Restoring Sri Lanka’s Central Highland Cloud Forests in Bopaththalawa:

A Nature-Based Fiscal Strategy for Climate Adaptation and Water Security

Contents

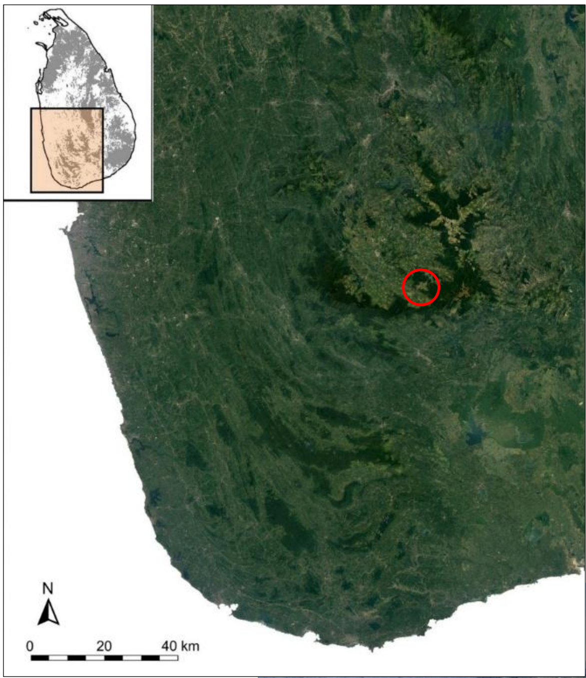
Preface

Sri Lanka's Central Highlands cloud forests are vital ecosystems that regulates regional hydrology, preserve biodiversity and provides critical ecosystem services. These habitats face severe threats due to anthropogenic activities. To minimize pressures, the Cloud Forest Restoration Project in Bopaththalawa was initiated as a long-term, community-driven model and a Nature-based Solution (NbS) to enhance climate and fiscal resilience.

This project by RDL Corporate Responsibility (Olu Tropical Water) and Earthlanka Youth Network (with donor-based research funds from the Adaptation Research Alliance (ARA)) outlines the restoration approach that integrates habitat & species assessment, Assisted Natural Regeneration, fire prevention and livelihood development. As Olu Tropical Water relies on water sourced from the cloud forest region for its operations, the restoration initiative represents the company's commitment to giving back to the environment that sustains water. Restoration activities were reinforced by educational programs by the project aimed at youth and local communities promoting long-term sustainability. Home-garden nursery networks and CSR co-financing reduced costs while increasing local engagement in restoration. The baseline biodiversity assessment recorded 39 species of flora and 35 faunae, of which over 34% were under IUCN threatened categories, forming a critical baseline for restoration monitoring. An adaptive invasive species removal methodology was implemented, targeting *Solanum mauritianum* and *Miconia calvescens* through staged manual removal to prevent regrowth within the habitat.

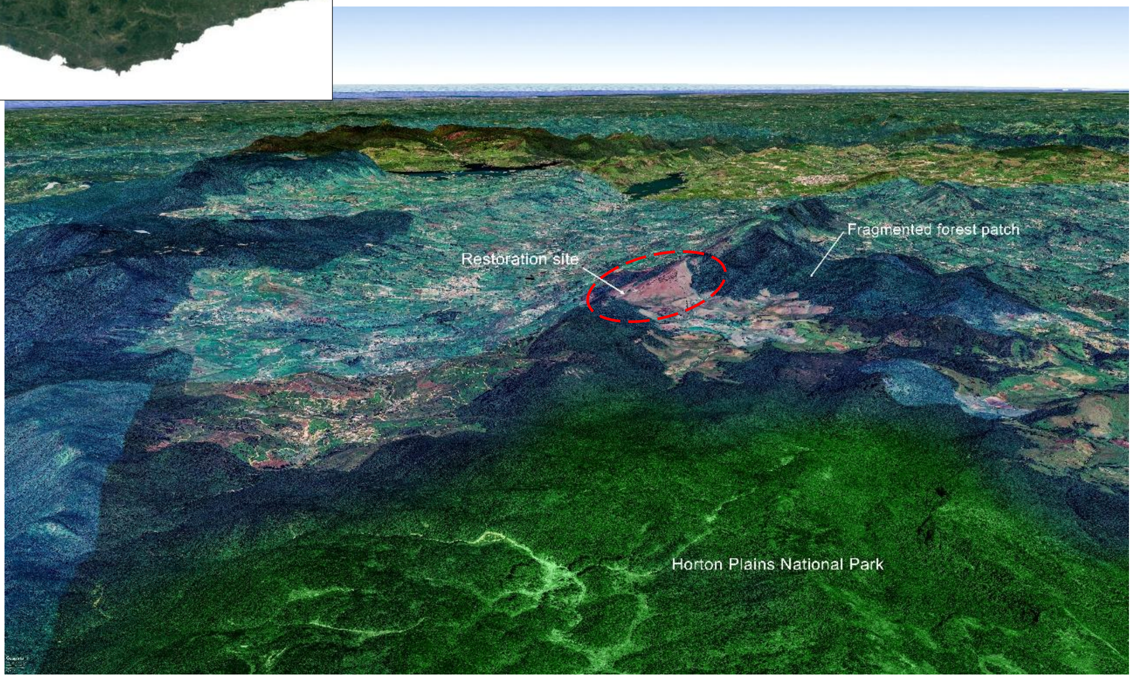
Beyond its ecological benefits, the 3- year project looked at the possibilities of NbS to deliver fiscal co-benefits to the country. These include the reduction of public expenditure on disaster mitigation, enhanced water security, and reduced human wildlife conflict. The restoration also opens up for carbon financing, biodiversity offset markets, and Payments for Ecosystem Services, highlighting a path for scalable, cost-effective climate adaptation mechanism. The restoration progress report is submitted to the Department of Forest Conservation with the aim of supporting evidence-based policy formulation and decision-making.

It could be argued that project incorporating into national fiscal and policy frameworks—such as Sri Lanka's NDCs and climate adaptation plans can generate long-term economic and ecological benefits. The case of Bopaththalawa restoration provides a replicable model for mountainous regions across Asia facing similar climatic and fiscal vulnerabilities.



Location:
Agarapathana, Bopaththalawa

6°80’95.06”N, 80°69’58.25”E



Background and Importance of the Site

Sri Lanka, together with the Western Ghats of India (a part of the Indo-Malayan biodiversity hotspot), is home to an exceptional concentration of endemic flora and fauna. However, it also suffers from significant ecological degradation, especially in its central highlands - home to the island's cloud forests. These montane ecosystems found at elevations above 1,000 meters are characterized by persistent moisture, seasonal microclimates and extremely rich endemism (Gunatilleke & Gunatilleke, 1990). Importantly, they play a central role in regulating the water cycle and feeding the country's 103 river across the island (IUCN, 2021).

