

# Recent Changes of Floral Diversity in the Hirikatu Oya Sub-Watershed, Sri Lanka

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## Abstract

The floral diversity contributes to invaluable ecosystem services and habitat values in a rich forested area. The Hirikatu Oya sub-watershed in the southwestern central mountain area of Sri Lanka is also one of the important forested areas with many recent challenges. This study aims to examine current changes in floral species in the Hirikatu Oya sub-watershed from the year 2000 to 2022. For the study, primary data were collected from a field survey of 25 stratified purposive sample sites (20 m × 20 m plots), along with 30 questionnaire surveys and 14 interviews. Primary-level findings were blended with secondary data sources. A mixed-methods strategy was employed to analyze the data. The study area is home to a diverse range of plant species, including woody, medicinal, tree species as well as, endemic and invasive plant species. Notably, the study revealed that 7 invasive plant species are available, while 4 plant species are already extinct and about 14% of tree species and 50% of vines are threatened. The outcome of the study highlights the need for effective management strategies and continuous efforts need to be made to strengthen management techniques, enforce relevant rules, encourage community involvement, and implement targeted initiatives for the sustainability of the forested area in the Hirikatu Oya sub-watershed in Sri Lanka.

**Keywords:** Ecosystems, Floral Diversity, Invasive Species, Sub-Watershed, Threatened Species.

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## 1. INTRODUCTION

Since Sri Lanka has a wide variety of ecosystems, temperatures, types of soil, and topography, it is well known for its high biodiversity, resulting in a wide range of flora and fauna. To preserve the island's distinctive biodiversity, conservation efforts, and sustainable management techniques are crucial, given the existence of endemic, vulnerable, and common plant species in Sri Lanka.

The National Red List of Sri Lanka (2012) states that approximately 44% of the country's flowering plant species are endangered (Lanka, 2023). Nearly half of the evaluated species on Sri Lanka's red list of native plants are in danger of going extinct (Rodrigo, 2021). The biodiversity of Sri Lanka is also threatened by Invasive Alien Plant Species (IAPS). In order to combat invasive species in Sri Lanka, the Plant Protection Act No. 35 of 1999 was created, and the Plant Protection Service of Department of Agriculture is in charge of putting the act into practice (Auditor General's Department [Sri Lanka], 2020). It is well known that plant invasions can have serious effects due to climate

change, as they are considered agents of global change (Kariyawasam et al., 2019). IAPS are becoming a bigger threat to ecological stability and biodiversity, but their effects have received little research, particularly in developing nations (Kariyawasam et al., 2019).

Human activities significantly have an impact on plant species diversity and composition in both desert and urban ecosystems. For instance, research indicates that desert urbanization affects the distribution, composition, and diversity of plant species in newly urbanized desert ecosystems, leading to the dispersal of new species and destruction of plant cover in certain desert areas (Hassan & Hassan, 2019). Salinity, as observed in Siwa Oasis, is an important factor limiting species diversity (Abdel et al., 2004).

In the Tibetan grasslands, human activities have led to a 1% loss in plant species richness on average (Huang & Fu, 2023). However, these activities have also increased the Shannon, Simpson, and Pielou diversity indices by 26%, 4%, and 5%, respectively (Huang & Fu, 2023). Less than 48% of areas demonstrated positive

impacts of human activities on plant species  $\alpha$ -diversity (Huang & Fu, 2023).

Anthropogenic changes in environmental limiting factors are likely to cause significant losses in plant diversity, resulting in many niches becoming vacant and plant communities becoming dominated by weedy species (Tilman & Lehman, 2001). The extent of this effect depends on the number and magnitude of environmental constraints that have changed. Vacant niches created by human-caused environmental changes could allow the invasion and spread of species with appropriate traits, even if they are poor competitors. Existing species may rapidly evolve to fill these vacant niches, but they are unlikely to be equivalent to species adapted to the original environmental conditions.

Research on temporal changes in plant species numbers often focuses on how species richness, composition, and diversity evolve over time due to various ecological and anthropogenic factors. For instance, long-term forest studies spanning 36 years have revealed significant temporal changes in species richness and diversity, emphasizing how forest dynamics are influenced by both natural succession and human-induced changes (Joshi *et al.*, 2024).

Global changes impacting diversity have led to local extinctions of some species while others have expanded their ranges, resulting in notable shifts in plant diversity over the last century (Jandt *et al.*, 2022).

In South Korea, a study examining the phylogenetic and functional traits of woody plants across different forest types found that while species composition changed over time, the phylogenetic and functional diversity metrics exhibited different patterns, suggesting that the ecological processes driving these changes are complex and vary by site (Chun & Lee, 2019). This study will similarly investigate site-specific changes in woody, medicinal, and vine species in the Hirikatu Oya sub-watershed. Collectively, these studies underscore the importance of long-term ecological research to understand how plant species numbers and community structures change over time, influenced by both natural processes and human activities.

Forests in Sri Lanka have suffered a great deal because of human activities like deforestation, logging, agriculture, and urbanization. Conversion of forest for farming or habitation results in the loss of natural ecosystems and changes the diversity of plant species. Because they disturb ecological processes and compete with local plants for resources in Sri Lankan forests. Especially in the dry zone of Sri Lanka stream reservations are affected due to new changes in land use such as Agro-well development (Perera, 2017).

