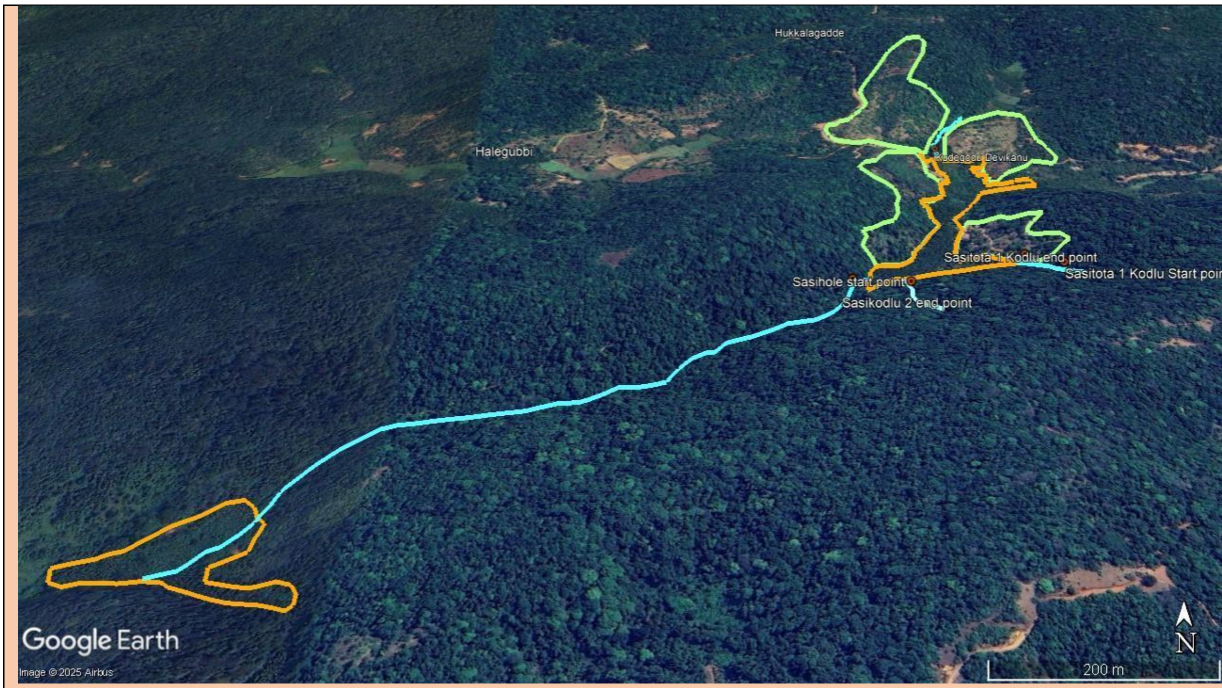

Fig 31. Action Plan- Kudegodu Devikanu cluster

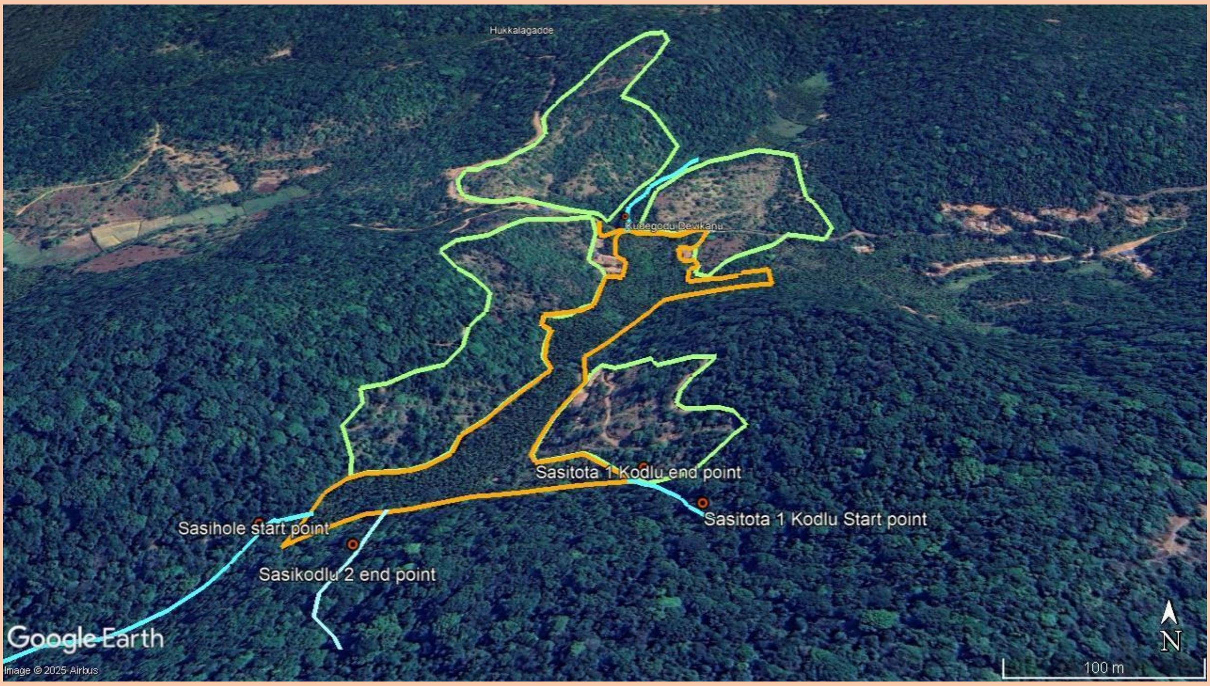

Fig 32. Action Plan- Kudegodu Devikanu cluster (enlarged view)

Action plan for Chare swamp:

In Chare, there are two swamps. Both the swamps are sources of water for agricultural land below. About 15 households and a temple depend on the water from these swamps. Catchments are in fairly decent condition, though the small part is converted into grassland. The evergreen forest is surrounded by the swamp catchment.

Villagers are interested in community-based water management systems with their participation. Streams are becoming deep which is resulting in the draining of surrounding swamp forests.

Swamp restoration needs some check dams to maintain the soil moisture during the lean periods.

Fig 33: *Chare swamps; Green polygons are swamps,*

In Nettikai, the swamp forest was cleared and an areca nut orchard has been raised. It is about 4 or 5 acres in total. This transformation has been happening for the past 15 years. People living adjacent to the swamp forests have slowly encroached on the forests. The presence of perennial water and streams attracts people to convert the land into commercial orchards.

Now there are migrants (16 families) occupying some forest land, and almost 15 years ago, the government-built houses for them in Maastbailu and Unchalli near the forest checkpost.

There are degraded forest patches and degraded betta land (revenue land allocated to pepper-growing farmers during the colonial period), and here forest fires are quite frequent. Otherwise, in the wet evergreen forests, there are no such incidents of fire.

The swamp forests' depression part is fine, but the nearby forests and catchment are degraded. Trees and undergrowth are being cleared in the Bettaland to allow more grass for feeding cattle and mulching the orchards.

Jambe Halla swamp culture

Jambehalla is one of the *Myristica* swamps that we found at the lower altitudes (120 m-125 m) from MSL. There are two more Myristica swamps, viz., Kattepalu 1 and Kattepalu 2, at both of the adjacent sides of Jambehalla (a little bit larger stream). In addition, *Myristica fatua* var. *magnifica* and *Gymnacranthera canarica* plants grow along the banks of Jambehalla, spanning approximately 600 m in length. Kattepalu 1 swamp currently spans an area of about 0.5 hectares. However, historical indicators and field evidence suggest that it may originally have extended up to nearly 1 hectare before experiencing fragmentation or degradation. Kattepalu 2, on the other hand, covers an area of approximately 0.6 hectares and exhibits relatively better connectivity to the mainstream.

The Jambehalla stream serves as a vital freshwater source for nearly 20 households residing in the vicinity. These families rely on its perennial flow for both domestic needs and small-scale agricultural practices.

Importantly, the stream fed by Jambehalla sustains approximately 20 hectares of agricultural land, supporting crops such as arecanut, coconut, and paddy. The sustained flow and water quality of the swamp are thus intimately linked to the agricultural productivity and water security of the local community.