Despite their ecological significance, Sri Lanka's cloud forests are increasingly challenged by anthropogenic pressures such as deforestation, forest fragmentation, land-use change for cultivation, Invasive Alien Species (IAS), and man-made fires (Wijesinghe et al., 2012; Senaratna Sellamuttu et al., 2013). The spread of non-native grasses like *Cymbopogon nardus* (citronella) increases the frequency and intensity of forest fires during the dry season, which in turn accelerates soil erosion and the loss of native biodiversity (Fernando et al., 2018). These pressures not only threaten the existence of endemic species but also weaken the ecosystem services critical to water security, climate stability, and local livelihoods.

The 23-acre cloud forest restoration project in Bopaththalawa, situated in the Central Highlands, was launched as a pilot project (in March 2022) to rehabilitate these degraded landscapes using nature-based solutions (NbS). The project was a collaboration of RDL Corporate Responsibility (Olu Tropical Water) and Earthlanka Youth Network with funds from ARA. During the three years of work, the project applied ecological restoration strategies such as native species reforestation, assisted natural regeneration, fire prevention belt establishments and biodiversity corridor development. It also generated strong community involvement through awareness programs, nursery operations and participatory planting initiatives. These efforts aim to re-establish the ecological integrity of the forest while helping ecosystem services such as water catchment replenishment, carbon sequestration, and microclimate regulation (Chazdon, 2017).

The project initiative aligns directly with the environmental objectives (with fiscal and climate adaptation goals). As climate change intensifies, the frequency and severity of extreme weather events also worsens (particularly droughts and floods). The degradation of natural ecosystems amplifies


Figure 1: Spotless Grass Yellow (*Eurema laeta*) a Vulnerable butterfly species found at Bopaththalawa

the vulnerability of water availability, agricultural productivity and rural community livelihood (IPCC, 2022). As a solution, nature-based approaches offer sustainable, cost-effective alternatives with broader social and ecological benefits (Seddon et al., 2020). This project was therefore implemented to test the practicality of such a nature-based action, as a solution for climate change driven water scarcity in Sri Lanka's highland regions.

By restoring cloud forest ecosystems, this project contributes to several commitments of Sri Lanka under Nationally Determined Contributions (NDCs), the National Adaptation Plan (NAP) and also global frameworks such as the UN Decade on Ecosystem Restoration and the Sustainable Development Goals (SDGs)—particularly SDG 6, SDG 13, and SDG 15 (Ministry of Environment Sri Lanka, 2021).

Also, the project centers around marginalized rural communities focusing on youth, women, and local farmers in ensuring the project's success. By offering trainings in nursery management, biodiversity monitoring and environmental education; the initiative looked at building environmental positiveness while contributing to climate-smart rural livelihoods (WWF, 2022). Success of the project shows how nature-based solutions can serve as both ecological safeguards and economically practical strategies for climate adaptation in Asia's vulnerable mountain regions.

Degradation Challenges at Bopaththalawa

Cloud forests in Sri Lanka's Central Highlands, though ecologically vital, are experiencing significant pressures from a complex interplay of anthropogenic and environmental threats. These ecosystems, which provide critical services such as climate regulation, biodiversity support and water catchment, are rapidly degrading due to forest fragmentation, land conversion, IAS and unregulated human activity (Senaratna Sellamuttu et al., 2013).

One of the key degradation factors is the expansion of agriculture, particularly tea and farm lands, which has pushed into the margins of protected montane forests. The area (formerly assumed to be covered by cloud forest) would have been converted centuries ago for agricultural farming/ estates. At present, government-owned farmland in the areas such as Bopaththalawa maintains a large pockets of monoculture grasslands, primarily for cattle grazing, which disrupts wildlife movement and limits native vegetation growth. These altered landscapes,

Figure 2: Women living in the area heading back home after the days' work

where some parts are bordered by electric fences, have also disrupted natural faunal movement, resulting in isolated populations and reduced genetic diversity (Fernando et al., 2018).

The spread of IAS, such as *Miconia calvescens, Koenigia Mollis, Solanum mauritianum* and *Cymbopogon nardus*, have created another set of issues. These plants thrive in the disturbed areas and outcompete the native vegetation. Some are highly flammable, continuing the spread and intensity of forest fires during dry season (from December to April each year). Fires are deliberately triggered by local communities as part of land/ pathway clearing practices or by irresponsible camping activities. These fires destroy native flora, degrade soil quality and further enable the spread of IAS (IUCN, 2021).

The lack of coordinated landscape management and effective enforcement of preventive measures further accelerates degradation. Even though legal protections exist under the Forest Ordinance, limited resources and local encroachment make enforcement challenging. In the absence of sustainable community-based alternatives and continued dependence on destructive land-use practices for livelihoods (Seddon et al., 2020) it is highly likely that the cloud forest will collapse ecologically in the next century.

As observed, these ecological challenges are intrinsically linked to broader economic and climate resilience matters. As climate change intensifies, rainfall anomalies and raised temperatures are common to be seen. The loss of cloud forests also reduces the buffering capacity of highland ecosystems. This may lead to more intensified flooding, prolonged droughts and increased sedimentation in downstream rivers, imposing high fiscal burdens on water infrastructure, disaster relief and agricultural productivity (IPCC, 2022; Ministry of

Figure 3: Horton Plains shrub frog (*Pseudophilautus cf alto*) in the ashes of a dead grassland habitat after forest fire

Environment Sri Lanka, 2021). Also, Climate/Temporal dynamics triggered native plant range expansion (such as *Kuruna densifolia* in Horton Plains National Park) may also have impacts on the holistic ecosystem dynamics. Such studies need to be carried out within the central highland of Sri Lanka, to identify if climate change impacts are further accelerating climate change.

The Bopaththalawa region illustrates the urgency of intervention as once densely forested parts of the area are now dominated by degraded grassland with sparse native vegetation. Yearly triggered fires and the absence of saplings prevents natural regeneration, while disconnected forest fragments hinder faunal movement and ecosystem recovery. Degraded forest edges continuously expand by the spread of IAS and due to forest fires favored by IAS.

The problem seems therefore twofold: ecological degradation and the lack of an integrated management; and the lack of monetarily support. Without intervention, continued degradation will lead to irreversible biodiversity loss and increased climate-related expenditure. At the same time, the absence of nature-based financial mechanisms such as payments for ecosystem services (PES) or biodiversity offsets limits the potential for sustainable recovery.

Addressing these interconnected issues requires a restoration strategy that not only recovers the ecological integrity of the cloud forest but also aligns with national adaptation priorities and economic planning.

Restoration Techniques and Field Implementation

The project was built on a gradually phased and adaptive framework that accounted for both biophysical site conditions and sociocultural dynamics. Restoration activities were designed to ensure minimal disturbance to the existing ecosystem while maximizing the ecological return through the recovery of forest structure, function and connectivity.