The Hirikatu Oya, a tributary of the Walawe River, is home to an array of diverse plants and animals,

and further it acts as a catchment water sponge. The region's biodiversity and natural heritage are dependent on protecting the river and its ecosystems. Forest degradation has led to changes in plant species, affecting the ecosystem and water catchment area. A mixed-methods strategy is employed to analyze both qualitatively and quantitatively. This study examines the impact of human influences on plant species changes in the Hirikatu Oya Sub-watershed. This study aims to determine whether human activities have had positive or negative effects on plant diversity in this region, similar to patterns observed in other ecosystems. Particular attention is given to the spread and distribution of invasive species, long-term changes in floral composition, and the expansion or extinction of species by comparing historical and current data. By examining the floral species changes, including both natural processes and anthropogenic influences, this research contributes to a deeper understanding of ecological trends in the sub-watershed.

The study emphasizes the urgent need for efficient management approaches to address recent floral species changes in the Hirikatu Oya sub-watershed. Community involvement and awareness are crucial for successful conservation activities. To prevent invasive species spread and encourage sustainable forest conservation, ongoing efforts must be made to reinforce management methods, enforce regulations, and implement targeted programs. The study underscores the urgent need for efficient management approaches to address the changing plant species in the Hirikatu Oya sub-watershed.

The history of Sri Lanka reveals that the country's floral diversity in forests was once rich but is now gradually declining. A number of studies including Perera and Nianthi (2016), have discussed the impact on floral diversity in the river basin context. Most of the Hirikatu Oya sub-watershed, in the Walawe River basin too is covered with forest. This region is experiencing forest degradation, which is critical for the survival of downstream areas. A watershed's ability to function depends on having a healthy catchment area and base flow. Distributional shifts in floral species have an impact on the severity of forest degradation. However, there are no significant studies on the degradation of the floral species in the Hirikatu Oya sub-watershed. Despite the critical role this sub-watershed plays, there is a lack of comprehensive research addressing floral species degradation in the area.

There are three objectives of this study as follows.

- To identify the tree species and vine/lianas species changes in the Hirikatu Oya sub-watershed.
- To analyse the distribution and spread of invasive plant species in the Hirikatu Oya sub-watershed.

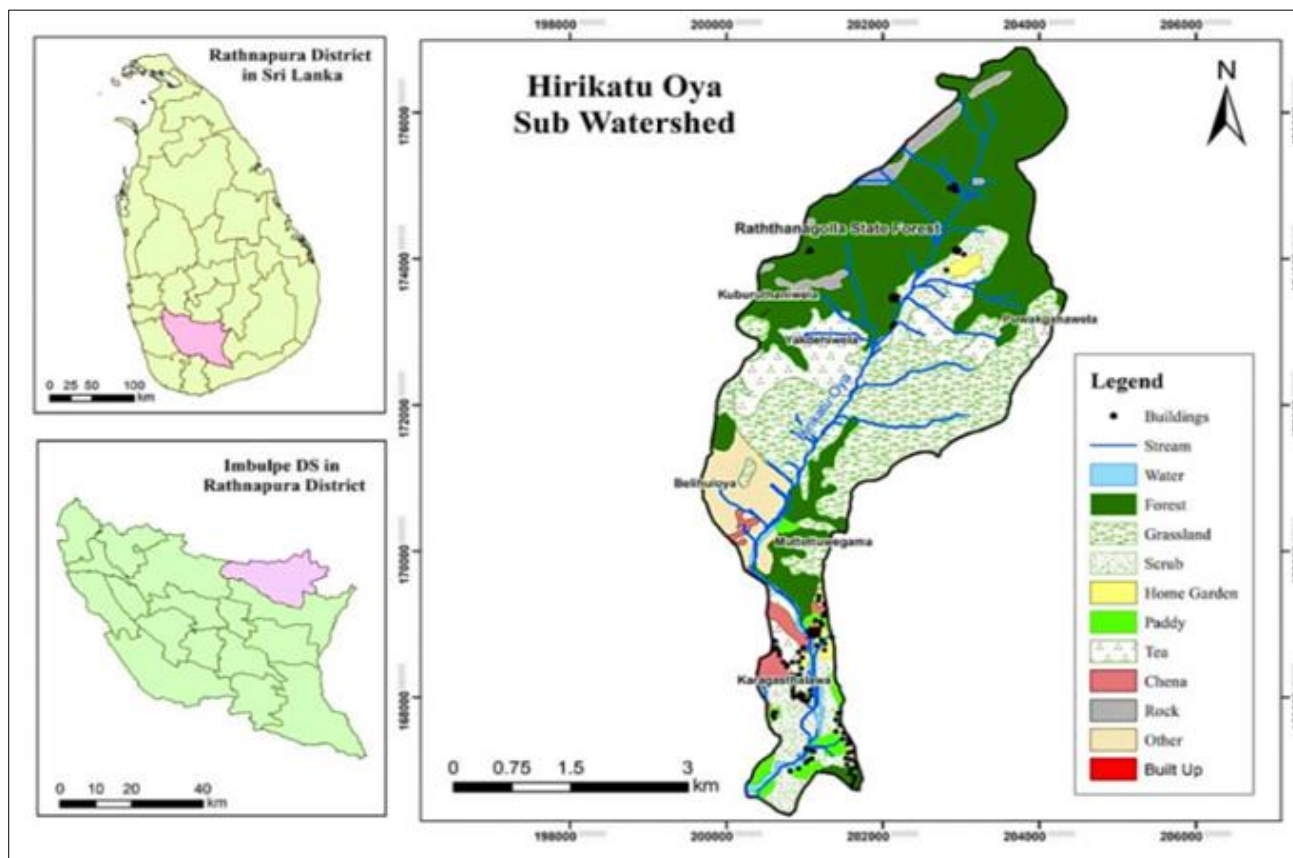
- To examine the threatened plant species in the Hirikatu Oya sub-watershed.