Action plan Kattepalu

In Kattepalu 1 swamp, it has been observed that a major portion is encroached upon, and many plants of Gymnacranthera canarica appear to have either been girdled or drilled and injected with pesticides, which is a significant concern requiring an immediate action. There is good amount of regeneration of *Myristica fatua* var. *magnifica* has been observed during field inventory, which offer ample scope for reintroducing the obligatory swamp species in degraded areas

In both swamps, the core areas contain understory open spaces that are not visible through satellite images, where obligatory swamp species should be planted. In Kotepalu 1 swamp, around 100 plants can be planted, and In Kotepalu 2, nearly 250 plants can be planted.

This swamp lies in Survey number 80 (Village- Halavalli, Hobli-Ankola, Taluk-Ankola, District- Uttarakannada). It consists of different land ownerships i. PRA/FRA lands

ii. Betta Land

ii. Department of Forest, Govt. of Karnataka

Survey number 208 is Bettaland, with an area of 9 acres (~4 ha.) suitable for restoration. Another *Betta land,* located next to the Jambehalla swamp cluster, covers a vast area of 406 acres (165 ha); however, most of this area does not fall within the precise catchment area of the swamp. The vegetation structure of these *Betta lands* have largely changed to deciduous due to years of resource extraction. Bringing back the evergreen species in this area would contribute to the health of the overall swamp and adjacent ecosystems.

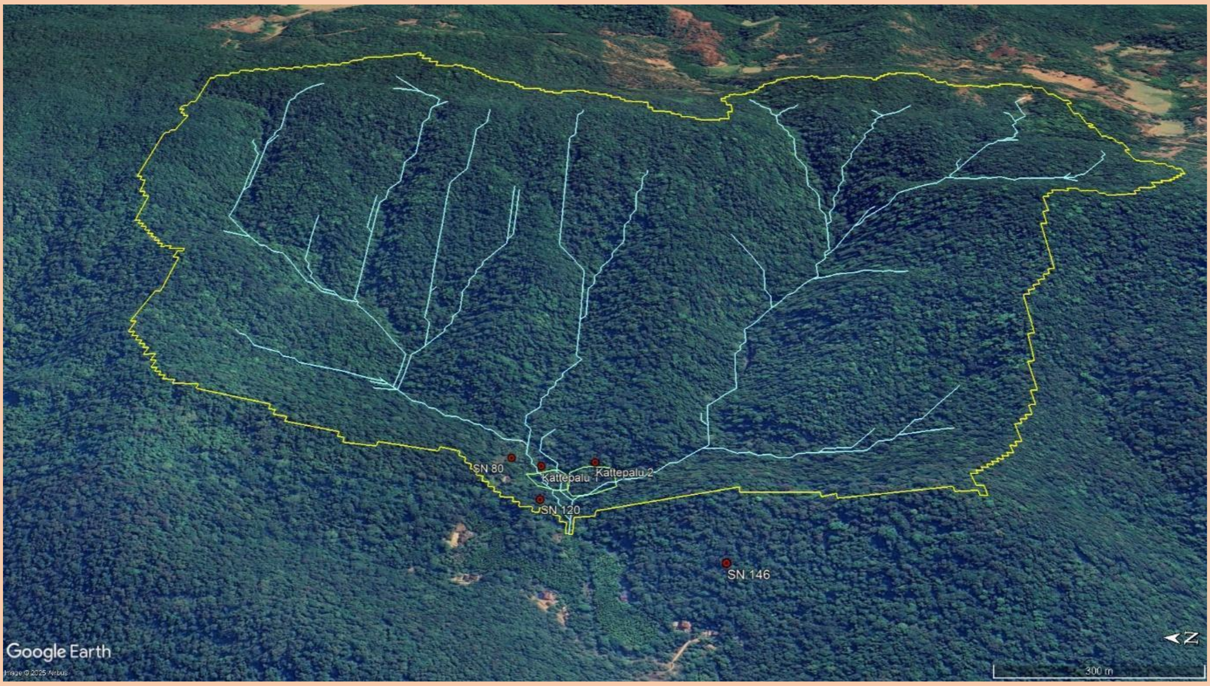

Fig 34. Catchment area and drainage networks in Jambehalla

ರೆಕಾರ್ಡ್ ಆಫ್ ರೈಟ್ಸ್, ಗೇಣಿ ಮತ್ತು ಪಹಣಿ ಪತ್ರಿಕೆ (R.T.C) ಫಾರಂ ನಂ. 16 Print Page No: 1/1 Village Account Form No. 2

Valid from 21/01/2015 05:49:00 PM To Till Date

ಗ್ರಾಮ ನಮೂನೆ 2
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1. ಸರ್ವೆ ನಂಬರು	3. ಖೇತವಾರು	ಎಕರೆ ಗುಂಟೆ ಆ	4. ಕಂದಾಯ	ರೂ. ಪೈ.	9. ಕಬ್ಜೆ ಅಥವಾ ಸ್ವಾಧೀನದಾರನ ಹೆಸರು ತಂದೆಯ ಹೆಸರು ಮತ್ತು ವಿಳಾಸ	ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ	ಖಾತೆ ನಂ.	10. ಕಬ್ಜೆ ಅಥವಾ ಸ್ವಾಧೀನತೆಯ ರೀತಿ	11. ಇತರೆ ಹಕ್ಕುಗಳು ಮತ್ತು ಋಣಗಳು ಹಕ್ಕುಗಳು:	ಋಣಗಳು:
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	ಪೂಟ್ ಖರಾಬ್ (ಬ)	9.00.00.00	(ಕ) ಸೆಸ್ಸುಗಳು	0.00						
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12. ಸಾಗುವ...

13. ...ಮಿಯ ಉಪಯೋಗ ಮತ್ತು ಬೆಳೆಗಳ ...

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RTC- SN 208

ರೆಕಾರ್ಡ್ ಆಫ್ ರೈಟ್ಸ್, ಗೇಣಿ ಮತ್ತು ಪಹಣಿ ಪತ್ರಿಕೆ (R.T.C) ಫಾರಂ ನಂ. 16 Print Page No: 1/4 Village Account Form No. 2
Valid from 17/01/2022 To Till Date

ಗ್ರಾಮ ನಮೂನೆ 9
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1. ಸರ್ವೆ ನಂಬರು	3. ಖೇತವಾರು	ಎಕರೆ ಗುಂಟೆ ಆ	4. ಕಂದಾಯ	ರೂ. ಪೈ.
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ಗಣಪತಿ ಬಿನ್ ಪರಮೇಶ್ವರ ಭಟ್ಟ (1-20-0)	0.00.00.00	658	MR T33/2021-2022 17/01/2022 -	ರಾಮನಗುಳಿ ಗ್ರೂಪ ಸೇವಾ ಸಹಕಾರಿ ಬ್ಯಾಂಕ	MR T48/2011-2012MR 11/2008-2009

12. ಸಾಗುವಳಿದಾರರು ಮತ್ತು ಗೇಣಿಯ ವಿವರ / 13. ಭೂಮಿಯ ಉಪಯೋಗ ಮತ್ತು ಬೆಳೆಗಳ ವಿವರ

ವರ್ಷ ಮತ್ತು ಕಾಲ 1	ವ್ಯವಸಾಯಗಾರರ ಹೆಸರು ಮತ್ತು ವಾಸಸ್ಥಳ 2	ಸಾಗುವಳಿ ಪದ್ಧತಿ 3	ಗೇಣಿಯ ವಿವರ ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ 4	ಗುತ್ತಿಗೆ 5	ಭೂಮಿಯ ಉಪಯೋಗ ವರ್ಗ 6	ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ 7	ಖುಷ್ಕಿ, ತರಿ, ಬಾಗಾಯ್ತು 8	ಬೆಳೆಯ ಹೆಸರು 9	ಬೆಳೆಯ ವಿಸ್ತೀರ್ಣ ಅಮಿಶ್ರ 10	ಮಿಶ್ರ 11	ಒಟ್ಟು 12	ನೀರಾವರಿಯ ಮೂಲ 13	ಎಕರೆಗೆ ಉತ್ಪತ್ತಿ 14	ಮಿಶ್ರ ಬೆಳೆಗಳ ಒಟ್ಟು ಮಿಶ್ರಣದ ಹೆಸರು 15	ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ 16
2024-2025 ಮುಂಗಾರು	ಮಂಜುನಾಥ ಬೆತ್ತಯ್ಯ ಶೇಟ ಹಂಗಾಮಿ ಲಾಗಣಿದಾರ 1122	1					–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಡಿವಿಜನಲ್ ಇಂಜಿನೀಯರ್ ಕರ್ನಾಟಕ ವಿದ್ಯುತ್ ನಿಗಮ ಮಾಗೋಡ	1					–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ನಾರಾಯಣ ಹೊನ್ನಪ್ಪಾ ನಾಯ್ಕ ಸಾಗ್ಗಳಿ ಚೀಟ ಮಂಜೂರಿದಾರ	1					–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಸರಕಾರಿ ಪೋರೇಸ್ಟ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಗಣಪತಿ ಬಿನ್ ಪರಮೇಶ್ವರ ಭಟ್ಟ	1					–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಪರಮೇಶ್ವರ ಬಿನ್ ಗಣಪತಿ ಭಟ್ಟ	1					–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		