Site Assessment and Baseline Mapping

Initial site assessments were conducted to evaluate the biodiversity, extent of degradation, fire damage and invasive species spread. The area lies at an elevation of approximately 1,820-1,940 m a.s.l., with annual mean rainfall ranging from 2,500 mm to 3,800 mm. The southern inter-monsoon season (May–July) plays a key role in the ecosystem's hydrological patterns. Preliminary mapping process included image-based visual overlays to identify existing forest edges, fragmented habitats and fire-disturbed zones. Field biodiversity assessments were carried out over a twenty-month (March 2022 - November 2023) period across the 23-acre restoration site and an adjoining twofold buffer zone. 5-day field sampling sessions per month (both day and night sampling) were carried out by the team of ecologists and restoration experts. Flora and fauna were surveyed using visual encounter survey methodology including random sampling and opportunistic observations (together with confirmation records from scat, skulls and recorded dead species). The study documented 15

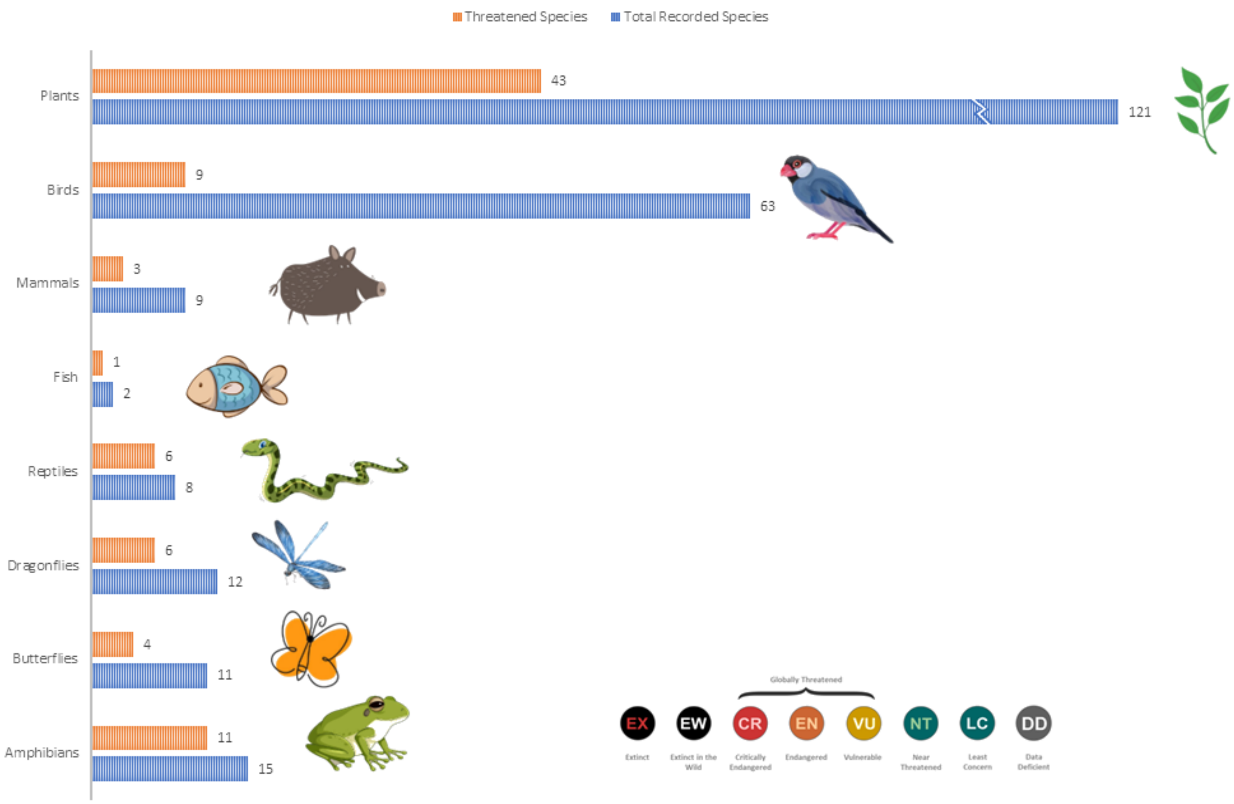
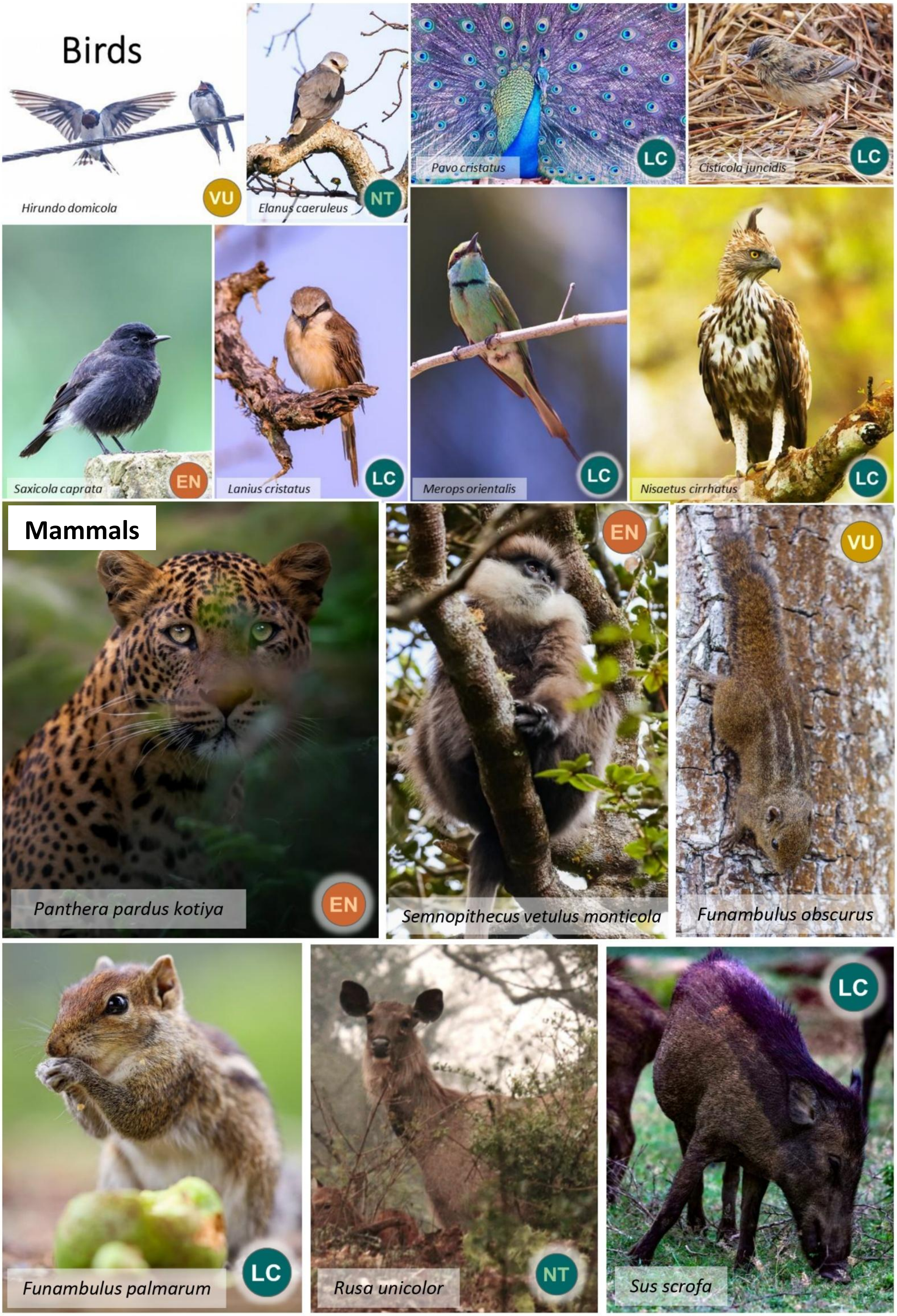