## 2. MATERIALS AND METHODS

### 2.1. Study Area

In this study, the Hirikatu Oya (Kirikati Oya) sub-watershed is used as the study region (Figure 1), and

the recent plant species changes between 2000 and 2022 were investigated. It is one of the Walawe River's sub-watersheds, covering an area of 2105.55 acres. It is located in Sri Lanka's wet and intermediate zones. This zone is recognized as a biogeographically significant area in Sri Lanka for its water source and eco-system value.



**Figure 1: Study area**

Source: Google Earth Pro (2022), Survey Department of Sri Lanka

In the research area, sub-montane forests, lowland-wet forests, and grasslands are the most common types. The Hirikatu Oya sub-watershed area holds great significance, and woods have a major role in ensuring the area's continued existence.

It originates in the Yakdehiwala GN Division and runs through Muththetuwagama and Karagasthalawa GN Divisions. The Hirikatu Oya River and the Belihuloya River merge in Kinchigune GN Division. It then enters the Samanawewa Reservoir as the Belihuloya River.

The Hirikatu Oya River is approximately 9 km long. The average temperature in the Hirikatu Oya sub-watershed is 25°C, with lows of less than 20°C due to north-facing slopes. Rainfall fluctuates between 2000mm and 4500mm. The Southwest and Northeast Monsoons have an impact on the research area. The region has various soil types, including steep rockland,

lithosols, mountainous terrain, hilly terrain, and rolling terrain. (Imbulpe Divisional Secretariat, 2021).

This area is home to a variety of plant species, such as Iramusu (*Hemidesmus indicus(L)R.Br*), Hathwariya (*Asparagus falcatus*), Badulla (*Semecarpus coriacea*), Milla (*Vitex pinnata*), Havarinuga (*Astonia macrophylla*), Acacia (*Acacia nilotica*), Ashoka (*Saraca asoca*), and Sathsada (*Aristolochi indica*) and some endemic plant species like Maharathmal. Various wildlife species, including deer, wild boars, leopards, rabbits, parrots, Golden orioles, and indigenous lizards like Ankattussa, can be identified.

### 2.2. Methodology

To acquire information regarding plant species changes in the Hirikatu Oya sub-watershed, this study used primary data methods such as questionnaires, interviews, and observations, as well as secondary data from books, reports, websites, articles, and maps. The

survey included 30 households, which represented 30 families that had lived in the neighborhood for 30 years or more. During the study, 14 officers were interviewed, including GN officers (02), agricultural officers (02), wildlife officer (01), forest officers (05), environmental officer (01), Regional council members (01) and members of non-governmental environmental organizations (02). The interviews provided information on forest degradation state, human interventions between 2000 and 2022.

25 stratified purposive samples (20 m × 20 m plots) were collected from both natural and human-affected forest regions within the watershed basin. The samples were utilized to determine changes in plant species, such as invasive, risky, already threatened, and extinct species. The samples were collected to verify the information gained from the questionnaires regarding the change in plant species in the research area.

The study attempted to determine changes in plant species in the Hirikatu Oya sub-watershed forest by collecting 20 samples and analyzing questionnaire data. The samples were taken from locations that had been damaged, such as burnt areas, abandoned forests near human settlements, crop-cleared areas, and natural forests. Secondary data were gathered using maps, websites, books, research publications, and institutional reports. Data from the Divisional Secretariat Office in Imbulpe, the Balangoda Range Forest Office and Wildlife Office, and the GN offices in Muthetuwegama, Yakdehiwala, Karagasthalawa, and Kinchigune, as well as satellite pictures, were gathered.

Surveys, interviews, and observations were used to conduct qualitative analysis, with an emphasis on the changes in plant species and the human factors that influence them. Google Earth was utilized in the study to determine the Hirikatu Oya sub-watershed and the extent of forest degradation. Plant species change data was presented in the form of charts, graphs, tables, and other statistical data. Quantitative analytic techniques were employed to analyse information gathered from institutional reports and data collected through questionnaires.

### 3. RESULTS AND DISCUSSION

#### 3.1 The Current Status of Plant and Tree Species in the Hirikatu Oya Sub-Watershed

The research area is home to a diverse range of plant species, including invasive, woody, and medicinal plants, as well as rare species such as *Maha Rathmal* Tree. Fauna species include deer, wild boars, leopards, rabbits, parrots, and lizards, among others. It is also possible to identify native lizards such as *Ankattussa*.

