Pilot Empirical Research

Research location: Human Ecology Practical Area – HEPA
Duration: From 27 October 2023 to 2 July 2024

Application and Comparison of Methods for Estimating Carbon Stock in Above-ground Biomass of Tropical Rainforests in the North-Central Vietnam

Key farmers – forest owners measuring tree diameter at breast height in a standard plot. Photo by SPERI, 9 April 2024

REPORT

Application and Comparison of Methods for Estimating Carbon Stock in Above-ground Biomass of Tropical Rainforests in the North- Central Vietnam

Research Scope/Location	"Carbon stock in above-ground biomass of the Human Ecology Practical Area – HEPA estimated by standard plots over 310.7 ha of regenerating natural forest area in Ngan Pho River upper watershed, Son Kim 1 commune, Huong Son district, Ha Tinh province, Central Vietnam"
Approval Authority	Ministry of Science and Technology
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Pages	61 pages including cover (1 page), main report (40 pages), Annexes 18 pages), and References (2 pages).
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Method for estimating carbon stock in above-ground biomass through identification, measurement, and calculation using standard plots for tropical rainforests in this research report respects three fundamental characteristics of ecosystem: Diversity, uniqueness and local knowledge of the Human Ecology Practical Area (HEPA), based on the philosophy of Nurturing Ecosystem.

Accordingly, criteria for the standard plot determination include: 1) Direction of Yang energy flows[2]; 2) terrain (elevation and slope); 3) spiritual belief of forest owners (world view on the ecosystem); 4) timber volume; 5) diameter class; and 6) species diversity. These six basic indicators are applied for calculation and comparative analysis as a fundamental criteria for this research.

The total calculated area is 310.7 ha with standard plots systematically set up according to direction, route, terrain and slope to ensure representativeness. The calculation formulas used and compared include: 1) Brown (1997), 2) Chave et al (2005), 3) Natural Resources Wales, and 4) Bao Huy (2012). The final formula chosen for calculation is Bao Huy (2012).

Accordingly, the total C-stock of the entire HEPA forest areas calculated in 2024 is 42,475.8 tons C (in which, **Ctb_total**[3] *is 136.71 (ton C/ha)* with **WD = 0.55 (g/cm^3);** *total CO2 equivalent that HEPA captures is* **155,886.19 tCO$_2$e (2024).**

[1] Participatory Action Research and Forest/Land Rights User (Chủ Sử dụng Đất-Rừng)
[2] Sun - Water - Wind.
[3] Ctb_total = C_AGB + C_BGB with C_AGB (ton/ha) and C_BGB (ton/ha).

List of Acronyms:

HEPA : Human Ecology Practical Area
CHESH : Center of Human Ecological Study of Highland
SPERI : Social Policy Ecology Research Institute
CODE : Consultancy on Development Institute
GHG : Greenhouse Gas
EU : European Union
ISO : International Organization for Standardization
MRV : Measurement, Reporting, Verification
NDC : Nationally Determined Contributions
ATV : Average Timber Volume. Unit: m3 per hectare
DBH : Diameter at Breast Height. Unit: cm.
C_AGB : Carbon in the above-ground biomass
C_BGB : Carbon in the below-ground biomass
tCO_2-e : Ton of Carbon Dioxide equivalent
GDP : Gross Domestic Product
MARD : Ministry of Agriculture and Rural Development
AGB : Above-ground biomass
PC : People's Committee
NFI : National Forest Inventory
IPCC : Intergovernmental Panel on Climate Change
CF : Default coefficient between carbon content and above-ground dry biomass

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I. General introduction

Under the mandate[4] of the Center of Human Ecological Study of Highland (CHESH)[5], a team of researchers from the Consultancy on Development Institute (CODE) and the Social Policy Ecology Research Institute (SPERI) has implemented a pilot empirical research **"Methodology for Estimating Forest Carbon Stock (Above-ground biomass) of Regenerating Tropical Rainforests 20 years after exploitation"** in the "Biodiversity Conservation area of the Ngan Pho River upper watershed", Huong Son district, Ha Tinh province, Central Vietnam. The research aims to promote sustainable co-governance of the upper watershed ecosystems, contribute to CO2 emission reduction, and fulfil social responsibility of the Vietnamese government towards the NetZero 2050 commitment at COP 26.

Since taking over the extremely poor and severely degraded post-exploitation forest area in this location under the Decision 1230/QĐ-UBND dated 5 June 2002, CHESH (commonly known as HEPA[6]) has been continuously implementing activities to restore, enrich, protect, and conserve the biodiversity of this upper watershed based on local knowledge, understanding, and customary law of ethnic minority farmers in nurturing forest. Closely collaborating with the local authorities of Son Kim 1 and 2 communes, the leadership of the Cau Treo Border Guard Station, local forest rangers, the Forest Protection Management Board, and the local police and army forces, and maximizing support from the People's Committees[7] and agencies of Ha Tinh province have become CHESH's key co-management strategy throughout time and resources in the journey to restore and enrich a once-thought-impossible-to-recover post-exploitation poor land, now transformed into a biodiversity conservation area for a growing variety of plants, animals, and medicinal herbs.

The process and methods of annual forest ecosystem restoration in HEPA are practiced by young eco-farmers selected from different villages along with HEPA staff according to season and weather: 1) Collect seeds of precious and rare timber tree species[8] as they ripen and fall; process the seeds according to the process of sowing seeds in nursery, caring for and planting seedlings at the forest edges. Accordingly, every year and every five years, key staff and farmers are invited to HEPA to attend training courses on forest changes monitoring, fire prevention, and mitigation of mechanical and biological risks in this forest.

During the period from 2010 - 2015 - 2020, HEPA staff collaborated with independent experts and officials from Ha Tinh provincial authorities to develop plans and jointly assess forest changes, estimate forest stock, observe the status of forest management, protection and enrichment, as well as risks and inadequacies caused by forest boundary overlaps (if any).

By 2015, the forest had grown in terms of both quality and cover, number of individuals, species and varieties, and forest stock. In particular, the density of trees with a circumference of more than 10 cm in the forest increased significantly. Accordingly, HEPA created opportunities and conditions for key farmers from villages and regions to come to HEPA to engage in field trips,

[4] CHESH/SPERI/CODE/MOU on cooperation and collaboration. Authorization Letter 43/CV/ 28/12/2023.
[5] The 310.7 ha – forest area has been used by CHESH to pilot a strategy for enriching depleted natural forests through natural regeneration and self-nourishment of the ecosystem.
[6] Human Ecology Practical Area
[7] At commune, district and provincial level.
[8] 1) Local indigenous tree varieties: Lim xanh (Erythrophleum fordii Oliv.), 2) Dổi xanh, 3) Táu (Vatica sp.), 4) g, 5) Vàng Tâm (Manglietia fordiana Oliv.), 6) Trâm đỏ; 7 Trám Trắng và Đen (Canarium album (Lour.) Raeusch.)

practice timber volume measurement skills, count the number of species, identify their functional uses, local names and Latin names through random determination method of standard plots that represents direction, slope, terrain and fundamental characteristics of the ecosystem.