Figure 4: Agra danio (*Devario monticola*) A Critically Endangered and a Point Endemic fish that is found within the Bopaththalawa water bodies.

amphibians, 11 butterflies, 12 dragonflies, 9 reptiles, 2 freshwater fish, 9 mammals, 63 birds, and 121 plants. Notably, 34.7% of the recorded species fell under threatened categories. This long-term fieldwork (with the technical assistance from the Earthlanka and Young Biologists' Association) allowed the project team to conduct one of the most detailed recent biodiversity assessments of the Bopaththalawa montane ecosystem.


Birds
Hirundo domicola
VU
Elanus caeruleus
NT
Pavo cristatus
LC
Cisticola juncidis
LC
Saxicola caprata
EN
Lanius cristatus
LC
Merops orientalis
LC
Nisaetus cirrhatus
LC
Mammals
Panthera pardus kotiya
EN
Semnopithecus vetulus monticola
EN
Funambulus obscurus
VU
Funambulus palmarum
LC
Rusa unicolor
NT
Sus scrofa
LC

Plants

Osbeckia lanata

Rhodomyrtus tomentosa

Drosera burmanii

Drosera lunata

Persicaria praetermissa

Sonerila silvatica

Exacum walkeri

Exacum macranthum

Exacum sessile

Podochilus saxatilis

Pinalia bicolor

Satyrium nepalense

Ipsea speciosa

Utricularia caerulea

Habenaria acuminata

Rhododendron arboreum subsp. zeylanicum

Reptiles

Cnemaspis upendrai

Calotes liocephalus

Calotes calotes

Rhinophis blythii

Aspidura trachyprocta

Ceratophora stoddartii

Calotes liolepis

Hypnale nepa

Dragonflies

Orthetrum pruinosum

Orthetrum luzonicum

Euphaea splendens

Neurobasis chinensis

Elattoneura leucostigma

Indolestes gracilis

Sympetrum fonscolombii

Orthetrum triangulare

Elattoneura tenax

Butterflies

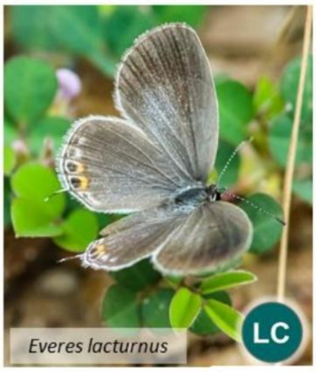
Eurema brigitta

Neptis hylas

Graphium doson

Libythea myrrha

Udara lanka



Everes lacturnus

Baracus vittatus

Amphibians

Pseudophilautus viridis

Pseudophilautus alto

Taruga eques

Pseudophilautus schmarda

Pseudophilautus sarasinorum

Pseudophilautus semiruber

Pseudophilautus microtympanum

Lankanectes corrugatus

Pseudophilautus femoralis

Minervarya greenii

Uperodon palmatus

Indosylvirana temporalis

Species Selection and Restoration Design

A decentralized nursery model was set up by selecting 11 smallholder local farmers, using surrounding forest trees for seed collection. Species selection was based on the climatic suitability, ecological functionality and native status of the plants. The identified species were either endemic or native to the cloud forest biome and included a mix of canopy-forming trees, sub-canopy species and understory vegetation. Selected native species included *Shorea spp., Syzygium rotundifolium, Calophyllum spp., Neolitsea cassia, Melicope lunu-ankenda, Elaeocarpus subvillosus/ E. glandulifer, Symplocos spp., Neolitsea fuscata, Macaranga peltate, Rhododendron arboreum subsp. zeylanicum* and *Ochlandra stridula* plants. Exotic or introduced plantation species such as *Eucalyptus grandis* and *Pinus caribaea*, which could alter soil chemistry and reduce biodiversity, were excluded from all phases of planting. Similarly, fast-growing plants with invasive potential or native other varieties that were not present in the region were avoided in favor of slow-growing but ecologically integrated species to support a more stable successional recovery. Planting took place along the forest edge with a general zoning idea to optimize habitat types.

Figure 5: local community home garden planting Damba plant (*Syzygium rotundifolium*) in rice bags. The plants were too heavy to be taken to the planting area and therefore shifting to smaller bag size was agreed.

Figure 6: Small plant of Rhododendron (*Rhododendron arboreum subsp. Zeylanicum*) optimizing growth and survivability in handling during planting

Assisted Natural Regeneration (ANR) was the primary restoration technique applied with plants introduced to the forest border. This involved introducing natural saplings of native pioneer species in degraded patches and protecting them through weeding, protecting and creating shade barriers. Forest borders (affected by invasives) that showed insufficient natural regeneration were supplemented with nursery-raised native seedlings of 2 feet or above. Originally thought of the project was to establish 6 feet tall trees while the plants took over 18 months to grow at the nurseries. These plants weren't hardy enough to withstand the immerging threats and were heavily damaged by the immediate forest fire after planting. Plants that were 1-2 feet were ideal to survive and shorter they were the hardier they grew with environmental stresses. Restoration belts were strategically placed to expand forest cover outward from intact patches, bridging fragmented zones ultimately to establish a biodiversity corridor to facilitate wildlife movement. Initial two years of ground assessments and maintenance and the third years planting work was sufficient to cover 3 acres of degraded land. The project operations took two years of assessments to understand ground conditions and conduct preliminary studies within the area prior introducing any saplings to the site area.

Nursery Establishment and Propagation Techniques:

A permanent nursery site was initially planned to be established within the project landscape to support ongoing restoration efforts. However, it was argued that this may not provide better leverage to those community members that provided more output. Thus, the community was told to use

Figure 7: Community members planting nursery grown plants within the forest edge with the principles of Assisted Natural Regeneration. These plants will grow towards the degraded grasslands and expand the forest border.

their home gardens for growing pioneer tree saplings and was then purchased by the project. The home garden nurseries served as a propagation hub for native species, ensuring a continuous supply of healthy planting stock for the project. Community members collected seeds from nearby intact forest areas, ensuring genetic compatibility and ecological appropriateness. Nursery operations were well collaborated with local community members, who were trained in plant care, pest management and early-stage plant handling techniques. This approach ensured local ownership, additional income generation and knowledge transfer, reinforcing sustainability from the project.