Through this study, 71 tree species were identified, and it was possible to identify the changes in forest degradation over time in woody plants, medicinal plants, invasive plant species, shrubs, and small plants in the forest area. The following figure 4 shows the current plant species, risk plant species, and threatened and extinct plant species that can be identified in the forests of the Hirikatu Oya sub-watershed (Figure 2).

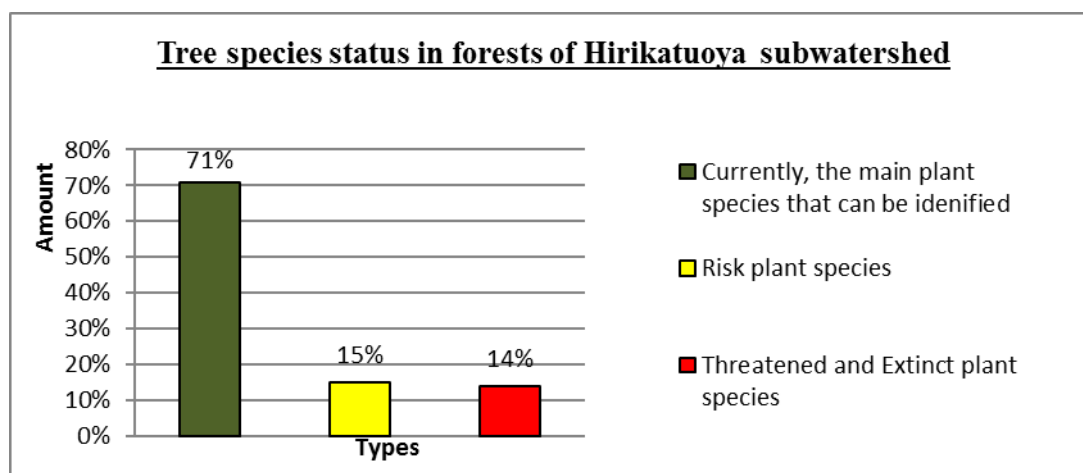
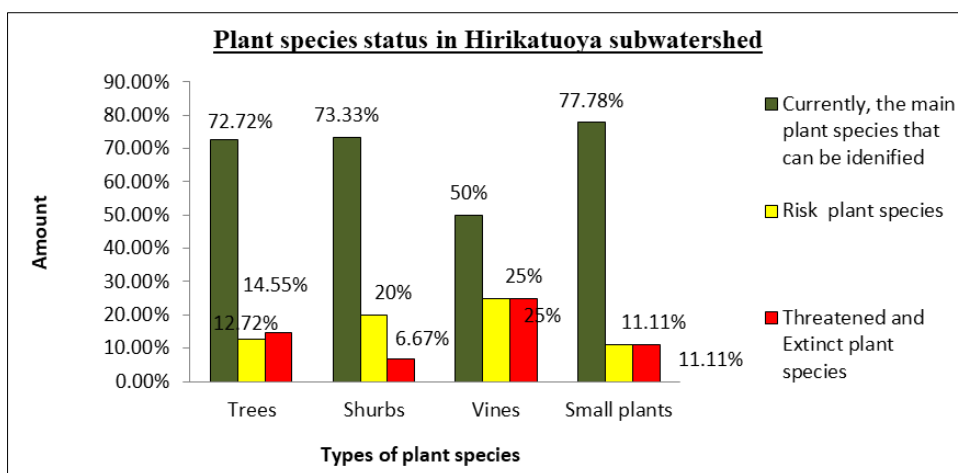


Figure 2: Tree species status in the Hirikatu Oya sub-watershed

Source: Questionnaire survey and Field Study, 2022

In the Figure 3, the plants that can be identified in the forest area of the Hirikatu Oya sub-watershed, the risk plant species, and the threatened and extinct plant

species are further classified as trees, shrubs, and vines and small plants (Figure 3).



**Figure 3: Plant species status in the Hirikatu Oya sub-watershed**

Source: Questionnaire survey and Field Study, 2022

Accordingly, more small plants can be identified in the deforested areas, which is 77%. Also, the number of risk plant species and the threatened and extinct numbers have taken the same value, which is 11%. 50% of the vines are currently identifiable, and fifty percent are at risk, threatened, and extinct. 73% of the shrub species can be identified at present, and 20% are under threat. 6.6% are already threatened or extinct. And when the quantitative values of abundant tree species are studied, it is 72%. At present, 14% are under threat or extinct, and 12% are under risk.

Several facts were revealed through interviews, questionnaires, field observations, and sample collection while studying the changes in plant species present in the forests of the Hirikatu Oya sub-watershed.

"In the Kumburutheniwala area, there were many types of medicines called *Jatamansha*, *Ashoka*,

*Bin Khomba*, and *Malithi*. The Muththetugama area was also sandalwood, as was *Wallapatta*, but now many of them have been cut off and are extinct in the forest area. Also, *Keena* trees die and fall on a large scale. Acres of *Na* trees are dying and falling. *Milla* trees are used to build houses for people, so they are taken when needed, and those plants are also becoming extinct. What was noted as a new addition has been causing great destruction through the cultivation of pines for many years. The water is pouring. The pine forest is being set on fire now. Pine forest fires are spreading quickly." (Non-governmental organization member: Imbulpe, 21/03/2022)

Interviews conducted with the Range Forest officers revealed that the reason for the deaths of *Keena* trees is that the groundwater level is insufficient and the lives of the trees have now ended. The University of Sabaragamuwa researched this and revealed the facts.