From 2016 to 2022, key farmers[9] continuously practiced skills in measuring and calculating forest carbon stock in HEPA, in Cao Quang commune in the Nan River watershed of Tuyen Hoa district, Quang Binh province, and in Kon Tu Ma village in Dak Bla River watershed of Mang Canh commune, Kon Plong district, Kon Tum province of the Central Highlands.

From October 2023 to July 2024, CHESH/HEPA authorized CODE and SPERI to conduct a pilot empirical research titled ”Application and comparison of methods for estimating forest carbon stock in tropical rainforests of the north-central Vietnam". Accordingly, CODE and SPERI have jointly implemented the "Methodology for estimating forest carbon stock (above-ground and below-ground biomass) of a regenerating natural forest over 310.7 ha in the Ngan Pho River upper watershed, Huong Son district, Ha Tinh province, Central Vietnam" towards legal regulations for forest owners[10], which enable them to fulfil their social responsibility to inventory GHG emission reductions.

The cross-cutting approach of this research topic is to *apply international and Vietnamese scientific formulas in accordance with MARD's current regulations and EU carbon credit standards*. The research focuses on identifying systematic and respresentative standard plots within the watershed area. For each tree with a DBH greater than 6 cm, the following steps are undertaken:
Measure DBH and clear bole height;
Count the number of individuals;
Record common name, local name, and Latin name;
Record information in a field notebook according to a template;
Store template in file;
Enter information into Excel formulas to calculate diameter, equivalent dry weight, timber volume, carbon stock, and CO2 equivalent in the identified standard plots;
Calculate conservation and development indicators for the 310.7 ha area in terms of CO2 equivalent from the carbon sequestration potential of the forest. The calculation results ensure adherence to proper procedures, technical application of calculations, and transparency throughout the implementation process.

Research Outcome indicator: Ensure the compliance with the Vietnamese standard and ISO 14064-2. The VCS Methodology VM0015 is referred carefully and screened[11].

Research Output indicator: Achieve ISO 14064-2 carbon credit certification standards and ensure compliance with Vietnamese legal framework[12].

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[9] The trainees, who well obtain practical skills in measuring and estimating carbon stocks, will later become trainers for the forest owners whose forest and land have already been granted land use rights Certificates upon forest and land allocation process conducted by SPERI in collaboration with local authorities.
[10] Circular 28/TT-BNNPTNT dated 16 November 2018.
[11] “Methodology for Avoiding Unplanned Deforestation” (v1.1), where relevant.
[12] Circular 28/2018, Decree 06/2022, Circular 23/2023: contribution towards “Vietnam’s Carbon Emissions Reduction Legal Framework of the Ministry of Agriculture and Rural Development/Forestry (contribution to achieving the overall national required level of emissions reduction of 129,8 CO2-e million tons by 2030). Among that, the entire forest area of 310.7 ha of HEPA has contributed a *total C-stock of 155,886.19* ***tCO2e*** *calculated on 5 June 2024, in which,* ***Ctb_total***[12] *is 136.71 (ton C/ha) with* ***WD = 0.55 (g/cm3)*** *equal to 42,475.8-****t C.***

Research Effect indicator: Achieve socialization of concepts and skills in calculating and approximating carbon stocks in natural forest trees, and converting into CO2 equivalent for young key farmers who are also forest owners in the watersheds.

Research Impact Indicator: Develop a curriculum and a process of behaviors and practical skills in determining the standard plot, measuring, counting, calculating carbon content according to the standard plots, interpolating from a forest tree/age/circumference/height/diameter/timber volume/carbon/CO2 equivalent conversions for the key farmers participating in the field trips. The young people, who practice steps of applying carbon calculation method of a tree in a standard plot, will continue to become trainers for forest owners in the villages. This is an participatory action research approach that involves the forest owners to achieve optimal economic efficiency.

II. Policies references

This pilot research has been undertaken with respect to the ongoing legitimate political references of the three following legal documents:

- Circular 28[13]/2018/TT-BNNPTNT dated 16 November 2018 regulating sustainable forest management plan.
- Decree 06/2022/ND-CP dated 7 January 2022 on mitigation of greenhouse gas (GHG) emissions and protection of ozone layer[14]. This Decree forms the backbone of the Vietnam's carbon emissions reductions commitment. Having been passed in January 2022, it outlines key reduction targets for each Ministry and the fields in which these ministries are responsible for reducing GHG emissions. At present, the Decree 06 is being consulted for public opinion through the electronic network in order to be finalized and in line with practical needs.
- Circular 23[15]/2023/TT-BNNPTNT dated 15 December 2023 regulating measurement, reporting and verification of results of GHG emission mitigation and GHG inventory in the forestry sector[16].

The application of carbon stock estimation methods for the AGB pool[17] (standing trees) in tropical rainforests using random and representative standard plots towards recommendations for a carbon credit formation process by forest owners will contribute to determining a key and decisive role of forest owners in the government's carbon credit market orientation from now to 2028.

[13] Circular 28/2018/TT-BNNPTNT on Sustainable Forest Management Master Planning of Forest Land Owners
[14] Decree 06. Article 4. 1. Mitigation of GHG emissions and protection of ozone layer shall be eligible for economic-social conditions, applicable laws and regulations and international treaties related to the purpose of developing a low-carbon economy and green growth associated with sustainable development.
Decree 06. Article 4. 3. GHG emission quota exchange activities
[15] Circular 23/2023/TT-BNNPTNT/national reporting/reduce GHG emission
[16] Decree 06. Article 6. Identified area for reducing greenhouse emissions. HEPA falls into the following categories: a) biodiversity; preservation; b) enriching and restoring forests by planting native forest tree species; c) sustainable watershed forest co-governance for inter-generationality; d) agro-ecology farming system in up land use master planning;
[17] This research does not measure carbon in other pools such as: 1) Humus; 2) litter layer; 3) dead biomass; 4) the air within the spatial boundary where standing tree biomass resides; and 5) existing forest products.

III. Research description:

III.1. Research title

Methodology for estimating carbon stock in above-ground biomass of a regenerating natural forest over 310.7 ha in the Ngan Pho River upper watershed, Huong Son district, Ha Tinh province, Central Vietnam.

III.2. Research objectives:

III.2.1. Have a forest carbon stock calculation report for regenerating natural forests 20 years after exploitation in compliance with the ISO14064-2 standard.

III.2.2. Have a curriculum on process of approaching, analyzing, comparing, and selecting a carbon stock calculation method for tropical rainforests in Vietnam based on commonly applied formulas worldwide.

III.2.3. Have a legal framework for carbon credit trading for forest owners in watersheds.

III.2.4. Have a key farmers group of forest owners in watersheds, who are proficient in mapping, standard plot boundaries determination, GPS applications, and natural forest carbon stock calculation and CO2 equivalent conversion in the journey of learning, understanding and recognizing the crucial values and roles of natural forests in CO2 emission mitigation efforts that enable Vietnam to achieve the NetZero 2050 commitment.

III.3. Research location background

The Human Ecology Practical Area (HEPA), managed by CHESH, was revitalized from a poor and degraded forest area encounting with social issues like smuggling and wildlife trafficking in the 1990s. Located on the Huyen Vi peak[18] of 499 meters above sea level and along National Highway 8A en route to Cau Treo International Border Gate, HEPA serves as a gateway to a vast trans-boundary natural forest between Vietnam and Laos.