Planting phase was carried out primarily during the southwest monsoon season (June–November) to maximize survival rates. During planting cycle, 20–30 cloud forest trees were introduced (on a monthly basis) into the landscape along the forest border vegetation. Planting was also carried out by hired local labor under the project supervision, with a focus on restoring structure and microhabitat complexity.

Invasive Species and Fire Management

Given the significant role of IAS in forest degradation, dedicated efforts were made to remove the most aggressive invaders: *Solanum mauritianum* and *Miconia calvescens*. Removal activities involved labor intense manual uprooting. As the propagation of the two invasive species were way beyond control, further removal (on a continued basis) and replacement on a native variety will be necessary to completely recover the habitat. No chemical herbicides were used (within this period), in line with the project's ecological restoration viewpoint.

To prevent forest fires, 1-meter-wide fire prevention belts were established around wind triggered degraded zone (opposite the community access paths) with the help of hired local labour. Due to budget constraints, the fire prevention belts establishment was only cleared and maintained twice during the project's initial stages. In addition, locals' awareness was conducted in nearby settlements to discourage setting up fire and promote alternative clearing techniques. Engagement with the local Forest Department officials supported the work, particularly in defining buffer zones and surveillance hotspots.

Figure 8: Fire prevention belt placement has saved the opposite restoration area while the other side has entirely got burnt.

Community Engagement and Environmental Education

A critical component of the methodology was the inclusive stakeholder engagement. The project conducted several community communications rounds to understand land-use needs, perceptions of the forest and willingness to participate in restoration efforts. Special focus was placed on empowering youth, schoolchildren (to take part in the project through field work, biodiversity workshops and awareness) and women.

Knowledge dissemination was facilitated through printed materials, discussions and guided training on biodiversity and restoration methodology. These activities were aiming conservation ethic and ownership rather than regulatory enforcements. Interested location-based youth participants from British Council Sri Lankas Youth Climate Ambassadors Program were also given a chance to get involve in biodiversity assessments, awareness and knowledge dissemination.

Figure 10: Site biodiversity study at the British Council Sri Lankas Youth Climate Ambassadors 3-day field workshop

Monitoring and Adaptive Management

Monitoring was embedded in the restoration cycle, allowing for real-time learning and course correction. Photographic evidence, GPS points and quadrat measurements were recorded for long-term evaluation and species assessments. The monitoring phase was carried out by field biologists to technically evaluate the progress. Adaptive management techniques were applied to

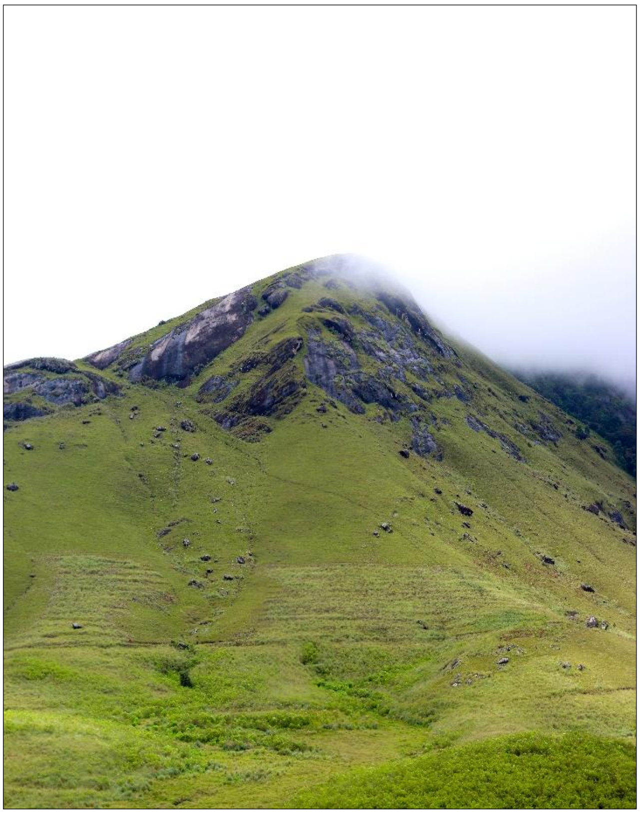


Figure 9: The famous “Haritha Kanda” peak covered with clouds during the rainy season.

refine species mix, planting techniques and maintenance routines based on field drawbacks. Planting density, plant height at planting and spacing were adjusted from experiential learning. Areas experiencing higher mortality were revisited and replanted with better-prepared and improved understanding.

Environmental Benefits and Climate Resilience

Cloud forests play a critical role in regulating hydrological cycles. The high-canopy vegetation supplements groundwater recharge and ensures perennial water flow in upper catchment streams (Bruijnzeel et al., 2011). These forests feed into Sri Lanka's major river systems, thereby supporting downstream agriculture, livelihood needs and hydropower generation. The degradation of these ecosystems by various causes threatens to disrupt these essential functions, potentially intensifying future water scarcity (Ministry of Environment Sri Lanka, 2021). By restoring cloud forest cover, the project helps recover these regulating services. The reintroduction of native vegetation enhances evapotranspiration, increases canopy cover and improves soil retention. All of the above services contribute to improved water regulation mechanisms in the Central Highlands towards to entire country. Restoration belts were planted along degraded slopes to reduce surface runoff, helping to stabilize stream flow and improve water quality.

By supporting hydrological services, cloud forest restoration significantly contributes to climate mitigation. Native tree species in these high-altitude ecosystems store carbon over long periods (biomass retention) due to slow decomposition rates. Reforestation of degraded montane forest zones will therefore support carbon sequestration and could potentially contribute to Sri Lanka's future inclusion in voluntary carbon markets or national REDD+ programs (Seddon et al., 2020). While the current project has not yet qualified for the biomass-based carbon

Figure 11: Zamba deer (*Rusa unicolor*) occupying the forest border and the newly establishing patch of vegetation

sequestration, the structure and species composition favor a long-term carbon sink.

A significant benefit from this project is that it enhances biodiversity-based resilience. Fragmented and degraded habitats reduce species' adaptive responses to environmental change. By linking isolated forest patches and encouraging faunal movement through biodiversity corridors, this project supports gene flow and increases the adaptability of wildlife populations to climate-induced habitat shifts. This is particularly important in montane zones, where migration of species is often limited by surrounding environmental pressures. The surrounding community pressure and agricultural expansion towards forest lands have significantly forced the species to constrained wildlife pockets. With the project, the objective is to expand these territories in a sustainable manner where species could freely roam and expand the genetic diversity.

An often-overlooked benefit of ecosystem restoration is its role in mitigating human-wildlife conflict. In Bopaththalawa region, the expansion of grasslands and conversion of forest into agricultural land has led to increased interaction between wild species and domestic cattle of farmland. By restoring native habitats and natural corridors, the project redirects animal movement patterns back into forested zones, which can reduce the frequency of negative encounters. Especially with species like sambar deer (that compete for vegetation with farmland cattle), and the apex predator, the Hill Country leopard, which preys on grazing cattle due to habitat encroachment and reduced natural prey. Also, the project provided awareness and discourages the use of cable snares within the habitat by the locals. These poaching methods are banned within Sri Lankan laws and are still been used illegally. Most of the snares are used by the local poachers for hunting sambar deer and wild boar, yet sometimes even traps the leopards that roam in the same territory.