**Figure 4: Dead Keena tree**  
Source: Field observation, 2022

Thus, it can be identified that the forest degradation is mainly in the Hirikatu Oya Sub-watershed

area, and in this way, the reduction of the groundwater level in the Hirikatu Oya sub-watershed can be thought

to be caused mainly by the human-caused forest fires and other degradation factors that are carried out in the upper parts of the forests. It can be recognised that this has negatively affected the survival of the plant species.

"Ashoka trees are very rare now. Also, Wallapatta and sandalwood were cut down a lot in the past. But these are the plants that used to be native here, but now they are under threat in the forest area." (Agricultural extension officer: Imbulpe, 16/03/2022)

"Wallapatta, Sandalwood, and Velan trees were cut down as a racket. Already, Wallapatta has been trapped since the beginning. There are separate smuggling groups behind each other. To tell the truth, at least one or two plants are not left in the garden; they are taken away by stealthily." (President of Haritha Mithuru Society, Imbulpe, 21/03/2022)

"The Wallapatta tree's wood is used to make premium incense, perfumes, and traditional medicines. It has been used for a very long time and is valued as a precious and scarce resource in Sri Lankan culture. The tree produces dense, long-lasting wood that can be used for building, producing furniture, and creating a variety of crafts." (Forest extension officer, Balangoda Range Forest office, 15/03/2022)

The sandalwood tree's wood is strong and dense, making it a good material for building, furniture, and a variety of handicrafts. Ayurveda medicine uses *Bin Kohomba* oil because of its anti-inflammatory and antiseptic properties. Both people and animals appreciate the fruits that *Mee* trees produce. The fruits are employed in regional cuisine and old-fashioned dishes because they are nutritious. *Mee* oil is used in food, cosmetics, and medicine. It is employed in traditional Ayurvedic medicine, cuisine, and cosmetics as a moisturizer. *Gammalu* and *Keena* trees are prized for their robust and dark-colored wood. High-end furniture, exquisite carvings, musical instruments, and handicrafts are all made from ebony wood. *Velan*, often referred to as Toon or Toona wood, is appreciated for its high-quality timber that is portable, simple to work with, and has exceptional strength and longevity. It is employed in building, constructing furniture, and creating musical instruments. The *Velan* tree has a variety of traditional medicinal purposes. The seeds, leaves, and bark are thought to have a variety of therapeutic benefits.

Also, there has been a decrease in valuable medicinal plants such as *Bin Kohomba*, *Hathavariya*, *Ekawariya*, *Iramusu*, and *Malithi* due to forest degradation. The extinction of plant species such as *Burutha* and *Kaluwara* can also be identified in the early period. Thus, the woody, medicinal, and other valuable of plants have been affected by humans, e.g., cutting down trees for wood, etc.

There are some facts revealed through the interviews regarding the plant species changes. *Keena* trees die and fall on a large scale. The reason for the deaths of *Keena* trees is that the groundwater level is insufficient, and the lives of the trees have now ended. *Milla* timber is used to build houses, so they are taken when needed, and those plants are also becoming extinct. *Wallapatta*, Sandalwood, and *Velan* trees were cut down as rackets. Already, *Wallapatta* has been trapped from the beginning. There are separate smuggling groups behind each other. *Asoka* trees are very rare now.

Pines only absorb water from the plant. It is taking the place of soil erosion. There is no soil conservation. With significant growth, *Acacia* and *Pine* plants can be identified. The local plant community has been impacted. Local plants have been cultivated, and although local plants are cultivated with priority among the plant species, there is no noticeable difference in the growth of local plants, and the growth of plants such as pines can be recognized over their growth.

A tree is a sizable, permanent woody plant with a single main stem or trunk that frequently includes branches and foliage that reach above the ground. Since several kinds of trees can grow to great heights and produce different canopies, height is a defining characteristic of trees.

According to information gathered from damaged forest areas, it was feasible to identify approximately 55 different types of trees that may be found in the forest areas in the early and later phases of the Hirikatu Oya Sub-watershed using samples from the research area and questionnaires. These trees were further categorized as having a dominant medicinal value, a dominating woody value, a dominant woody and medicinal value, and others (Table 1).