CHESH was granted a Land Use Rights Certificate under Decision 1230/QD-UBND/5/6/2022[19]. Accordingly, all CHESH activities are based on the philosophy of "Nurturing Nature" with annual strategy and action plan: (1) Regenerating and restoring forest while respecting natural seasonal succession of the watershed ecosystem; (2) village elders and young key farmers[20], who practice the philosophy of nurturing nature in the villages, are the main source of knowledge to develop training curriculums based on the "Teaching by Learning - Learning by Doing" approach, building culture and behaviour towards nurturing nature in HEPA; (3) cooperating and collaborating with the local Forest Ranger Department, Cau Treo Border Gate Border Guard Station, Huong Son District Protection Forest Management Board, Son Kim Commune People's Committee, Commune Police, and key farmers in the villages under the participatory co-governance strategy that involves many actors in the border region, are the guiding principle of HEPA; 4) organizing regular visits to HEPA for sharing and enriching skills in practicing agro-ecology, replicating local indigenous varieties, sharing rituals, festivals and offerings in worshipping forest according to the beliefs of ethnic groups; 5) strengthening and developing young leaders in villages through agro-ecology networking for

[18] VN 2000. X: 468718.17; Y: 20333336588.90
[19] https://co2justice.org/giay-chung-nhan-quyen-su-dung-dat-so-v266105.html
[20] http://ecofarmingschool.org/

commercializing post-harvest products from HEPA forests is the driving force to transform young eco-farmers into community entrepreneurs upon the young leadership development strategy; 6) ecosystem landscape planning and management planning for farming models within HEPA forest area are the solution to create self-sustaining livelihood for HEPA staff and farmers living in HEPA; 7) maintaining diary of ecological changes and developing practical agro-ecology curriculums, hosting student from universities in Vietnam and abroad for internship[21] and research opportunities are the solution for generating income and improving livelihoods based on intellectual capital and self-generated eco-products of HEPA.

Five-year cycle 2010 – 2015 - 2020, HEPA forest was monitored for changes and assessed for growth in terms of stock, species composition, cultivation layer color, and water storage and release capacity. This was done jointly by the key farmers - forest owners in the watersheds, HEPA staff, independent experts, and representatives from the Ha Tinh provincial agencies.

In 2020, the average carbon stock of HEPA forests estimated based on satellite images was 196 tons per hectare, while in 2023[22] - 194.64 tons per hectare.

III.4. Research location

This map below provides the whole territory of HEPA with a total forest land area of 310.7 hectares under the CHESH management in accordance with Decision 1874[23] of the Ha Tinh PPC in 2022. *(Figure 1 at bellow Map page).*

[21] http://ecofarmingschool.org/eng/
[22] https://datrungcongdong.org/hepa
[23] https://co2justice.org/upload/files/00_1874_PD%20PAQLRBV%20Trung%20tam%20Vung%20Cao.pdf

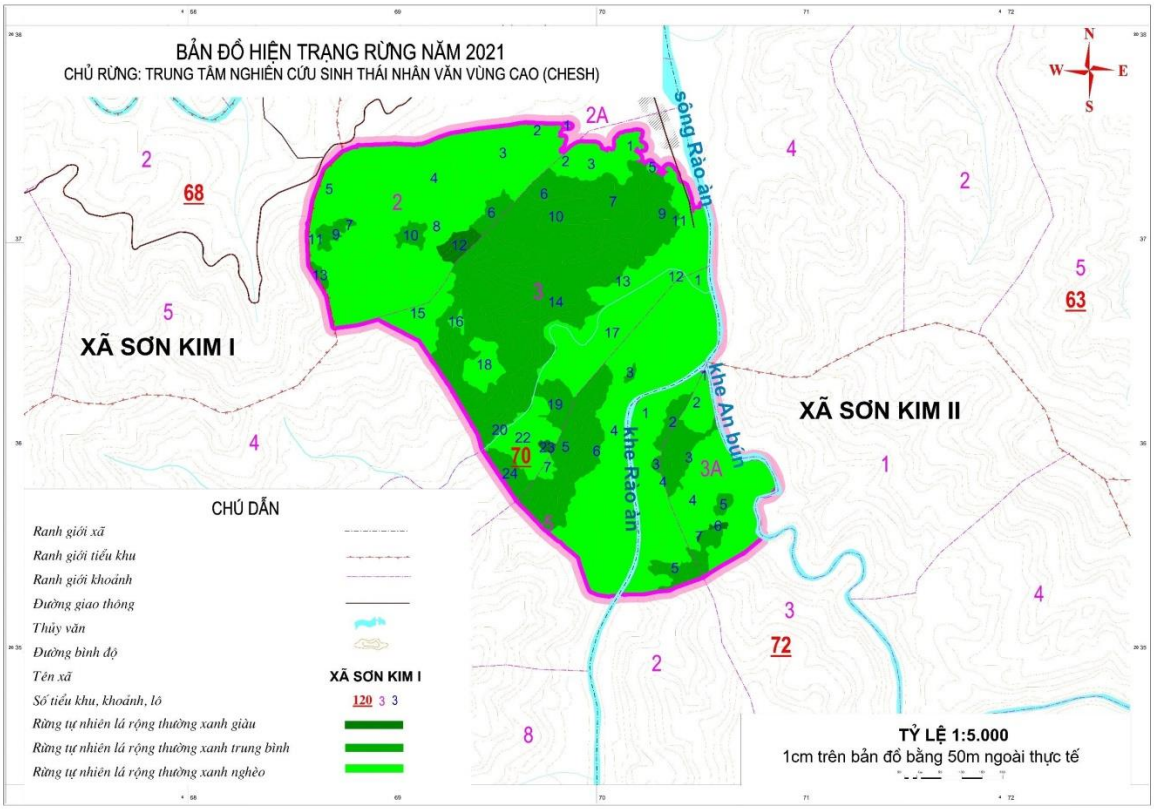


Figure 1: Map of the HEPA forest status by 2021 recognized by the official approval upon the Sustainable Forest Management Plan by 2031, Son Kim 1 commune, Huong Son district, Ha Tinh province.

GPS coordinates covering the HEPA forests area (Projection: VN2000)

No.	X	Y
M01	470358	2037599
M02	469745	2037635
M03	470127	2038074
M04	469676	2038328
M05	469526	2038369
M06	468945	2037991
M07	468758	2037785
M08	468386	2037963
M09	468253	2037626
M10	466953	2037498
M11	467248	2037281
M12	468346	2036716
M13	468657	2036513

No.	X	Y
M14	469415	2035970
M15	469416	2035649
M16	469609	2035729
M17	470125	2035550
M18	471111	2035244
M19	471459	2035794
M20	470492	2036433
M21	470308	2037584
M22	470372	2037385
M23	470411	2037294
M24	470476	2036915
M25	470444	2036807
M26	470530	2036764
M27	470297	2037369
M28	470226	2037444
M29	470134	2037492
M30	470081	2037441
M31	469982	2037360
M32	469899	2037492
M33	470092	2037529
M34	468355	2037189
M35	468704	2037487
M36	468947	2037484
M37	469940	2037204
M38	469474	2037087
M39	469215	2036749

Figure 2: GPS coordinates covering the HEPA forest land boundary marks, Projection VN2000.