Figure 12: Removed cable snare at regular patrolling activities. 5 such snares were removed during the visits

From a policy perspective, the ecosystem services restored through such initiative align directly with Sri Lanka's NAP, NDCs under the Paris Agreement and SDGs. Specifically, the project supports targets under: SDG 6 – improving water quality and availability through restoration of natural systems, SDG 13 – enhancing climate action through nature-based adaptation, SDG 15 – promoting biodiversity and halting land degradation.

Also, it highlights the economic validation for integrating NbS into fiscal planning. Restoration of ecosystems like cloud forests offers long-term cost savings by reducing the need for expensive grey infrastructure. It also helps to mitigate future government spending on disaster recovery and water scarcity relief (Dasgupta, 2021). Additionally, the government should look into opening up future restoration opportunities as PES, biodiversity offsetting and green financing schemes, which could help sustain restoration beyond donor or project-based funding.

The ability of cloud forests to buffer microclimates-reducing extreme temperature fluctuations and supporting pollinator activity, also has indirect economic benefits for highland agriculture that depend on stable water supply and food productivity. These benefits, while not always significant and seen contributing towards national accounts, are critical to the long-term viability of Sri Lanka's rural economies and agricultural needs.

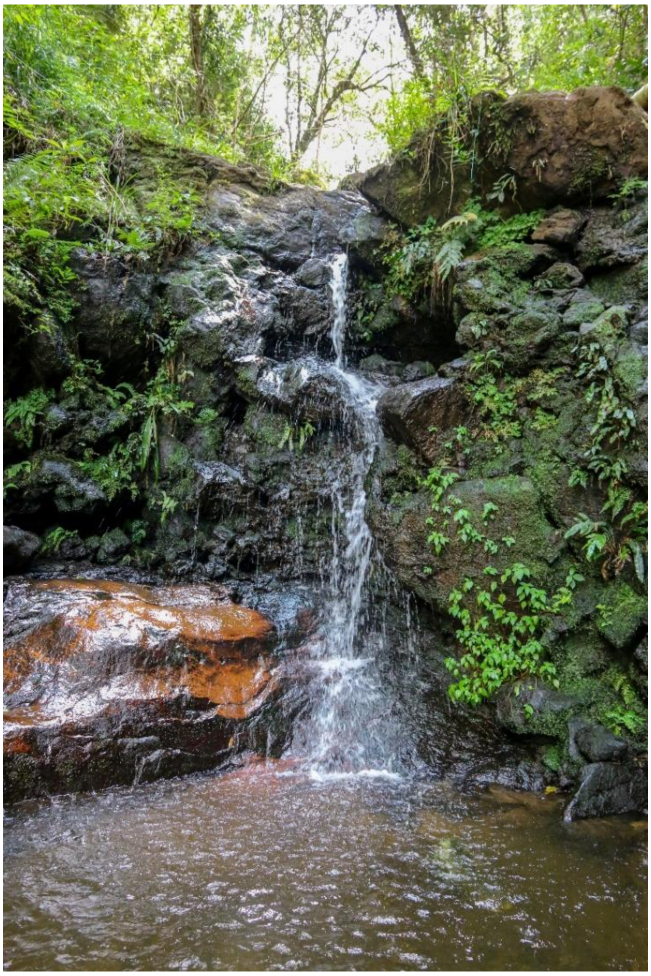


Figure 13: A small waterfall that feeds the surrounding habitat

Lastly, the educational and participatory approach taken by the project strengthens social capital and institutional resilience, both of which are essential components of climate adaptation. Community involvement in restoration, nursery management and ecological awareness creates a conservation ethic that can outlast way beyond policy cycles or external funding, embedding resilience within environment and people.

Institutional Support, and Governance

While ecosystem restoration is often viewed through an ecological or conservation lens, Bopaththalawa cloud forest restoration project highlights the substantial fiscal and economic value of investing in NbS. This project signifies how strategic private sector (Olu Tropical Water) Corporate Social Responsibility/ CSR support and Donor organizations such as the Adaptation Research Alliance (ARA) funding (together with youth volunteer groups) investments in ecological restoration can yield long-term cost savings that create alternative livelihoods, reduce government spending on disaster management and support national climate goals. The project was also featured at UNFCCC COP28 in Dubai at joint collaborative initiatives case study from Sri Lanka in preventing future climate change.

Figure 14: Presenting the initial findings at UNFCCC COP28 Sri Lanka Pavilion in Dubai

Reducing Public Expenditure Through Nature-Based Infrastructure

The degradation of Sri Lanka's cloud forests holistically has direct fiscal implications. As these ecosystems deteriorate, the country faces increasing costs from flood management, irrigation maintenance, landslide mitigation and water treatment. The degradation of cloud forests disturbs natural water cycle regulation, requiring increased investment in grey infrastructure to manage floods, irrigation, and drinking water supply (Ministry of Environment Sri Lanka, 2021).

Leveraging Ecosystem Services for Economic Return

The project has the potential to be established as a Sri Lankan initiative to integrate PES into fiscal policy. As ecosystem services become better quantified, mechanisms could be created where downstream users-including industries maintain the upstream ecosystems. Additionally, the project is looking at a voluntary biodiversity offsetting mechanism as an alternative solution to offset the impacts on organizational land use. The initiative measures and promotes corporates to invest in conservation or restoration activities as compensation for land use related habitat loss elsewhere. Such mechanisms not only generate direct funding for conservation, but also offsets ecological impacts from corporate operations, nurturing responsible business. Olu Tropical Water is looking at biodiversity offsetting of their operations with this initiative.

Community-Based Livelihood Models with Economic benefits

The community-centered model used in Bopaththalawa presents a cost-effective implementation strategy compared to general reforestation schemes. By decentralizing nursery operations into local home-gardens and purchasing saplings from locals, the project channeled funds directly into the immediate community. This approach reduced overhead costs, and also created green income streams for the marginalized communities. Together with the capacity-building components (particularly among youth and women), enhanced the rural human capital development and local employment. These social co-benefits, although harder to quantify, reduce fiscal dependency by strengthening household-level resilience to climate stressors.

agriculture and biodiversity. By looking into an interconnected and a replicable model, this project supports strategic goals with a practical field-level framework. The project contributes directly to catchment-level water security strategies by enhancing infiltration, streamflow consistency, and soil stability

From a fiscal policy perspective, the government could institutionalize NbS through: green budget tagging within national budgets to prioritize nature-based

Figure 15: Routine work of local women in Bopaththalawa working at government owned NLDB farm

Alignment with National Fiscal and Policy Priorities

The restoration initiative strongly aligns with Sri Lanka's NDCs under the Paris Agreement, which recognize the role of forest ecosystems in climate mitigation and adaptation. Similarly, the NAP encourages integrating NbS across several key sectors including water,

investments, fiscal incentives for private-sector contributions to restoration (e.g. tax deductions for PES schemes), public-private-community partnerships (PPCPs) that co-finance restoration, particularly in upper catchment regions that feed industrial or energy infrastructure.