**Table 1: Recorded main Tree species in Hirikatu Oya sub-watershed**

No	Local Name	Scientific name	Family	Identified in year 2000	Availability at present
<b>Medicinal value</b>					
1.	Aralu	<i>Terminalia chebula</i>	Combretaceae	✓	✓
2.	Bulu	<i>Terminalia bellirica</i>	Combretaceae	✓	✓
3.	Nelli	<i>Phyllanthus emblica</i>	Phyllanthaceae	✓	✓
4.	Boo	<i>Ficus religiosa</i>	Moraceae	✓	✓
5.	Gammalu	<i>Pterocarpus marsupium</i>	Fabaceae	✓	✗

Timber value					
6.	Rukkaththana	<i>Allamanda, grandiflora</i>	Apocynaceae	✓	✗
7.	Badulla	<i>Semecarpus coriacea</i>	Anacardiaceae	✓	✓
8.	Kudu-dawula	<i>Neolitsea fuscata.</i>	Lauraceae.	✓	✓
9.	Milla	<i>Vitex pinnata</i>	Lamiaceae	✓	✗
10.	Velan	<i>Pterospermum suberifolium</i>	Malvaceae	✓	✗
Other values					
11.	Bata doba	<i>Balsamaria inophyllum Lour</i>	Calophyllaceae	✓	✓
12.	Erabadu	<i>Erythrina variegata</i>	Fabaceae	✓	✓
13.	Kahata	<i>Careya arborea</i>	Lecythidaceae	✓	✓
14.	Bala boothara	<i>Eleusine indica</i>	Poaceae	✓	✓
15.	Divi Kaduru	<i>Pagianta dichotoma</i>	Apocynaceae	✓	✓

Source: Questionnaire survey and Field Study, 2022

### 3. 2. Vines/Lianas Species Changes in the Hirikatu Oya Sub-Watershed

Plants with lengthy, trailing, or climbing stems—known as vines—cannot stand upright on their own. To climb and expand, they frequently rely on outside supports like trees, trellises, or other buildings. Specifically designed elements, like tendrils or twining stems, are frequently found on vines, which help with attachment and climbing.

The number of vines mainly in the study forest area was 12, of which 5 were vines with medicinal value. The remaining seven are used for other purposes. Examples: cane, for weaving cane. All in all, one of the medicinal vines that were identified in the early period is difficult to identify now, and it is possible to think that 50% of vines species of the total number of vines in the area have been affected and are threatened (Table 2).

Table 2: Vines species changes in the Hirikatu Oya sub-watershed

No	Local name	Scientific name	Identified in year 2000	Difficult to Identified in present period/extinct
Medicinal value				
1.	Weniwalgata	<i>Coscinium fenestratum</i>	✓	✗
2.	Hathavariya	<i>Asparagus falcatus</i>	✓	✗
3.	Iramusu	<i>Hemidesmus indicus(L)R.Br.</i>	✓	✗
4.	Ekaweria	<i>Rauvolfia serpentine (L.) Benth. Ex Kurz</i>	✓	✗
5.	Sassada	<i>Aristolochia indica L.</i>	✓	✗
Other values				
6.	Babarawel	<i>Dalbergia pseudo-sissoo Miq.</i>	✓	✓
7.	Wewal	<i>Calamus rotang</i>	✓	✗
8.	Kalawel	<i>Derris trifoliata</i>	✓	✓
9.	Kahabiliya	<i>Tragia involucrate L.</i>	✓	✓
10.	Pota	<i>Pothos scandens L.</i>	✓	✓
11.	Walgammiris	<i>Piper sylvestre Lam</i>	✓	✓
12.	Agamula nathi wel	<i>Cuscuta reflexa Roxb.</i>	✓	✓

Source: Questionnaire survey and Field Study, 2022

### 3.3. Invasive Plant Species in the Hirikatu Oya Sub-Watershed

A species that is non-native to the ecosystem in question and whose introduction has the potential to affect the environment, the economy, or human health is referred to as an "invasive species". Among other characteristics, invasive plant species have the ability to generate vast amounts of seed, flourish in disturbed soil, and have active root systems that can spread widely.

There are several ways that invasive plant species affect native species, communities, and ecosystems (Pyšek *et al.*, 2012). Invasion-induced reductions in native biota's species richness, abundance, and local species diversity lessen the individuality of

biological communities over a range of geographical scales (Pyšek *et al.*, 2012).

For moisture, sunlight, nutrition, and space, invasive species directly compete with native plants. Plant diversity in general may decline. Wildlife habitat can be harmed by the establishment and spread of invasive species. It leads to low agricultural land quality. Reduced recreational options, deteriorated water quality, and increased soil erosion alter the balance of nature upon which all species rely.

Some of the invasive plant species that have been found in Sri Lanka are *Havarinuga (Alstonia macrophylla)*, *Mahogany (Swietenia macrophylla)*,

*Gadapana (Lantana camara)*, and *Acasia (Acacia nilotica)*.

The following table lists the primary invasive plant species that can be found in analysing the spread of invasive plant species in the Hirikatu Oya sub-watershed (Table 3).

**Table 3: Invasive or exotic plant species in Hirikatu Oya sub-Watershed**

No	Local name	Scientific name
1.	Havarinuga	<i>Alstonia macrophylla</i>
2.	Gadapana	<i>Lantana camera</i>
3.	Acacia	<i>Acacia nilotica</i>
4.	Wel nidikumba	<i>Mimosa invisa</i>
5.	Katakalu bovitiya	<i>Clidemia hirta</i>
6.	Wathupaluwel	<i>Macania micrantha</i>
7.	Pines	<i>Pinus caribea Morelet</i>

Source: Field study, 2022

According to the data, out of the total floral species, 20% (7 species out of 34) are invasive or exotic plants. One of the most prevalent plant species in sub-mountainous areas, the *Hawarinuga* plant spreads quickly in the humid zone. The plant spreads widely because it produces a lot of seeds, which are swiftly

dispersed by the wind, develop quickly, and are challenging to control. It is especially easy to spread regions of natural forests. Additionally, it harms biodiversity since they outgrow other plant species in the forests (Figure 5).