The research site (HEPA) is a biologically sensitive ecosystem, diverse in topography and complex in conditions and mechanical impacts since it is located at the gateway to the natural border forest, a critical watershed providing water for hundreds of thousands of people living and working in the downstream areas.

From *1975 to 2000*, the forest area[24] (now known as HEPA) was over-exploited, resulting in the dry riverbed and the loss of habitat for animals and micro-organisms. HEPA was born with a mission of "Nurturing Nature" and a challenging startup. Given the difficult circumstances, HEPA had adopted a gradual and community-based approach with young key farmers in the watersheds as the main resource, the close cooperation with neighbouring forest owners and functional agencies as the priority strategy, and the practice of agro-ecology as the guiding principle from the very beginning of the HEPA forest management.

Since 2002, with a strategy of restoring natural ecosystems while respecting HEPA ecosystem characteristics of inter-dependence, interaction, adaptability and uniqueness, HEPA has achieved remarkable results: 1) a growing annual forest growth; 2) an increasing canopy cover and soil moisture; 3) a growing diversity of plant and animal species; 4) a rising water level in streams and the Rao An River; 5) a carbon stock measured by standard plots reaching **155,886.19-t CO2-e**; 7) HEPA is attracting the interest of a growing number of young farmers from villages across the country and neighbouring countries in the Mekong region.

III.5. Leakage management

As analyzed above, the co-governance solution among neighbouring forest owners and local authorities has enabled HEPA to protect its forests through the spirit of collective responsibility among forest owners in the entire border area of Cau Treo border gate. The unique features that have inspired local farmers are: 1) HEPA has planned a seasonal regeneration space with wild banana, betel leaves, mugwort, perilla, wild pineapple leaves, wild conical leaf plants, and other seasonal herbs to provide opportunities for border farmers to harvest during the off-season, contributing to increasing their income; 2) HEPA staff have created all conditions for farmers to participate in learning and practicing skills of building agro-ecological gardens; 3) annually, HEPA organizes workshops for sharing and learning lessons on co-governance among neighbouring forest owners, and developing updated plans for following years.

III.6. Risks Assessment

At present, no risks to expect.

III.7. Research's compliance with laws and other regulatory frameworks

All HEPA's operation and activities are in line with the Vietnamese Law documents and updated regulations of local authorities and functional agencies. See Policies References above and other details as below:

1. CHESH's Registration Certificate[25] for Scientific and Technological Activity.
2. CHESH's Land Use Rights Certificate[26].
3. Sustainable Forest Management Plan[27] in line with Circular 28/2018.

[24] Under the management of the Huong Son Forestry Services Enterprise, which later was taken over by CHESH for management with the land use rights Certificate under Decision 1230/5/6/2002/QĐ-UBND dated 5 June 2002 of the Ha Tinh PPC.
[25] https://co2justice.org/chung-nhan-dang-ky-hoat-dong-khoa-hoc-va-cong-nghe-nam-1999.html
[26] https://co2justice.org/giay-chung-nhan-quyen-su-dung-dat-so-v266105.html
[27] https://co2justice.org/upload/files/00_1874_PD%20PAQLRBV%20Trung%20tam%20Vung%20Cao.pdf

4. Forest survey results[28] of the Ha Tinh provincial Agricultural and Rural Development Department
5. HEPA has completed a detailed mapping system in compliance with the forest regulations. The Sustainable Forest Management Plan for 2021-2031 has been updated by HEPA to reflect changes, and is managed with a logical database, adhering closely to Circulars, Decrees, and Guidelines of MARD, the Administration of Forestry, as well as updates and notices from the provincial Department of Agriculture and Rural Development and the local Forest Rangers. Therefore, HEPA has been protected, managed and developed stably. Since taking over the forest, HEPA has not committed any violations that have led to reprimands from higher level authorities.
6. At present, HEPA is promoting the Forest/Rung – Upland Farm/Ray – Valley Rice Field/Ruong (also known as 3R) model[29] in the community livelihood functional area towards enriching soil health, contributing to increasing the resistance of the cultivation layer (humus) according to the 3R ecosystem–based system planning and detailed design (a traditional farming method that is currently being gradually eroded due to the impacts of the industrial agriculture). The following seven key activities will be carried out in the current and future years:
    a) Continue implementing plans for forest and forest ecosystem management and protection according to Article 37 of the Forest Law and forest management regulations, and consolidating forest protection plans.
    b) Continue implementing plans for biodiversity conservation and protection of endangered, precious, and rare forest plant and animal species and endemic species according to Article 38 of the Forest Law and forest management regulations, and determining high conservation value forests.
    c) Continue implementing forest fire prevention and control plans according to Article 39 of the Forest and forest management regulations.
    d) Continue implementing measures for prevention and elimination of organisms harmful to forests according to Article 40 of the Forest Law and forest management regulations.
    e) Continue determining locations, area and species of plants, determining silvicultural measures and special use forest development measures according to Articles 45 and 46 of the Forest Law and MARD's forest management regulations on silvicultural measures.
    f) Continue preparing scientific research, training, and practice plan according to Clause 1 Article 53 of the Forest Law and forest management regulations.
    g) Continue preparing curriculums, time and space for implementation of training and environmental awareness raising activities (e.g. summer camps for primary, secondary and high schools, training in system planning and detailed design of the 3R landscape ecosystems for students of universities of agriculture and forestry, and circular economy, as a destination for young people towards agro-ecology, and a reliable place for domestic and international students to come for internship, research, practice and application of methods for calculating carbon stocks, water storage capacity of tropical rainforests and

[28] https://co2justice.org/upload/files/00_%20VB-tham-dinh-PA(08_08_2022-17h09p34).pdf
[29] Argumentation for the 3R-based ecosystems planning and development in HEPA, 2017 – 2022 – 2027

upper watershed areas, etc.) to unlock the potentials of forests in accordance with Clauses 2, 3, 4 and 5 of Article 53 of the Forest Law and forest management regulations.

Avoiding unplanned deforestation is a social strategy for forest protection. With the philosophy of nurturing nature and the methodology of approaching young key farmers as the center, especially the co-management strategy between HEPA and local authorities in Huong Son district for more than two decades since 2002, HEPA has been and will be able to control risks from unplanned deforestation.

The above are the basic steps that HEPA is taking to contribute to not only providing key farmers - forest owners with basic knowledge about CO2 emission reduction but also working hand in hand with the government to realize the NetZero 2050 commitment.

Table 1: 10 filling documents to be prepared for research approval

Documentations and Activities	Status of completion by June 2024
1. Clear legal status and ownership	Done
2. Existence of substantial threat of destruction (if any)	Done
3. Good maps of local region and land use	Done
4. Inventory of biomass	Done
5. Sustainable forest management plan, 2022 – 2031	Done
6. Availability of leakage areas (if any).	Done
7. Calculation of Carbon stock	Done
8. Approval of Ha Tinh PPC	Done
9. Approval of authorized organizations (CODE-SPERI)	Done
10. Approval of management agency (Ministry of Science and Technology)	In progress

IV. Methodology

IV.1. Methodology for avoided unplanned deforestation:

All information and database related to the application of the research will be fully documented and carefully stored as the basis for certification to respect the EU regulations and Vietnamese law. The emission reduction calculation methodologies are based on the VCS Methodology VM0015 “Methodology for Avoiding Unplanned Deforestation” (v1.1), where relevant.