Regional Replicability & Economic Resilience

The broader implication of the project lies in its potential replicability across Sri Lanka's highland ecosystems and other montane regions in Asia. Countries across South and Southeast Asia, including India, Nepal, Bhutan, and parts of Vietnam, face similar pressures from highland deforestation, soil erosion, and agricultural water dependence, compounded by limited financing for grey infrastructure. This project's approach offers a low-cost, community-driven model for landscape restoration that delivers both ecological and fiscal dividends. As many of these countries explore sustainable economic recovery and climate financing under green growth strategies, nature-based fiscal policy solutions such as restoration of degraded ecosystems offer a pragmatic and scalable pathway. Integrating cloud forest restoration into a country's climate finance plan could improve access to funding mechanisms such as the Green Climate Fund (GCF) or Adaptation Fund from regional partners.

Opportunities for Replication and Local Benefits

Although the Project is still in its early stages, several measurable and qualitative outcomes have already been documented by the team, reinforcing the ecological, social and fiscal value of the intervention. These indicators at a very young age of the project show that with strategic planning and practical implementation, even small-scale ecological restoration projects can generate impactful results across multiple dimensions.

Figure 16: Planting shorter saplings at the edge of forest. During the second phase of planting.

Ecological and Landscape Recovery

The project's implementation enabled the restoration of approximately three acres of degraded cloud forest edge habitat. Over 120 native tree saplings were introduced across selected zones using ANR techniques. Species were planted with ecological sensitivity, keeping in mind of their slow-growth and structurally diverse native varieties suited to such highland microclimates. Restoration efforts have led to the early re-establishment of complex native vegetation layers. Species like *Neolitsea fuscata, Rhododendron arboreum subsp. Zeylanicum, Calophyllum walkeri* and *Syzygium rotundifolium* have shown strong early regeneration through both planted and wild-recruit saplings. These species are known for their role in supporting montane bird and mammal populations, suggest the start of broader ecosystem recovery. Understory vegetation such as shrubs were also reintroduced (excluding the 120 trees) to increase habitat complexity.

Plant survival rates exceeded 60% in most zones, particularly for 2-foot-tall saplings that showed higher resilience compared to earlier trials using taller 6-foot plants. These learnings have been used for adaptive planting strategies for current phases. Restoration belts have already begun to alter surface runoff patterns on steeper slopes, which may be reducing slope soil erosion. These physical indicators are expected to improve over time as canopy structure strengthens and microhabitats mature.

Figure 17: Sambar deer (*Rusa unicolor*) seen at the very edge of the cloud forest border opposite the restoration site.

Random faunal sightings have increased in newly restored forest edges from the results of Edge effect analysis surveys. The diversity suggests that the biodiversity corridors might begin to support wildlife movement and foraging as soon as they are created. Records/ indirect signs like scat and footprints suggested that the reconnecting forest edge is already supporting increased animal movement. These early findings showcase the effectiveness of the biodiversity corridor design and demonstrate how ecological restoration may be beneficial for threatened fauna in fragmented landscapes. Though faunal movement changes are a long-term process, the presence of species like sambar deer indicates that the restoration is assisting species to utilize newly established habitat as opportunistic transition zones.

Community Impact and Knowledge Transfer

One of the most significant impacts of the project has been its positive influence on the marginalized local community. The decentralized home garden plant nursery model, which incentivized locals to propagate native species, created a small but impactful income stream for 11 families in the area. Community members, particularly women and also the school children at Bopaththalawa Sinhala School, were able to engage in seed collection, nursery care and finally in observing transplanting process gaining practical skills and ownership over the restoration effort.

The environmental education and cloud forest capacity development workshops were conducted targeting students, teachers and local youth groups. These workshops covered biodiversity monitoring, restoration techniques and ecological importance of cloud forests. By including schoolchildren in cloud forest field visits and awareness programs, the project raised a growing interest in conservation among the younger generation.

Figure 18: Cloud Forest field awareness workshop for local youth

With donner support from Olu Tropical Water and the corporate partners, a school health camp was also conducted during the project phase. Bopaththalawa School, is classified as a low-resource rural institution with limited access to educational and healthcare services. All these students come from the local farming community, and most of them from families with limited financial capabilities to support education and healthcare of their children. The camp provided free medicine and consultation to the school staff members, a few parents and even some locals from the area with a total of 124 individuals.

Local-level communications with community groups have somewhat contributed to reducing high-risk behaviors such as setting up forest fires and placing cable snares. While budget limitations prevented ongoing fire belt maintenance, the initial establishment of 1-meter-wide fire breaks and regular patrolling for snares helped minimize the severity of illegal activities during the continuation.

Institutional Engagement and Policy Visibility

Figure 19: Doctor checking a student at the school health camp at Bopaththalawa Sinhala School

Through close coordination with the Forest Department, technical support from Earthlanka, and funding contributions from ARA and Olu Tropical Water CSR funds, the project created a replicable mechanism for community-led ecological restoration. Project's first phase was shared at International Forestry and Environment Symposium (of University of Sri Jayewardenepura) as research abstract publications showcasing how Sri Lanka is pioneering NbS to prevent future climate-related degradation. While the project's biodiversity offsetting is currently volunteer-based, it establishes a foundation for formalization corporate restoration contributions whose land use activities may have impacted surrounding ecosystems. This early alignment with PES and biodiversity offsetting will enhance the project's potential for scalability and policy mainstreaming.

Indicators of Fiscal Efficiency

Although a comprehensive financial analysis has not yet been completed, the expenditure data indicates that the community-centered model offers a cost-effective approach to restoration. Costs were notably lowered by avoiding centralized operation and instead funding directly went into local community. Uniform plant health was difficult to achieve due to variability in home garden conditions and community-level propagation practices. The use of locally available plant seed collection further reduced input costs and ensured ecological compatibility.

The integration of CSR funding from Olu Tropical Water and contributions from ARA funds directed via Earthlanka, also minimized financial strain on the project. This hybrid funding model presents a feasible pathway for other degraded cloud forest and needy environmental initiatives with limited government funds. This suggests that locally driven ecological restoration projects can be

Figure 20: Local community women going through the project work pictorial document

both ecologically sound and fiscally viable, even under constrained budgets.

Lessons Learned and Recommendations

The implementation of the project offered a valuable set of insights into the practical realities of restoring ecologically fragile montane ecosystems in a fiscally efficient and local community-empowered manner.