**Figure 5: Invasive/exotic plant species in forests of Hirikatu Oya sub-watershed**

Source: Field observation, 2022

In some open lands in the humid intertidal zones, the spreading *Welnidikumba* can be identified in the widespread Hirikatu Oya sub-watershed forest area. This plant affects the growth of other plants and produces many seeds, so it is difficult to control once it spreads. It can also lead to the spread of forest fires. These plants stifle local species and harm biodiversity. Plant regeneration is hampered by this.

With significant growth, *Acacia* and *Pines* plants can be identified. The local plant community has been impacted, even though pine and acacia plants have been grown as part of numerous projects run by the forest conservation department.

"Local plants have been cultivated, and although local plants are cultivated with priority among the plant species, there is no noticeable difference in the growth of local plants, and the growth of plants such as *Pines* can be recognized over its growth." (Forest extension officer: Balangoda Range forest office, 15/03/2022)

This was further confirmed through the field study. Accordingly, it was also revealed through the questionnaire given to the villagers that the increased growth of this plant species has posed a greater threat to the local plant community. Based on the analysis, a fact that was revealed through the questions that were asked was the negative attitude they have towards these plant species.

"*Pines* and *Acacia* plants are mostly found in the mountains in the upper part of the area. In the lower part, they are mainly spread in Kuburuthaniwala village and Yakdehiwala village. Here, these plants absorb a lot of water. Also, fire spread is common in pine forests. At least some of the water from the *manan* is absorbed into the soil. *Pines* only absorb water from the plant. It is taking place because of soil erosion. There is no soil conservation." (Agricultural extension officer: Imbulpe, 16/03/2022)

Also, according to the facts revealed through the interviews, it is also shown that these plants are causing damage to the species.

"The biggest damage from the Acacia plant is caused to bees. Everything affects the paddy fields. It is important that these plants be removed and trees like coconut and jackfruit replanted." (Agricultural extension officer: Imbulpe, 16/03/2022)

Among the issues presented by the villagers in the above questions, it was recognized that invasive plant species present in the Hirikatu Oya Sub-watershed affect the biodegradation of its forests and adversely affect the local plant species. Increased plant species in forests in the Hirikatu Oya sub-watershed, as well as *Havarinuga*, Pines, and Acacia, can be identified in the Hirikatu Oya sub-watershed. As well, some rare plant species can be identified in the forests of the Hirikatu Oya sub-watershed, such as *Binara*, *Maharathmal*, etc.

### 3.4. Risk, Threatened and Extinct Plant Species in the Hirikatu Oya Sub-Watershed

The International Union for the Conservation of Nature (IUCN) Red List criteria serves as the global benchmark for estimating the risk of extinction (Le Breton *et al*, 2019). According to this method, species

are evaluated against quantitative criteria based on indicators of extinction risk and given a graded threat category, such as Vulnerable (VU), Endangered (EN), or Critically endangered (CR) (Le Breton *et al.*, 2019). About 12,102 species of plants, representing 326 plant families, have been classified as globally imperiled (CR, EN, or VU) according to the IUCN Red List of imperiled Flora (Le Berton *et al.*, 2019).

There has been a noticeable decline in the number of plant species in the forests of the Hirikatu Oya sub-watershed, and some plant species have even gone extinct. Here, it was discovered that the decline in plant species was primarily caused by human activity, including logging, illegal tree-cutting for a variety of reasons, and other forest crimes. The following table shows the threatened plant species in the forests of the Hirikatu Oya sub-watershed.

The number of plants that could be identified as 5-10 was categorized as at risk. According to this study, the risk plant species identified in the study area is about 44% (Table 4).

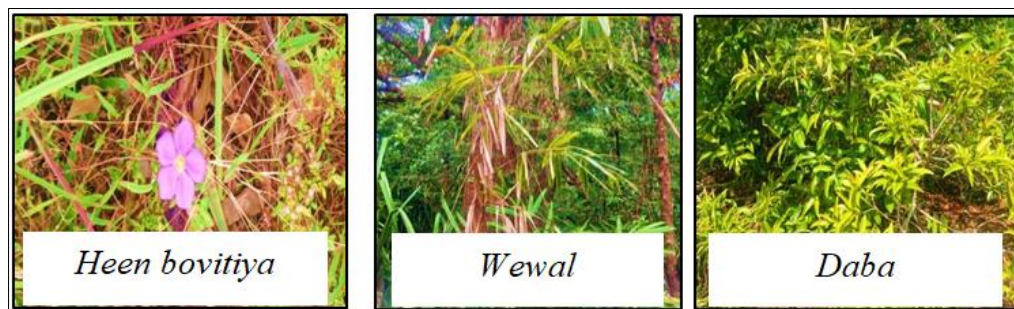
**Table 4: Risk plant species in Hirikatu Oya sub-watershed**