RTC DIGITALLY SIGNED ON 1/17/2022

ವಿಸ್ತೀರ್ಣ ಎಕರೆ ಮತ್ತು ಗುಂಟೆಗಳಲ್ಲಿ * : ಬೆಳೆ ಸಮೀಕ್ಷೆ ಮಾಹಿತಿ ಸ್ವೀಕೃತವಾಗದ ಕಾರಣ, ಬೆಳೆ ಮಾಹಿತಿ ನಮೂದಿಸಿರುವುದಿಲ್ಲ ಕರ್ನಾಟಕ ಭೂಕಂದಾಯ ನಿಯಮಾವಳಿ 1966 ರ ನಿಯಮ 40, 42, 58 ಮತ್ತು 70 ಭೂಮಿ ಲ್ಯಾಂಡ್ ಐಡಿ: 6033 5700 0122

RTC- SN 80 A

ರೆಕಾರ್ಡ್ ಆಫ್ ರೈಟ್ಸ್, ಗೇಣಿ ಮತ್ತು ಪಹಣಿ ಪತ್ರಿಕೆ (R.T.C) ಫಾರಂ ನಂ. 16 Print Page No: 1/17 Village Account Form No. 2
Valid from 27/06/2022 To Till Date

ಗ್ರಾಮ ನಮೂನೆ 9
ತಾಲ್ಲೂಕು ಮೊಹರು ತಾಲ್ಲೂಕು : ಅಂಕೋಲ ಹೋಬಳಿ : ಅಂಕೋಲಾ ಗ್ರಾಮ : ಹಳವಳ್ಳಿ ಪುಟದ ಕ್ರಮ ಸಂಖ್ಯೆ :

1. ಸರ್ವೆ ನಂಬರು	3. ಖೇತವಾರು	ಎಕರೆ ಗುಂಟೆ ಆ	4. ಕಂದಾಯ	ರೂ. ಪೈ.
80 1ಅ	ಒಟ್ಟು ವಿಸ್ತೀರ್ಣ	3.05.00.00	(ಅ) ಭೂ ಕಂದಾಯ	0.00
	ಪೂಟ್ ಖರಾಬ್ (ಅ)		(ಬ) ಜೋಡಿ	0.00
	ಪೂಟ್ ಖರಾಬ್ (ಬ)		(ಕ) ಸೆಸ್ಸುಗಳು	0.00
	ಉಳಿದದ್ದು	3.05.00.00	(ಡ) ನೀರಿನ ದರ	0.00
2. ಹಿಸ್ಸಾ •			ಒಟ್ಟು	0.00

5. ಮಣ್ಣಿನ ನಮೂನೆ	7. ಮರಗಳ ಸಂಖ್ಯೆ		8. ಖೇತುವಾರ ಪ್ರಕಾರ ನೀರಾವರಿಯ ವಿಸ್ತೀರ್ಣ					
	ಹೆಸರು	ಸಂಖ್ಯೆ	ಕ್ರ. ಸ.	ನೀರಾವರಿ ಮೂಲ	ಮುಂಗಾರು	ಹಿಂಗಾರು	ಬಾಗಾಯ್ತು	ಒಟ್ಟು
ಕೆಂಪು								
6. ಪಟ್ಟಾ ಸರ್ಕಾರ								

9. ಕಬ್ಜೆ ಅಥವಾ ಸ್ವಾಧೀನದಾರನ ಹೆಸರು ತಂದೆಯ ಹೆಸರು ಮತ್ತು ವಿಳಾಸ	ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ	ಖಾತೆ ನಂ.	10. ಕಬ್ಜೆ ಅಥವಾ ಸ್ವಾಧೀನತೆಯ ರೀತಿ	11. ಇತರ ಹಕ್ಕುಗಳು ಮತ್ತು ಋಣಗಳು ಹಕ್ಕುಗಳು:	ಋಣಗಳು:
ಸರಕಾರಿ ಪೋರೇಸ್ಟ	2.14.08.00	169	574, -	ನೀರಾಶ್ರಿತರ ಪ್ಲಾಟಿನ ಬಗ್ಗೆ 716 ಉಪಯೋಗಕ್ಕೆ ಬಿಟ್ಟಿದ್ದು 117	
ದೇವಿ ಕೋಂ ಬೀರಾ ಗೌಡ	0.01.02.00	5	1056 -		
ಬೋಡ್ಕೆ ಬಿನ್ ಅಂತು ಸಿದ್ದಿ	0.01.02.00	5	1056 -		
ಗಣಪು ಬಿನ್ ಸಣ್ಣು ಸಿದ್ದಿ	0.01.02.00	5	1056 -		
ಕೃಷ್ಣ ಬಿನ್ ಬೀರಪ್ಪಾ ನಾಯ್ಕ	0.01.02.00	5	1056 -		
ನಾಗಪ್ಪ ಬಿನ್ ಈರಪ್ಪಾ ನಾಯ್ಕ	0.01.02.00	5	1056 -		
ಗೋಪಿ ಬಿನ್ ನಾಗು ಸಿದ್ದಿ	0.01.02.00	5	1056 -		
ನಾಗಮ್ಮಾ ಕೋಂ ರಾಕು ಗೌಡ	0.01.02.00	5	1056 -		
ವಿಠ್ಠಲ ಬಿನ್ ಯೇಗು ನಾಯ್ಕ	0.01.02.00	5	1056 -		ರಾ. ಗಾ. ಆ. ಯೋ. ಅ. ಕಾ. ಗ್ರಾ. ಪಂ. ಡೊಂಗ್ರಿ ಬೋಜಾ ರೂ. 5000/- ಲೀಲಾವತಿ