Practical Restoration Insights

A key lesson from the project is the importance of adaptive planting techniques. Early assumptions regarding ideal plant height (6-foot saplings) had to be revised based on actual survivability rates under harsh climatic conditions. The project observed that 2-foot-tall plants, though smaller, were far more resilient to fire and harsh environmental conditions. We believe that shorter saplings had a higher survival rate and better capacity to acclimate to the microclimate. Although long-term impacts on faunal migration and corridor functionality remain to be not yet fully assessed, early indicators suggest promising trends that opportunistic biodiversity responds positively when ecological space is provided, even at small scales. In the case of forest fires, a continuation of a fire prevention belt is highly necessary to significantly control habitat destruction and positive restoration effects. These positive interventions will ensure degraded landscape restoration at an area that faced budget limitations during this project cycle.

Socioeconomic and Institutional Lessons

The success of the home garden nursery model implemented through local families was not only based on cost savings, but also strengthening communal empowerment and creating ownership of the restoration initiative. The sapling propagation though had a quality variation, was addressed by the team through continued communication and monitoring. A local agriculturally experienced community coordinator was also appointed in the area to visit these families regularly and provide input and suggestions. Also, in celebration of International Women's Day 2025, the team donated field gear and needy

Figure 21: International Women's Day 2025 donations to the local women at Bopaththalawa farm site

rations to the local community women. This was a very heartwarming give away while many mentioned that this was the only gift that they have ever received.

Similarly, community involvement through school children and youth groups revealed that conservation can be both an enjoyable and educational tool. Practical exposure to field work made the youth gain early environmental habits in the future generation of the area and embedded a positive conservation mindset. Integrating ecological education into school programs can thus be a transformative strategy, especially in marginalized areas where there's a high level of school dropouts at a very young age. This attitudinal change makes the rural communities more embracing in their surrounding environment, even if they quit education at a very young age.

The school health camp, organized as a co-benefit during the project timeline, strengthened the need to address community wellbeing alongside conservation objectives. The outreach to look at empowering health, confirmed the idea that ecosystem restoration projects can integrate human development needs too, particularly in underserved areas. This was a way in which corporates could focus CSR funding to empower marginalized communities and truly focus on adding value lives. The health camp generated goodwill and strengthened community trust towards the project, reinforcing local engagement in the broader restoration objectives.

Financial Sustainability Considerations

A great lesson learned in this project was that locally led restoration is not only ecologically sound, but also fiscally practical. By shifting to micro-nurseries, using locally available labor and minimizing transport costs, the model ensured practical fiscal viability. At the same time, the lack of uniform plant quality shows the need for technical support and quality assurance, even when working in decentralized systems. Even though uniform plant quality was not achieved (holistically), it made the restoration phase more diverse.

Interestingly, some less-maintained saplings demonstrated greater environmental resilience, suggesting that localized growing conditions may sometimes favor adaptive traits. This way uniformity of the plants was not taken as a significant factor for consideration.

The hybrid funding structure combining CSR support, donor contributions and youth volunteerism, proved effective in sustaining the initiative. This blend of volunteerism, private commitment and grassroots participation is great for replicability. However, for long-term continuity, mechanisms such as PES schemes, biodiversity offsets or possible green financing frameworks need to be looked at beyond the project cycle to achieve sustainability.

Policy endorsements

Based on the project's implementation and outcomes, several policy-oriented recommendations emerge:

- Mainstream nature-based solutions (NbS) into National Adaptation Plan (NAP) and NDCs.
- Facilitate PES and biodiversity offsetting mechanisms at national level to financially support community-led restoration programs.
- Introduce fiscal incentives or tax benefits for corporates investing in valid ecosystem restoration activities.
- Strengthen forest buffer zones and firebreak maintenance particularly throughout degraded hill country ecosystems that are covered with invasive species and therefore are fire-prone.
- Integrate ecosystem restoration and biodiversity monitoring into school curricula and national volunteer programs to build long-term social resilience.

Conclusion and Policy Recommendations

The restoration project proves that even small scale, locally driven restoration efforts can produce valuable outcomes in biodiversity enhancement, climate resilience and community wellbeing. In a country like Sri Lanka where ecological degradation, economic stress and climate vulnerability intersect, NbS solutions such as this one offer a pragmatic and scalable approach to recovery and resilience-building.

While the project's primary goal was biodiversity assessment and ecological restoration, its impacts have extended beyond landscape rehabilitation. By leveraging community empowerment and a hybrid funding model, the initiative adopted a decentralized approach that reduced overhead costs, enabled cost-effective restoration and created positive behavioral changes within the local community. The project actively engaged youth and school children in conservation activities. Women were empowered through income-generating propagation work and broader community members became more aware of the importance of preserving their surrounding ecosystems. In parallel, fire risk reduction, identifying a significant number of threatened species, opportunistic species reappearance and improved water retention on restored slopes signifies early ecological recovery, that will likely multiply over time.

Furthermore, this model demonstrated that climate adaptation does not necessarily depend on scaled infrastructure or high-capital investments. When designed with the landscape and its people in mind, small-scale interventions can be both impactful and replicable. The restoration process in Bopaththalawa offers a replicable template for other highland regions across Asia where montane ecosystems are under threat, and government budgets are constrained. The project's early success also shows a strong entry point for fiscal policy integration, where NbS are not seen as external to development, but as foundational components of national climate strategies. As Sri Lanka navigates a post-crisis development path, investing in ecological restoration; particularly in upstream water catchments presents an opportunity to balance environmental security with fiscal prudence.

One of the most severe threats to the restoration efforts and local biodiversity comes from anthropogenic activities, especially in the practice of purposely setting fires to clear pathways. These forest fires destroy already degraded landscapes (Wijesinghe et al., 2012; Senaratna Sellamuttu et al., 2013) which are dominated by dry grasses and invasive species. While many invasive plants such as Cymbopogon nardus (citronella) within the habitat regenerate rapidly from underground rhizomes that remain unaffected by fire, native saplings—especially those newly planted—are often unable to survive such extreme conditions. Fires also trap and kill the fauna that lives within the area, further increasing ecosystem degradation. Illegal tree felling (for fuelwood) remains a persistent challenge within the forest area to date. Despite the legal restrictions, some local residents continue to harvest forest trees, often looking into convenience over sustainability. This practice weakens restoration outcomes, contributing to degraded forest gaps, and accelerates habitat loss within the forest area. While regular patrolling has proven effective in preventing some of these illegal activities, community engagement and awareness-raising initiatives have also played a role in forest protection. From the community discussions conducted, we suggest innovative approaches such as utilizing invasive tree biomass as a substitute for fuelwood option and long-term behavioral change to effectively manage the cloud forest.

To support the scaling and sustainability of similar efforts, the following final recommendations were made:

- Formally recognize cloud forest restoration as a priority sector within Sri Lanka's climate adaptation strategies, enabling targeted investments.
- Develop a national framework for PES to allow restoration beneficiaries as private sector to compensate upland communities for protecting vital ecosystems.
- Create fiscal incentives for private sector entities contributing to voluntary biodiversity offsets, PES or forest restoration through CSR funds.
- Promote ecological literacy in rural schools and integrate NbS modules into national youth volunteer schemes to

create a platform of correct environmental literacy.

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