No	Local name	Scientific name	Family
1.	Keena	<i>Calophyllum walker</i>	Calophyllaceae
2.	Velan	<i>Pterospermum suberifolium</i>	Malvaceae
3.	Mee	<i>Madhuca longifolia</i>	Sapotaceae
4.	Bin kohoba	<i>Munronia pinnata</i>	Meliaceae
5.	Thippili	<i>Piper longum</i>	Piperaceae
6.	Aralu	<i>Ailanthus excelsa Roxb.</i>	Simarubaceae
7.	Bulu	<i>Terminalia bellirica</i>	Combretaceae.
8.	Katakella	<i>Bridelia retusa</i>	Phyllanthaceae
9.	Daba	<i>Eugenia revoluta Wight</i>	Myrtaceae
10.	Heen bovitia	<i>Osbeckia octandra</i>	Melastomataceae
11.	Urugonna	<i>Origanum vulgare</i>	Lamiaceae
12.	Wewal	<i>Calamus monoecus Roxb</i>	Arecaceae
13.	Maharathmal	<i>Rhododendron, arboretum-zeylanicum</i>	Ericaceae
14.	Hathawariya	<i>Asparagus falcatus</i>	Liliaceae.
15.	Iramusu	<i>Hemidesmus indicus</i>	Periplocaceae

Source: Field study, 2022

According to that, in forests in the Hirikatu Oya sub-watershed area, plant species changed during the

2000–2022 time. It can be predicted that 15% of plant species will become at risk (Figure 6).



**Figure 6: Risk plant species (going to extinction)**

Source: Field observation, 2022

According to this study, plants that could be identified only 1-5, are categorized as threatened plant

species. It was identified that 10 plant species became threatened.

**Table 5: Threatened plant species from the Hirikatu Oya sub-watershed**

No	Local name	Scientific name	Family
1.	Gammallu	<i>Pterocarpus marsupium</i>	Fabaceae
2.	Ashoka	<i>Saraca asoca</i>	Fabaceae
3.	Rukkaththana	<i>Alstonia scholaris</i>	Apocynaceae
4.	Milla	<i>Vitex altissima</i>	Lamiaceae
5.	Weniwalgata	<i>Coscinium fenestratum</i>	Menispermaceae
6.	Jatamansa	<i>Nardostachys jatamansi</i>	Valerianaceae
7.	Malithi	<i>Woodfordia fruticosa</i>	Lythraceae
8.	Ekaweriya	<i>Rauwolfia serpentine</i>	Apocynaceae
9.	Sathsada	<i>Aristolochia indica</i>	<i>Aristolochiaceae</i>
10.	Wishnukranthi	<i>Evolvulus alsinoides</i>	Convolvulaceae

Source: Questionnaire survey and Field study, 2022

According to the study, the following 4 plant species could not be identified in the study area. Those

plant species can be identified as extinct plant species from the area.

**Table 6: Already extinct plant species from the Hirikatu Oya sub-watershed**

No	Local name	Scientific name	Family
1.	Sandalwood	<i>Tantalum album</i>	Santalaceae
2.	Wallapatta	<i>Gyrinops walla</i>	Thymelaeaceae
3.	Burutha	<i>Chloroxylon swietenia</i>	Rutaceae
4.	Kaluwara	<i>Diospyros ebenum</i>	Ebenaceae.

Source: Questionnaire survey and Field Study, 2022

According to that, in forests in the Hirikatu Oya sub-watershed area, plant species changed during the 2000–2022 period. It can be predicted that 14% of plant species have become threatened or extinct because of forest degradation. So, we can conclude that these areas have forest degradation through the plant species changes in the forest of the study area.

#### 4. CONCLUSION

There were 71 plant species which have been recognized, in the Hirikatu Oya sub-watershed and it has been severely impacted by human activities such as logging, land conversion for cultivation, and infrastructure development. This deforestation leads to changes in plant communities and degradation of floral diversity. Unsustainable practices in farming areas also impact nearby forested areas, leading to the destruction of forested land due to chena farming. Expanding agricultural activity into woodland regions can cause diverse plant populations to turn into monocultures, reducing the complexity of the ecosystem and resources accessible to native plant species, and leading to a loss of biodiversity. Human activities in the Hirikatu Oya sub-watershed can have substantial ecological effects, such as loss of biodiversity, modifications to the nutrient cycle, changes to habitat layout, and decreased ecosystem resilience. To lessen these effects and safeguard plant species, sustainable land use, conservation, and awareness-building are crucial.

Currently, 4 species (5.6%) are already threatened or extinct. Further 15 species, including *Keena*, *Velan*, *Mee*, and *Bin Kohomba*, have been threatened, and Sandalwood, *Wallapatta*, *Burutha*, and *Kaluwara*, have already been extinct from the area. Invasive plant species pose a serious threat to the ecosystem health of the Hirikatu Oya sub-watershed, and about 10% of plant species are considered invasive. The core causes of these threats such as illicit logging and habitat damage, must be addressed. Cooperation between governments, conservation groups, local communities, and the public is crucial to protecting the biodiversity and ecological balance of the impacted regions and beyond. Immediate and targeted management and control efforts are necessary to reduce their detrimental effects on local plant species and to preserve the area's distinctive flora.

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