IV.2. Ground measurement in standard plots

- 22 pieces of tool were used for conducting ground-verified standard plots and measuring AGB per hectare.
- They consist of :
  - The (1) tape measure from NLI (combining both circumference and diameter values on the same tape) and (2) Data sheets (2.1.), one for recording trees timber values and divided into two groups: (a) trees > 6 cm (DBH) and (b) < 1 - 6 cm (DBH)), and the other (2.2.) recording herbal plants species in the plots.

Figure 3: A set of tools HEPA used for measurement in each standard plot (2023-2024). Detailed description provided as below:

1: Map	13: Notebook
2: Monofilament wire	14: Pen
3: Tape measure 50m	15: Staple
4: Tape measure 20m	16: Scissors
5: Sticks for plot center and corners sign	17: Knife
6: GPS handheld	18: Safety helmet
7: Battery	19: First aid kit
8: Stick for defining 1.3m height	20: Black fabric
9: Tape measure 5m (for diameter and circumference)	21: Camera
11: Compass	22: Clear bag
12: Acrylic paint	10: Laser height measure (apply formulas for carbon stock calculation with H variable)

- The data sheets are designed to fully capture information per standard plot (20m x 25m) including geo-data, GPS coordinates for four corners of each plot and one additional at the center of the plot, and the trees' key parameters (DBH), height (H)[30], and local names and scientific names of trees. The geo-data files are stored and governed in compliance with CHESH regulations.

[30] Practically, height (H) can be hardly calculated accurately, even using laser equipment, and is time-consuming, especially for forest owners who are local residents. Therefore, for each standard plot, five trees of different diameter classes were selected and carefully measured. The collected data from all standard plots was then used to develop a H/DBH model, from which the height of each tree in each standard plot could be estimated.

- The selection of the standard plots (20m x 25m = 500 square meters) is implemented in line with the Circular 33/2018/TT-BNNPTNT, Article 11. 2. (b). HEPA is under the category of natural evergreen forest)[31].
- For the natural evergreen forests in the Ngan Pho River watershed (HEPA):
    - The standard plot area is 500m2 (rectangular size 20m x 25m).
    - Each plot is 50m - 200m apart according to determined routes[32].
    - Measure trees with DBH >= 6cm
- The standard plots are marked with acrylic paint.

Figure 4: The field team conducting measurement in a standard plot (2023-2024). (See more information in the footnote)[33]

- The C-stock measurement process started from October 2023 and for all the trees with DBH[34] > 6 cm (at 1.3 m of the trees). For those with DBH < 6 cm (at 1.3 m of the trees), the team counted all these trees and then calculated the average values of their all DBHs and heights. The team did not include estimates and calculations of those trees (DBH < 6-cm) in the final C-stock calculation, but only counted them for reporting AGB[35] quantification.

[31] Circular 33/2018/TT-BNNPTNT/Forest auditing update
Circular 33/2018/TT-BNNPTNT dated 16 November 2018 prescribing forest survey, inventory, and forest transition monitoring. **Article 11**. **Forest stock survey**. **2.** Forest stock survey approaches: b) Using standardized typical-pattern grid cells covering an area of between 500 m2 and 1,000 m2, with respect to condition of natural forests covering an area of less than 2,000 ha; providing between 0.01% and 0.1% of their area for sampling.
[32] To accurately locate the standard plots in the field, pre-designed routes were mapped, and VN2000 coordinates for each plot were calculated in advance based on the distances between the routes and the plots on the route. These coordinates were then input into a GPS device to precisely locate the plot in the forest. Additionally, a randomized plot selection method was employed, and GIS was used to convert the standard plot's coordinates into GPS coordinates for accurate field determination.
[33] Photos taken by HEPA staff.
Left-photo: From left to right: Mr. Nguyen Thanh Trung (YIELDS-AGREE member in HEPA) and Mr. Nguyen Tien Vương (YIELD-AGREE member in Kon Tum). Other information on the bottom left corner of the photo: VN 2000, UTM Zone 48N. X: 522604.881 m. Y: 2035353.021 m. WGS84 – ETGS: 432618, 18.407133570, 105.215881070. Errors: 4.92 m. Height: 200.72 m. Photo direction: East (1080). 2024/04/08. 16:08:08.
Right photo: From left to right: Mr. Nguyen Tien Vuong (YIELD-AGREE member in Kon Tum), Mr. Nguyen Thanh Trung (YIELDS-AGREE member in HEPA), and Mr. Nguyen Duc Su (YIELDS-AGREE member in Cao Quang). Other information on the bottom left corner of the photo: VN 2000/Ha Tinh. X: 468876.457 m. Y: 2036925.064 m. WGS84 – ETGS: 432618, 18.415710670, 105.207243660. Errors: 13.58 m. Height: 350.36 m. Photo direction: North-West (3220). 2024/04/09. 14:48:21
[34] Diameter at Breast Height
[35] Above-Ground Biomass