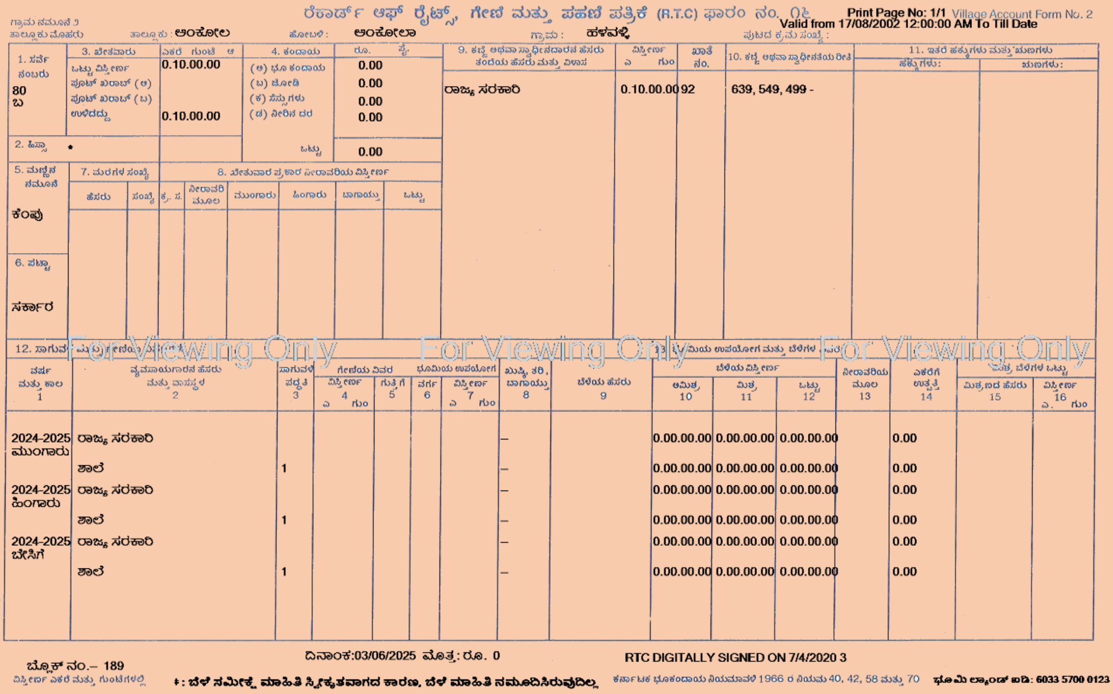
12. ಸಾಗುವಳಿದಾರರು ಮತ್ತು ಗೇಣಿಯ ವಿವರ / 13. ಭೂಮಿಯ ಉಪಯೋಗ ಮತ್ತು ಬೆಳೆಗಳ ವಿವರ

ವರ್ಷ ಮತ್ತು ಕಾಲ 1	ವ್ಯವಸಾಯಗಾರರ ಹೆಸರು ಮತ್ತು ವಾಸಸ್ಥಳ 2	ಸಾಗುವಳಿ ಪದ್ಧತಿ 3	ಗೇಣಿಯ ವಿವರ ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ 4	ಗುತ್ತಿಗೆ 5	ಭೂಮಿಯ ಉಪಯೋಗ ವರ್ಗ 6	ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ 7	ಖುಷ್ಕಿ, ತರಿ, ಬಾಗಾಯ್ತು 8	ಬೆಳೆಯ ಹೆಸರು 9	ಬೆಳೆಯ ವಿಸ್ತೀರ್ಣ ಅಮಿಶ್ರ 10	ಮಿಶ್ರ 11	ಒಟ್ಟು 12	ನೀರಾವರಿಯ ಮೂಲ 13	ಎಕರೆಗೆ ಉತ್ಪತ್ತಿ 14	ಮಿಶ್ರ ಬೆಳೆಗಳ ಒಟ್ಟು ಮಿಶ್ರಣದ ಹೆಸರು 15	ವಿಸ್ತೀರ್ಣ ಎ ಗುಂ 16
2024-2025 ಮುಂಗಾರು	ಸರಕಾರಿ ಪೋರೇಸ್ಟ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ದೇವಿ ಕೋಂ ಬೀರಾ ಗೌಡ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಬೋಡ್ಕೆ ಬಿನ್ ಅಂತು ಸಿದ್ದಿ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಗಣಪು ಬಿನ್ ಸಣ್ಣು ಸಿದ್ದಿ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಕೃಷ್ಣ ಬಿನ್ ಬೀರಪ್ಪಾ ನಾಯ್ಕ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ನಾಗಪ್ಪ ಬಿನ್ ಈರಪ್ಪಾ ನಾಯ್ಕ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ಗೋಪಿ ಬಿನ್ ನಾಗು ಸಿದ್ದಿ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		
	ನಾಗಮ್ಮಾ ಕೋಂ ರಾಕು ಗೌಡ						–		0.00.00.00	0.00.00.00	0.00.00.00		0.00		

RTC DIGITALLY SIGNED ON 6/27/2022

ಬ್ಲೋಕ್ ನಂ.76 ಅ
ವಿಸ್ತೀರ್ಣ ಎಕರೆ ಮತ್ತು ಗುಂಟೆಗಳಲ್ಲಿ * : ಬೆಳೆ ಸಮೀಕ್ಷೆ ಮಾಹಿತಿ ಸ್ವೀಕೃತವಾಗದ ಕಾರಣ, ಬೆಳೆ ಮಾಹಿತಿ ನಮೂದಿಸಿರುವುದಿಲ್ಲ ಕರ್ನಾಟಕ ಭೂಕಂದಾಯ ನಿಯಮಾವಳಿ 1966 ರ ನಿಯಮ 40, 42, 58 ಮತ್ತು 70 ಭೂಮಿ ಲ್ಯಾಂಡ್ ಐಡಿ: 6033 5700 0124

RTC- SN 80 A1



ರೆಕಾರ್ಡ್ ಆಫ್ ರೈಟ್ಸ್, ಗೇಣಿ ಮತ್ತು ಪಹಣಿ ಪತ್ರಿಕೆ (R.T.C) ಫಾರಂ ನಂ. 16 Print Page No: 1/1 Village Account Form No. 2
Valid from 17/08/2002 12:00:00 AM To Till Date

ತಾಲ್ಲೂಕು : ಅಂಕೋಲ ಹೋಬಳಿ : ಅಂಕೋಲಾ ಗ್ರಾಮ : ಹಳವಳ್ಳಿ

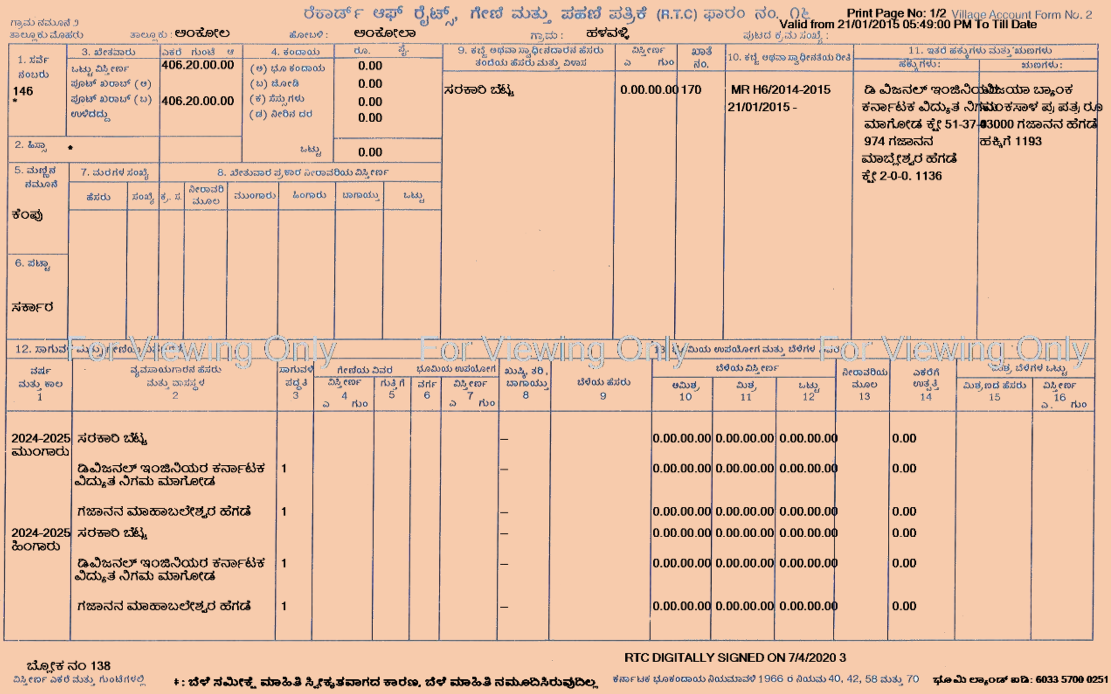
1. ಸರ್ವೆ ನಂಬರು: 80 ಬ
3. ಒಟ್ಟು ವಿಸ್ತೀರ್ಣ: 0.10.00.00; ಉಳಿದದ್ದು: 0.10.00.00
4. ಕಂದಾಯ: (ಅ) ಭೂ ಕಂದಾಯ 0.00; (ಬ) ಜೋಡಿ 0.00; (ಕ) ಸೆಸ್ಸುಗಳು 0.00; (ಡ) ನೀರಿನ ದರ 0.00; ಒಟ್ಟು 0.00
5. ಮಣ್ಣಿನ ನಮೂನೆ: ಕೆಂಪು
6. ಪಟ್ಟಾ: ಸರ್ಕಾರ
9. ರಾಜ್ಯ ಸರಕಾರಿ | 0.10.00.00 | 92 | 10. 639, 549, 499 -