IV.3. Location of the standard plots determined from October 2023 to June 2024

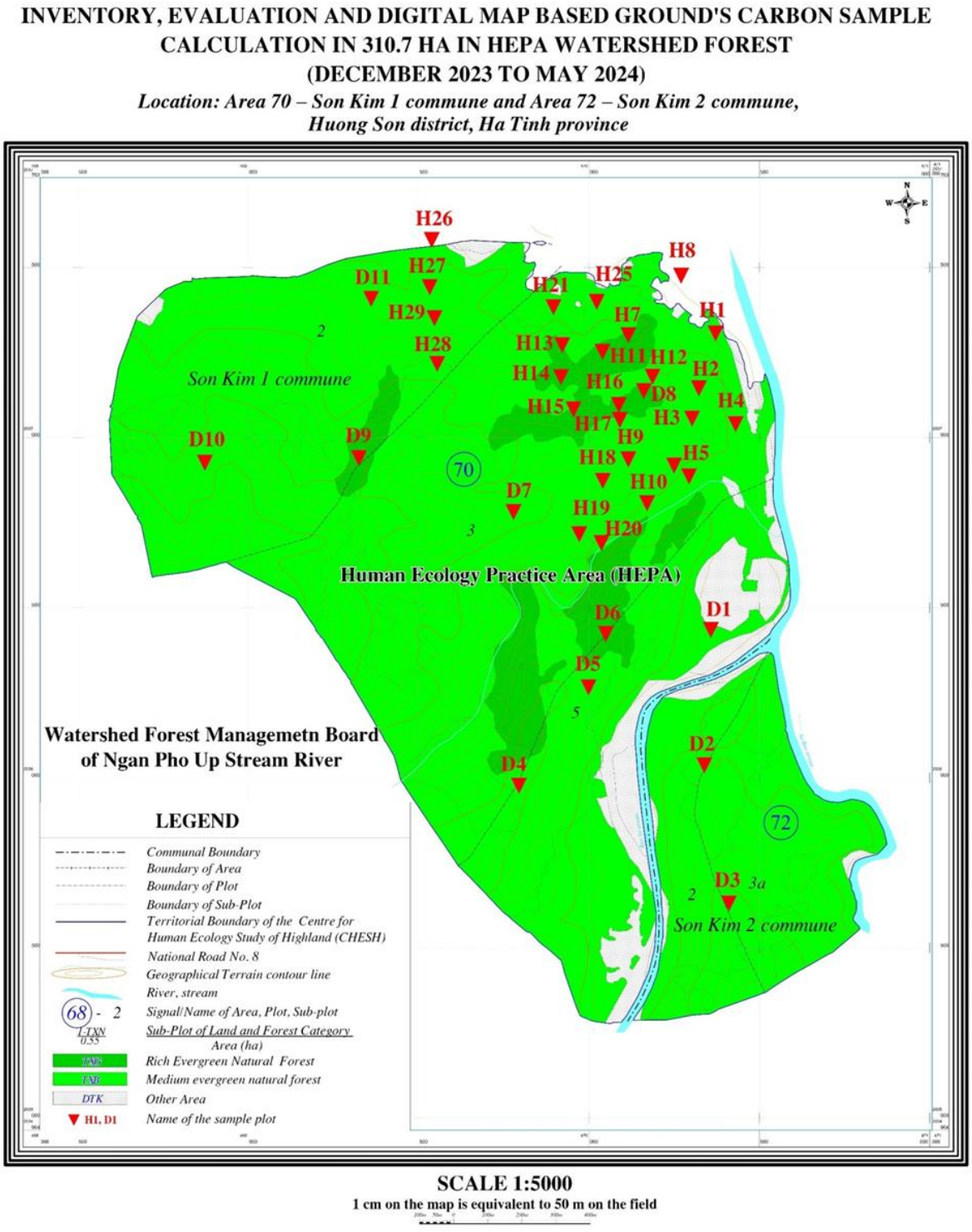


Figure 5: Mapping of 37 standard plots' GPS coordinates during the two forest C-stock surveys in HEPA (2023 – 2024)

- Both structured and systematic approaches were employed to select the standard plots. The plots were selected by route and direction in two phases: December 2023 (21 standard plots)

and April 2024 (16 standard plots), with the participation of key farmers from different villages and HEPA staff.

IV.4. Remote sensing and results

- After reviewing several ongoing technological innovations in measuring overall biomass of an area through comparison and analysis of advantages to ensure reliability and accuracy (especially under limited finance), for instance, the satellite image application, in 2023, CODE and SPERI approached a technical company based in Vietnam to source the provision of satellite images. The Planet satellite images were bought at 3-m resolution, and measured in May 2023.
- After selecting the best images taken on clear day/time, the Planet image of May 2023 captured the entire HEPA forest, the best satellite data and QGIS software were used to analyze images of forest land in its most actual state and determine the actual area corresponding to the latest forest land type classification.
- At that time, and from 2020, we also checked the Global Forest Resources Assessment 2020 report[36] data (pages 56 to 60), and data from Vietnam (Circular 26[37] dated 15 November 2017 stipulating forest change monitoring with 12 groups of forest status classification (latest).
- Given the measurement and calculation methods at that time (2017 and 2020), we approached and used those values based on the Circular 26 (which were the closest and nearest to our needs).
- After this, the recognized forest classification were harmonized into 17 types, of which 12 forest types are from the National Forest Inventory (NFI) map. This data is the secondary one which is published annually.
- We used the average values representing the 12 groups of forest status from the NFI's results table, specifically biomass stock (NFI Cycle IV (2006 -2010)); the National Forest Inventory and Statistic (NFI%S) (2013-2016) and the NFI (2016 -2020) as references.
- We took the average biomass value per forest type and multiplied it by the actual area of that forest type (after image processing and analysis), then we added them all to generate the value of biomass over the entire HEPA forest (for that particular year).
- Then, the carbon fraction in biomass was used at the default value of 0.47 (IPCC 2006) to estimate the carbon stock per hectare for each and all forestland types in HEPA in that particular year. The total C-stock measured in 2023 for HEPA is 194.64 t/ha (AGB only). For the entire 310.7 ha area, the total C-stock (AGB only) is 60,474.64 tons (2023).

[36] https://www.fao.org/vietnam/news/detail/vn/c/1396970.
[37] https://thuvienphapluat.vn/van-ban/Bat-dong-san/Thong-tu-26-2017-TT-BNNPTNT-quy-dinh-theo-doi-dien-bien-rung-va-dat-quy-hoach-phat-trien-rung-368314.aspx.

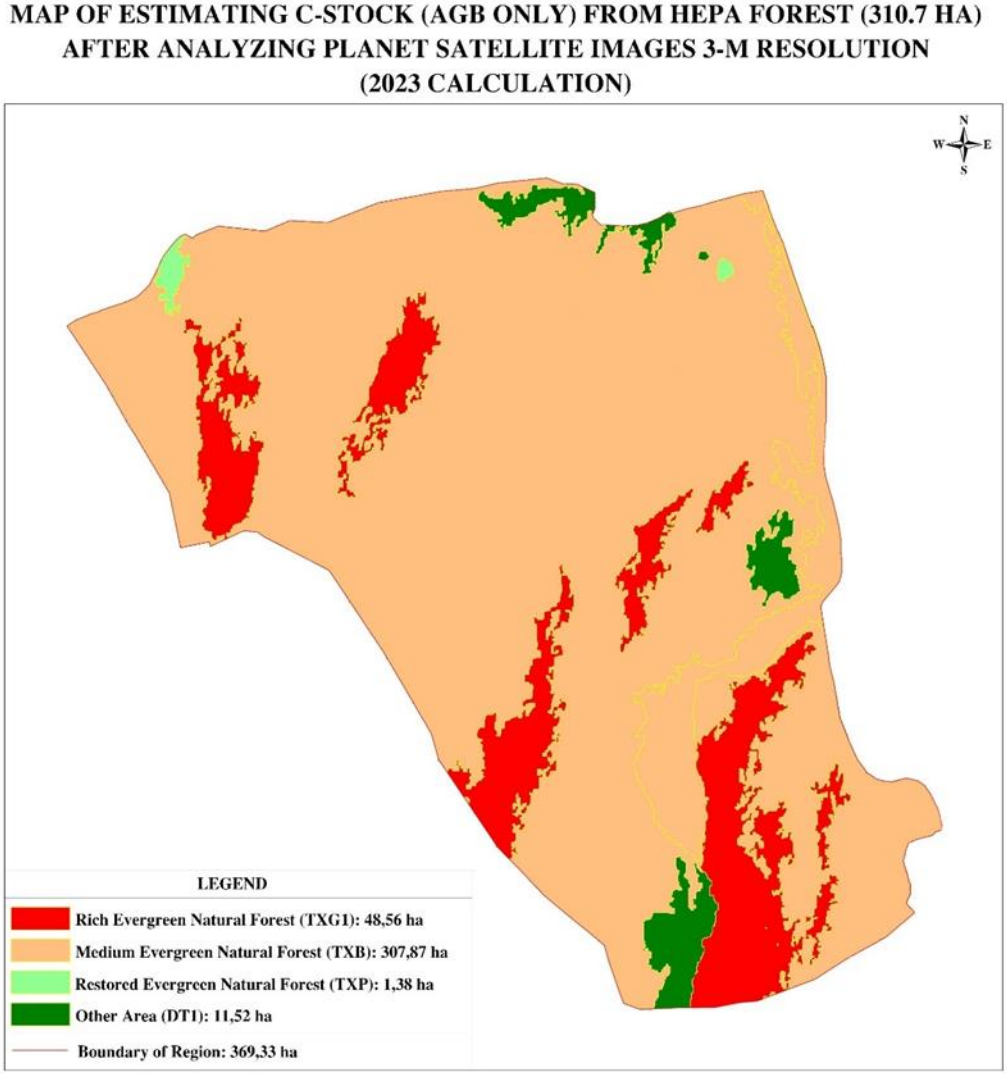


Figure 6: Estimating C-stock (AGB only) of HEPA forests (310.7 ha) after analysing Planet Satellite Images 3-m resolution (2023 calculation).