ವರ್ಷ ಮತ್ತು ಕಾಲ	ವ್ಯವಸಾಯಗಾರರ ಹೆಸರು ಮತ್ತು ವಾಸಸ್ಥಳ	ಸಾಗುವಳಿ ಪದ್ಧತಿ	ಬೆಳೆಯ ವಿಸ್ತೀರ್ಣ ಅಮಿಶ್ರ	ಮಿಶ್ರ	ಒಟ್ಟು	ಎಕರೆಗೆ ಉತ್ಪತ್ತಿ
2024-2025 ಮುಂಗಾರು	ರಾಜ್ಯ ಸರಕಾರಿ		0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಶಾಲೆ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00
2024-2025 ಹಿಂಗಾರು	ರಾಜ್ಯ ಸರಕಾರಿ		0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಶಾಲೆ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00
2024-2025 ಬೇಸಿಗೆ	ರಾಜ್ಯ ಸರಕಾರಿ		0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಶಾಲೆ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00

ಬ್ಲಾಕ್ ನಂ.– 189 ದಿನಾಂಕ:03/06/2025 ಮೊತ್ತ: ರೂ. 0 RTC DIGITALLY SIGNED ON 7/4/2020 3

ಭೂಮಿ ಲ್ಯಾಂಡ್ ಐಡಿ: 6033 5700 0123

RTC- SN 80 B



ರೆಕಾರ್ಡ್ ಆಫ್ ರೈಟ್ಸ್, ಗೇಣಿ ಮತ್ತು ಪಹಣಿ ಪತ್ರಿಕೆ (R.T.C) ಫಾರಂ ನಂ. 16 Print Page No: 1/2 Village Account Form No. 2
Valid from 21/01/2015 05:49:00 PM To Till Date

ತಾಲ್ಲೂಕು : ಅಂಕೋಲ ಹೋಬಳಿ : ಅಂಕೋಲಾ ಗ್ರಾಮ : ಹಳವಳ್ಳಿ

1. ಸರ್ವೆ ನಂಬರು: 146
3. ಒಟ್ಟು ವಿಸ್ತೀರ್ಣ: 406.20.00.00; ಉಳಿದದ್ದು: 406.20.00.00
4. ಕಂದಾಯ: 0.00; 0.00; 0.00; 0.00; ಒಟ್ಟು 0.00
5. ಮಣ್ಣಿನ ನಮೂನೆ: ಕೆಂಪು
6. ಪಟ್ಟಾ: ಸರ್ಕಾರ
9. ಸರಕಾರಿ ಬೆಟ್ಟ | 0.00.00.00 | 170 | 10. MR H6/2014-2015 21/01/2015 -
11. ಡಿ ವಿಜನಲ್ ಇಂಜಿನಿಯರ ಕರ್ನಾಟಕ ವಿದ್ಯುತ ನಿಗಮ ಮಾಗೋಡ ಕ್ಕೆ 51-37-0 974 ಗಜಾನನ ಮಾಬ್ಲೇಶ್ವರ ಹೆಗಡೆ ಕ್ಕೆ 2-0-0. 1136 | ಸಿಂಡಿಕೇಟ ಬ್ಯಾಂಕ ಮುಂಕಸಾಳ ಪ್ರ ಪತ್ರ ರೂ 3000 ಗಜಾನನ ಹೆಗಡೆ ಹಕ್ಕಿಗೆ 1193

ವರ್ಷ ಮತ್ತು ಕಾಲ	ವ್ಯವಸಾಯಗಾರರ ಹೆಸರು ಮತ್ತು ವಾಸಸ್ಥಳ	ಸಾಗುವಳಿ ಪದ್ಧತಿ	ಬೆಳೆಯ ವಿಸ್ತೀರ್ಣ ಅಮಿಶ್ರ	ಮಿಶ್ರ	ಒಟ್ಟು	ಎಕರೆಗೆ ಉತ್ಪತ್ತಿ
2024-2025 ಮುಂಗಾರು	ಸರಕಾರಿ ಬೆಟ್ಟ		0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಡಿವಿಜನಲ್ ಇಂಜಿನಿಯರ ಕರ್ನಾಟಕ ವಿದ್ಯುತ ನಿಗಮ ಮಾಗೋಡ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಗಜಾನನ ಮಾಹಾಬಲೇಶ್ವರ ಹೆಗಡೆ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00
2024-2025 ಹಿಂಗಾರು	ಸರಕಾರಿ ಬೆಟ್ಟ		0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಡಿವಿಜನಲ್ ಇಂಜಿನಿಯರ ಕರ್ನಾಟಕ ವಿದ್ಯುತ ನಿಗಮ ಮಾಗೋಡ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00
	ಗಜಾನನ ಮಾಹಾಬಲೇಶ್ವರ ಹೆಗಡೆ	1	0.00.00.00	0.00.00.00	0.00.00.00	0.00

ಬ್ಲಾಕ ನಂ 138 RTC DIGITALLY SIGNED ON 7/4/2020 3

ಭೂಮಿ ಲ್ಯಾಂಡ್ ಐಡಿ: 6033 5700 0251

RTC- SN 146

Activity 2.3 : Active planting In degraded patches initially in the state forest department-owned land in association with VFCs

Based on the action plans developed for each site, planting has been carried out in degraded swamp forests—Katlekan, Aitalimane, Kattepalu, Jambehalla, Kaljaddi, and Maryana Kodlu are the degraded swamps where we have planted obligatory and associated swamp species. Along the ridge evergreen species are also planted. Bekematha (where we organized the design thinking workshop) and Kattinhaklu are the catchment regions in which the planting of evergreen and moist deciduous species was done. In total, 9542 seedlings belonging to 32 species were planted (details provided in the annex 8).

In Katlekan we planted a total of 465 saplings, dominated by *Gymnacranthera canarica* (200) and *Syzygium travancoricum* (50). In Kattepalu 2, a total of 339 saplings were planted, with strong representation from *Cinnamomum malabatrum* (45), *Syzygium travancoricum* (35), and *Lophopetalum wightianum* (30). Kattepalu 1 had 389 plants, dominated by *Gymnacranthera canarica* (130) and *Lophopetalum wightianum* (45). Aitalimane was restored with 516 individuals—the largest among all sites—with 150 *Gymnacranthera canarica* and 150 *Calophyllum apetalum*. The lowest number of saplings planted was in Kaljaddi (60 saplings), mainly *Syzygium travancoricum* (40) and *Myristica malabarica* (4).

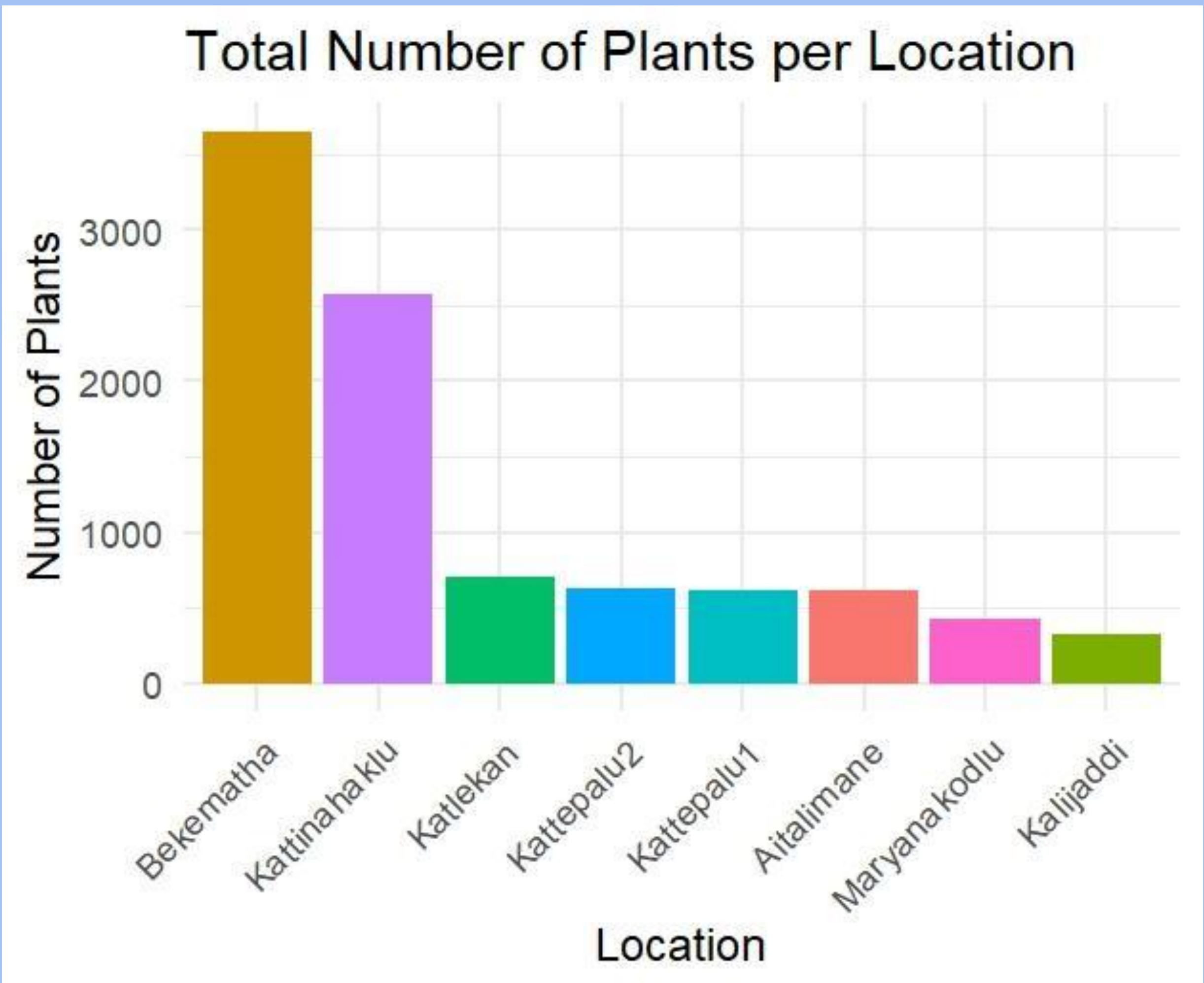


Fig 35. Details of number of saplings planted in each site

Bekemath and Kattinahaklu (the springshed and catchment area of the Kalajaddi swamp), where we planted 3651 and 2576 saplings, respectively, belonging to 29 different species.

Objective 3. ***To undertake microclimate studies to understand the microclimate requirement of obligatory swamp species.***

Activity 3.1 - Data collection from all swamp areas once in 15 days **(May to June 2024)**

Methods

Microclimate loggers (www.tomst.com) were installed in TFSFs near swamp obligatory species. These loggers measure temperatures at soil below 10 cm, surface temperature, and air temperature at 10 cm above ground every 15 minutes. and soil moisture (see fig. 9). Each logger measures three temperatures, and soil moisture data is recorded every 15 minutes. Five loggers in three Myristica swamps were installed. We are assessing the plant species and all obligatory species around each of these loggers in a 10 x 10-meter quadrant.

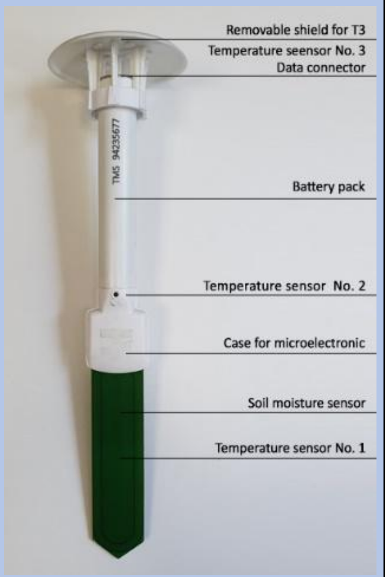


Fig 36: TOMS logger details

For microclimate studies, the following methods were used:

- We measured variables such as soil moisture and soil temperature throughout the year.
- The number of days of submergences of habitat and soil moisture variation across several years and species survival and growth will be assessed.
- Examining the species association in relation to the microclimate variation.

Results/Outputs

Microclimate studies:

Several interesting results emerge from the analysis of microclimatic factors, particularly the correlation between soil moisture and soil temperature, which we briefly present below:

The figures below show how environmental gradients shape the species composition and structure of Myristica swamps (core area) and their adjacent/surrounding landscapes. In the figures below

i) Triangles (coloured as per the legend) represent the mean soil temperature and soil moisture preferred by each species.

ii) Coloured dots indicate the observed occurrences of species across different soil temperature and moisture conditions.

iii) Elliptical outlines illustrate the distribution range of species with respect to soil temperature and soil moisture conditions with 90% confidence.

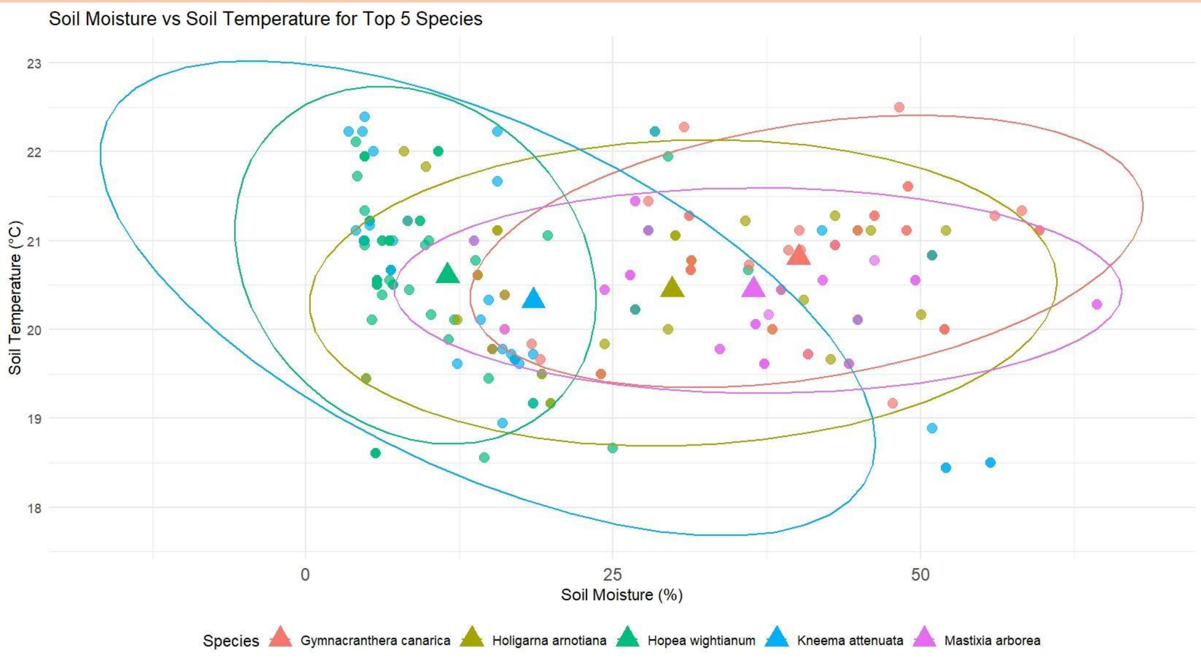


Fig 37. Analysis of soil moisture vs soil temperature for selected top 5 swamp species

There are five Myristicaceae species that share the landscape, namely, *Myristica fatua var. magnifica*, *Gymnacranthera canarica*, *Knema attenuate*, *Myristica malabarica*, and *Myristica beddomei/dactyloides (M. dactyloides* was used in all earlier literature; however, this species is identified as *M. beddomei).* Analysis was done to understand the microclimate niche separation among these. The correlation analysis between soil moisture and soil temperature reveals distinct niche differentiation among the five studied Myristicaceae taxa (Figure 5). Swamp-specialist species such as *Myristica fatua* (r = 0.485) and *Gymnacranthera canarica* (r = 0.284) exhibit moderate positive correlations, indicating that increases in soil moisture tend to co-occur with higher soil temperatures within their occupied microhabitats. This pattern may reflect the thermal buffering capacity of swamp substrates, where saturated soils retain heat more effectively under canopy cover.