V. Measurement, Calculation, and Analysis of results of standard plots

V.1. Summary

The C-stock_AGB was calculated in the standard plots of the entire HEPA forest area of 310.7 hectare by using the formulas of: 1) Brown (1997), 2) Chave et al (2005)), 3) Natural Resources Wales, and 4) Bao Huy (2012). The results obtained from the Bao Huy (2012) formula was chosen by this research for the final report with the C-stock_AGB of ***155,886.19 tCO2e*** *in which,* ***Ctb_total***[38] *is 136.71 (ton C/ha) with WD = 0.55 (g/cm3), equivalent to* ***42,475.8-t C.***

[38] Ctb_total = C_AGB + C_BGB, where: C_AGB (ton/ha) and C_BGB (ton/ha) are the average C-stock in the above-ground biomass and the average C-stock in the below-ground biomass (mainly in timber trees' roots), respectively.

V.2. Description of results after measurement and analysis

A standard plot represents three characteristics of the watershed: 1) Direction of Yang energy flows[39]: Sun, Water, and Wind; 2) Elevation representation: Peak, Slope, Valley; and 3) Location of watershed terrain features[40].

The standard plot is measured in meters. Each standard plot is 500 m² (25 x 20). The total number of standard plots is 37, covering all four directions: East, West, South, and North; Watershed elevation: Peak, Slope, and Valley. The total area covered by the 37 standard plots is 18,500 m² (500 m² x 37 standard plots).

V.2.1. I. Results of standard plot analysis by energy directions

Table 2: Distribution of standard plots representing the three Yang energy flows (Sun, Water and Wind)

No	Direction	Number of standard plots	Percentage %	Notes
1	Multi-direction[41]	8	21.62	
2	East	6	16.22	
3	West	1	2.7	
4	South	4	10.81	
5	North	18	48.65	
	Total	**37**	**100**	

The entire 310.7 hectares[42] of the biodiversity conservation area are based on the fundamental characteristics of the Ngan Pho River watershed ecosystem and the worldview of ethnic minority groups in the Mekong region.

The peak zone is designated as a spiritual zone where the Spirits of Heaven, Earth, Wood, and Waterfall reside with eight standard plots at the peak coordinates representing all four directions: East, West, South, and North of the watershed. HEPA believes this zone is a sacred and serene space of the Spirits (Huyen Vi Peak).

[39] BHE 1999 – 2009 - 2019.
[40] The Biogeochemical process operates in the Forest - Upland Farm - Valley Rice Field ecosystem, determining the quality and content of carbon, oxygen and hydrogen in the micro-circulation of organisms that form the life and sustainability of tropical rainforest in the watershed. It serves as a basis for determining the carbon quality (Diamond, Gold, Silver, etc. according to the market economy).
[41] Huyen Vi peak at coordinates: X 468657, Y2036513, H 499
[42] Decision 1874/QĐ-UBND/2022

The buffer zone surrounding the Huyen Vi Peak is a strict zone where the Spirits discuss matters of Heaven, Earth, and the earthly realm. (The buffer zone protects the Huyen Vi Peak).

Descending further down the slope is the enrichment zone of wisdom, knowledge, and customary laws of the ethnic minority groups. This zone is a cultural exchange space where village elders and their young successors gather periodically and seasonally to exchange and practice knowledge of traditional medicinal herbs, natural dyeing techniques, and identification of various plant species with different uses. This zone serves as a repository of native medicinal plant varieties under the forest canopy and as an ecological livelihood space for the highland ethnic groups.

V.2.2. Results of standard plot analysis by spiritual functions

Table 3: Results of standard plot analysis by spiritual functions

No	Functional zoning	Number of standard plots	Percentage %	Notes
1	Spiritual zone	21	56.76	
2	Enrichment zone	16	43.24	
	Total	**37**	**100**	

V.2.3. Results of standard plot analysis by elevation

Table 4: Distribution of standard plots by elevation

TT	Elevation (m)	Number of standard plots	Percentage %	Notes
1	63 – 90	4	10.81	
2	90 -150	15	40.54	
3	150-395	18	48.65	
	Total	**37**	**100**	

V.2.4. Analysis of standard plots by topographic features

Table 5: Distribution of standard plots by topographic features

No	Location	Number of standard plots	Percentage %	Notes
1	Mountain peak	8	21.62	
2	Mountain slope	19	51.35	
3	Mountain foot	10	27.03	
	Total	**37**	**100**	

V.3. Analysis results by diameter class and timber volume

V.3.1. By diameter class

65.95% of the trees have a diameter at breast height (DBH at 1.3 m) of less than 20 cm, followed by 27.5% of trees with a DBH between 20 and 40 cm. 6% of the total trees have a DBH greater than 40 cm.

Table 6: Tree counting by diameter class

No	Diameter class	Number of individuals	Percentage %	Notes
1	6 - 20 cm	916	65.95	
2	20 - 40 cm	382	27.50	
3	40 - 60 cm	68	4.90	
4	>=60 cm	23	1.66	
	Total	**1389**	**100**	

The relationship between tree diameter (D) and tree height (H) of the measured individuals (trees) is shown as below:

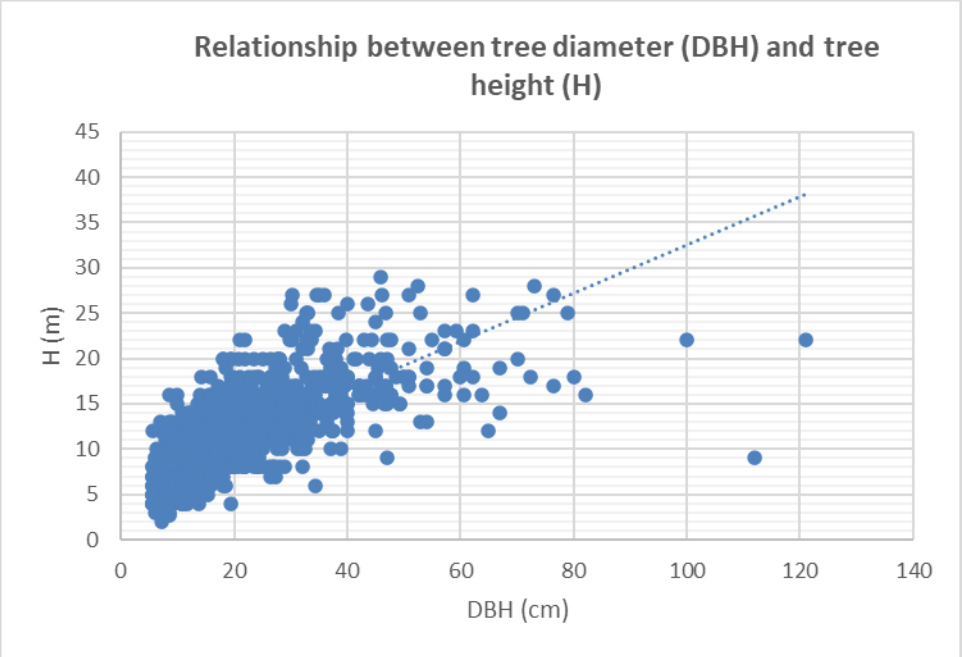


Figure 5 : The relationship between diameter at breast height (cm) and height (m) of 37 standard plots in HEPA (January 2023 – April 2024)