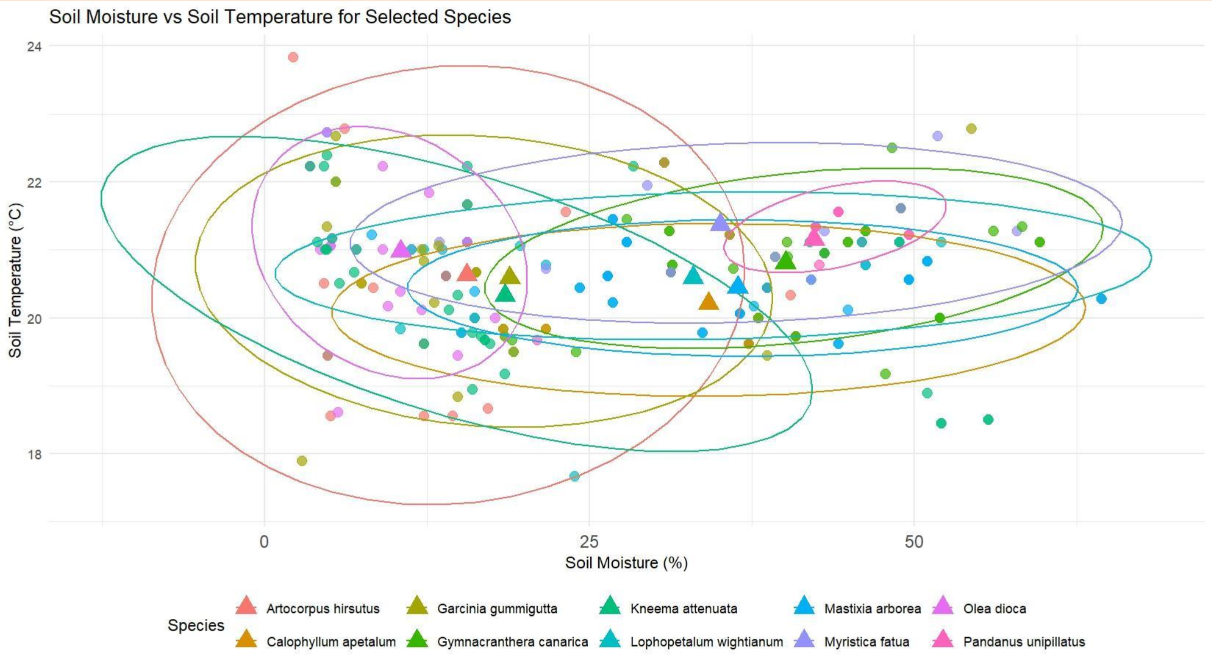


Fig 38. Analysis of soil moisture vs soil temperature - obligatory & facultative swamp species and other evergreen species

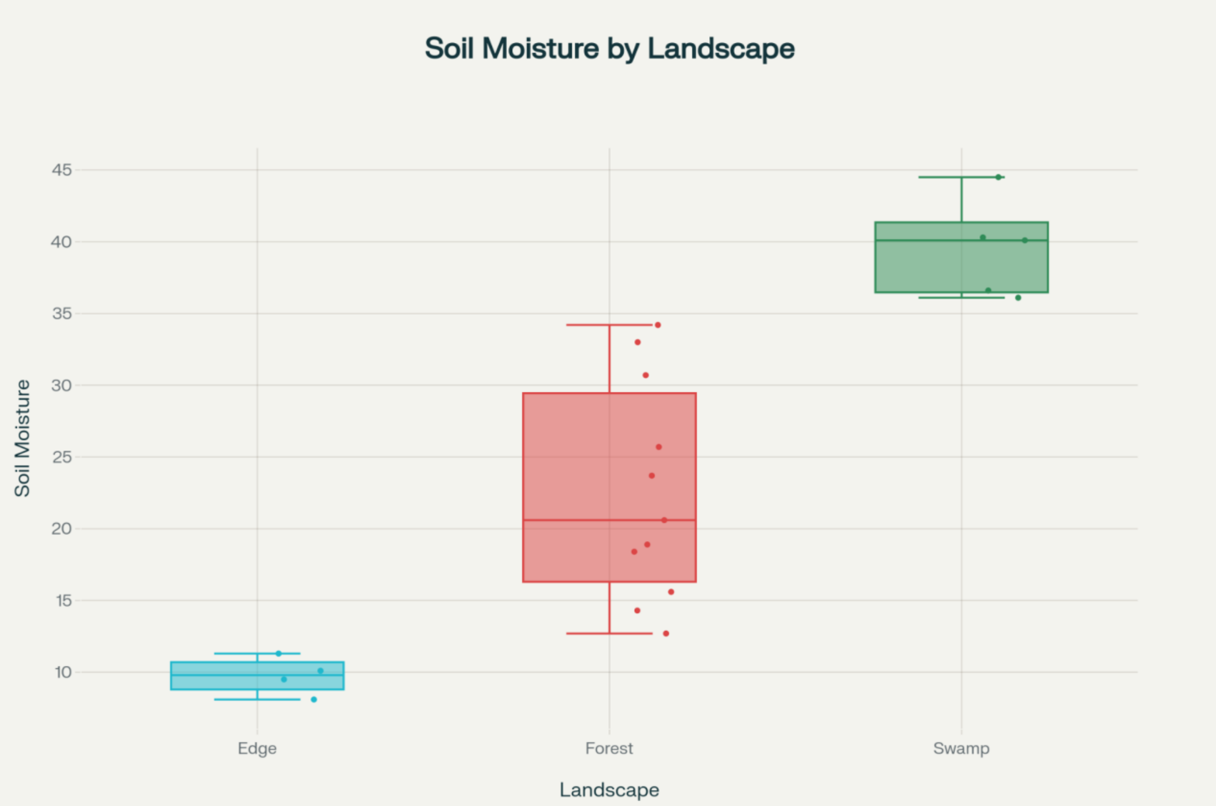


Fig 39. Soil moisture distribution across landscape types showing clear separation between swamp, forest, and edge habitats

The soil moisture data reveals distinct environmental gradients across three landscape types, with soil moisture showing significant variation while temperature remains relatively stable. The results demonstrate clear habitat differentiation based on soil conditions.

Soil moisture patterns

Swamp habitats maintain the highest soil moisture levels, averaging 39.5% with remarkably consistent conditions across species (range: 36.1-44.5%). *Pandanus unipapillatus* exhibits the highest moisture tolerance at 44.5%, while all swamp species show adaptation to waterlogged conditions.

Forest environments display intermediate moisture levels (22.5% average) but with the greatest variability among landscape types. The coefficient of variation reaches 33.5%, indicating substantial microhabitat diversity within forest ecosystems. *Calophyllum apetalum* thrives in the wettest forest conditions (34.2%), while *Garcinia morella* occupies the driest forest microsites (12.7%).

Edge habitats consistently exhibit the lowest soil moisture (9.8% average), representing drought-stressed environments. The narrow range (8.1–11.3%) suggests uniform low moisture conditions, with *Holigarna grahami* showing the greatest drought tolerance at 8.1% moisture.

Soil temperature

Soil temperature shows remarkable consistency across all landscape types, with means ranging only from 20.6°C (forest) to 21.0°C (swamp). This narrow variation (overall range: 19.9-21.5°C) suggests that soil temperature is primarily controlled by regional climate and local landscape characteristics.

This is a narrow variation in the soil temperature recorded, indicating there is no significant difference in soil temperature within core swamp area, and its adjacent ecosystems indicate that soil temperature is not influenced by soil moisture rather controlled by total landscape structure, which may include several vegetation parameters such as species composition and plant density, canopy area and density (light penetration), and other parameters such as slope, soil structure and texture, etc.

It also indicates the ideal soil temperature for *Myristica* swamps to occur is around 20 to 21°C. This is crucial information for guiding future restoration and creation of new swamps in suitable areas. For successful establishment, the soil at selected sites should consistently remain within this temperature range, as it supports the hydrophytic (water-loving) nature of Myristica and other swamp species. It guides us in prioritizing the regions where the mean annual soil temperature meets this requirement when identifying potential sites. Maintaining such thermal conditions is likely to promote optimal growth, regeneration, and long-term ecological stability of swamp-adapted species. Based on this, we can also employ soil temperature monitoring and management techniques to ensure that conditions remain favourable for Myristica species to thrive, especially when introducing them into new or restored habitats (in the case where the landscape provides ideal characteristics for swamp species but the soil temperature and moisture are not).

Objective 4: Influence the creation and expansion of the Myristica-specific budget head in the management plans of the Karnataka Forest Department.

Activity 4.2: Regular meetings and discussions with senior forest officials, the state biodiversity board, and other line departments (watershed development programs) for allocating more investments on TFSF protection (**May 2024 to July 2025**).

Results/Outputs

We met senior forest officials especially to utilize the existing budget for the Myristica swamp properly. For example, we have observed that pits are being dug well before the monsoon in the swamp forests, and non-swampy, non-obligatory species are being planted.

Besides, we have planned to meet the Principal Chief Conservator of Forests, Karnataka with the following objectives:

- We will explain to the Principal Chief Conservator of Forests (PCCF) the details of the ongoing TFSF project that Snehakunja is implementing with support from a THT grant.
- Explore the possibility of using the CAMPA fund in the reclamation of FRA rejected land (Maryana Kodlu, Sirsi Forest Division) to set an example of securing the land adjacent to critical ecosystems such as swamp forests.
- Seek permission to visit Pushpagiri, Brahmagiri, Kudremukh wild life sanctuary in Coorg and entire Western Ghats region in Karnataka state regarding TFSF identification and mapping.
- Possible discussion on TFSF (Myristica swamp) fund utilization and bringing norms to ensure allowed activities.
- Restoration of tea estate belonging to Karnataka State Forest Industries Limited, in Vanachal, the estate adjacent to an Elaeocarpus swamps (about 150 to 200 acres).
- Participation in swamp festival held during March 2025 at Siddapur

Jaddi Habba or Swamp Festival- 2025

Swamp Festival was organized by the Sirsi Forest Division, Karnataka State Forest Department, in collaboration with Village Forest committees of Siddapur taluk.

Date – 26 March 2025

Time – 10.00 AM to 4.30 PM

Objectives:

1. To create conservation awareness about biodiversity and importance of Myristica swamps
2. Sensitising staff and stakeholders towards swamp protection and restoration
3. Distribution of benefits to stakeholders under various schemes of forest department for supporting forest conservation

The program was organized at Shankara Math, Siddapur, Uttara Kannada district. It was inaugurated by Shri Bheemanna Naik, MLA, Sirsi, and Siddapur. Chief guests were Conservator of Forests, Canara circle Vasanth Reddy (IFS); Deputy Conservator of Forests, Sirsi Forest Division Ajjayya G R (IFS); Prof. Vasudev, Dean, College of Forestry; Dr. Narasimha Hegde, Snehakunja Trust; and Balachandra Hegde, Honorary Wildlife Warden, Uttara Kannada. Others included ACF, Janmane, and ACF, Siddapur.

Shri Bheemanna Naik, MLA, highlighted the importance of involving local people in conservation activities. Several awards for SHGs and schools were given.

Deputy Conservator of Forests welcomed the dignitaries and participants and said the department was planning to organise such a swamp festival for the past one year. He explained the objectives of the festival as mentioned above.

Conservator of forests said, because of efforts from various organisations and institutions, a large number of swamps have been identified in Canara circle compared to any other forest circles in the Western Ghats. Now the forest department has taken measures to protect the swamp forests through various activities like fencing, planting and avoiding any land use change, especially conversion of swamp forests into agricultural land.

Dr Vasudev, presented the importance of swamp and role of college of forestry in restoring endangered species *Semecarpus kathlekanensis* and planting in other swamps across Western Ghats. He said the relic forests are under severe threat due to various anthropogenic activities and need to protect them.

Dr Narasimha Hegde spoke about experiences of restoration of swamps over the last two decades. He highlighted community participation in conservation of Myristica swamps. He explained about coining the name Rampatre Jaddi in Kannada for Myristica swamps by Snehakunja during the previous CEPF funded project, which is now the official Kannada name for the Myristica swamps in Karnataka.

Identifying and mapping swamps in the Western Ghats – he said, before the Snehakunja project only 52 swamp forests had been identified in the district and the team added another 60 swamps to the list.

Few examples of activities carried out during the project period, like establishing decentralised nursery, involving them in nursery establishment and active planting, promoting sustainable production methods including establishing of Parna Western Ghats Farmer Producer Company near swamp forests. Publishing popular activities on swamps, organising series of meetings and workshops aiming for long term conservation were explained. Further, restoration protocols to be followed were discussed.

Balachandra Hegde spoke about ecological parameters that the swamps require and ecosystem services of swamps.

A display of Myristica swamps model and fact sheets about swamp forest, species and ecological importance.

Villagers demanded for future workshops should be organised in villages where swamps are located.

Participants:

Total participants 350

40 forest Department staff including range forest officers from Kyadgi and Siddapur attended the workshop.

Students from Ayurveda college, Siddapur, media people and journalists, few individuals from the swamp region, Gram Panchayat members and Women SHG members

Follow up of activities:

Swamp festival including swamp walk in the swamp region to be held for minimum two days in near future

Why is it important for Snehakunja and THT projects on TFSFs?

Many of the front-line forest department staff and officials were newly transferred to this area and provided opportunities to get connected with them and also to explain the conservation and restoration protocols.

Participation in developing state forest department working plan 2025 to 2030

A separate chapter on TFSF was added in the working plan of the forest department of Sirsi division. Restoration swamps with obligatory swamp species, improve the biodiversity and hydrological regime in the swamp catchment region. study the microclimate requirement of the swamp species and plant them accordingly, strengthen local VFCs or EDCs in the swamp region so that they can participate in the restoration and long-term management. Raising more evergreen species in the state forest department nurseries, especially those in the swamp region. Further, we have suggested to promote self-organised trading of NTFPs through VFCs to enable responsible harvesting and involve them in the long-term conservation aspects.

TFSFs future plan of activities

TFSFs and spring sheds

- Identification and mapping of spring sheds, wetlands and TFSFs catchment area for restoration
- Restoration of spring sheds and TFSFs, establishing new swamps in the primary streams (or conversion of ecologically suitable spring sheds into swamp forests) largely in Uttara Kannada district
- Nursery establishment of RET species, TFSFs and evergreen species (partly through women SHGs) – this shall be part of the restoration activity
- Community led water management systems (both TFSFs and spring sheds), establishing soil moisture conservation units
- Constant monitoring of swamp forests to avoid further encroachment and other kind of degradation in the Western Ghats part of Karnataka
- Explore possibilities of restoration of spring sheds and TFSFs in the other Western Ghats region of Karnataka
- Research on relationship between hydrological flow, catchment area and forest cover

Catchment region

- Restoration of catchment area of swamps - more evergreen species and improving the hydrological regime
- Resource augmentation of various plant species to increase the availability of forest products in Betta land and forest lands
- Establishing medicinal plant garden emphasizing growing of locally endangered medicinal; plant species
- Planting of more NTFP species instead of monoculture plantations

Capacity strengthening and income generation activities

- Strengthening the local community organisations for effective management of natural resources (VFCs and SHGs)
- Identifying local forest products that needs sustainable harvesting training, value addition and value chain development possibilities, market linkages. Establish common processing centre for processing of NTFPs

- Promote self-organized trading of NTFPs through VFCs.
- Training existing biodiversity committee (within village panchayat) to motivate them for effective participation in the biodiversity conservation
- Liaison with biodiversity management committee for effective management of natural resources and judicial use of village panchayat grants allocated for biodiversity conservation

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