V.3.2. By timber volume

Average timber volume of each forest type in HEPA next page:

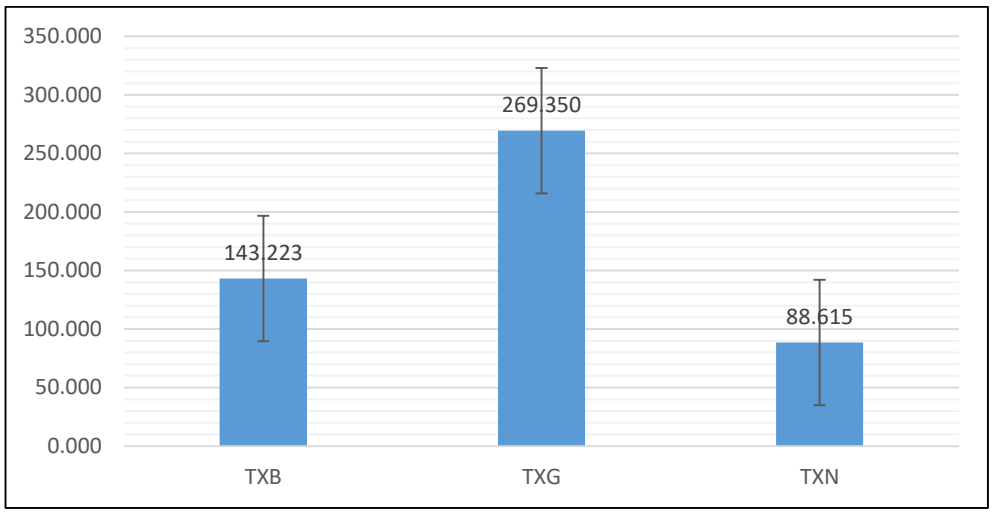


Figure 6: Average timber volume (m³/ha) of each forest type in HEPA. Classification by Vietnamese Standard. TXB: average evergreen broadleaf forest; TXG: rich evergreen broadleaf forest; TXN: poor evergreen broadleaf forest

Circular 16 (Vietnamese Forestry policies) updated and corrected Circular 33[43. 44]

Table 7: Results of average timber volume (m³/ha) of each forest type of HEPA Forest. Classification by Vietnamese Standard.

TT	Forests Status	Medium-forest TXB	Rich-forest TXG	Poor-forest TXN
1	Average Value	143.22	269.35	88.62
2	Standard Deviation	+/- 27.34	+/- 64.54	+/- 7.89
3	Minimum value	28.48	214.54	80.14
4	Maximum value	198.48	382.10	99.07

Average timber volume was measured and calculated as above.

- Average timber volume of medium forest: 143.22 +/- 27.34 (m^3/ha).

[43] https://Circular No/16-2023-TT-BNNPTNT/revised circular No. 33-2018-TT-BNNPTNT/Up-date forest inventory/ -592961.aspx

[44] Circular . 34/2009/TT-BNNPTNT/Up-date Forest Category

Article 8. Wooden Volume Based Forest Category

1. Wooden Forest Classification:

a) Very Rich: 300 m^3/ha.

b) Rich: 201- 300 m^3/ha.

c) Average: 101 - 200 m^3/ha.

d) Poor: 10 - 100 m^3/ha.

đ) Forest not yet for volume measurement: < 8 cm - 10 m^3/ha.

2. Bamboo forest: Based on bamboo species, density and diameter

- Average timber volume of rich forest: 269.35 +/- 64.54 (m^3/ha).
- Average timber volume of poor forest: 88.62 +/- 7.89 (m^3/ha).

V.4. Analysis results of species diversity (biodiversity)

V.4.1. Analysis by individual and classification by family

Among 37 standard plots, a total of 1,389 individuals belonging to 39 families and 52 genera has been measured. Among these, Dẻ (Legume), Dầu (Dipterocarpaceae), and Gai dầu (Cannabaceae) families are the three most abundant, with 14.69%, 8.06%, and 7.27%, respectively.

Table 8: Seven most abundant families

No	Top Seven abundant families	Number of individuals	Percentage %	Notes
1	Dẻ - Fabaceae	204	14.69	
2	Dầu – Dipterocarpaceae	112	8.06	
3	Gai dầu – Cannabaceae	101	7.27	
4	Sim – Myrtaceae	76	5.47	
5	Nguyệt quế- Lauraceae	75	5.40	
6	Trúc đào – Apocynaceae	66	4.75	
7	Đậu – Fagaceae	58	4.18	

Based on the 37 measured and analyzed standard plots, the indices: 1) IVI, 2) species diversity (Shannon index), and 3) concentration of dominance ratio, have been analyzed as the tables shown below:

V.5. IVI (Important Value Index)

IVI of each species is determined by the formula: **IVI = RD + RF + RBA** (*Mishra, 1968*)
Where: RD – Relative Density (%), RF – Relative Frequency (%), RBA[45] – Relative Basal Area (%).
N- Number of individuals, D – Density, F- Frequency

Table 9: Seven species with the highest IVI

No	Name of trees	Latin name	N	D	RD	Number of standard plots with occurrence	F	RF	BA	RBA	IVI
1	Lim xanh	*Erythrophleum fordii* Oliv.	71	1.919	5.112	26	0.703	3.741	5.445	9.525	18.378
2	Ngát	*Gironniera subaequalis* Planch.	100	2.703	7.199	32	0.865	4.604	3.344	5.851	17.655
3	Táu	*Vatica sp.*	110	2.973	7.919	28	0.757	4.029	3.217	5.627	17.576

[45] See Annex 3 on how to calculate values of RD, RF and RBA.

No	Name of trees	Latin name	N	D	RD	Number of standard plots with occurrence	F	RF	BA	RBA	IVI
4	Dẻ	*Castanopsis sp.*	54	1.460	3.888	21	0.568	3.022	2.513	4.396	11.306
5	Trâm	*Syzygium cinereum*	67	1.811	4.824	20	0.541	2.877	1.822	3.187	10.888
6	Ràng ràng	*Ormosia sp.*	35	0.946	2.520	17	0.460	2.446	3.224	5.641	10.607
7	Mức	*Wrightia nnamensis*	66	1.784	4.752	14	0.378	2.015	1.872	3.276	10.042

Despite having the highest IVI values, the IVI values for these seven tree species are relatively low (ranging from 10 to 18.38), indicating an absence of dominance by any particular species in the ecosystem.

V.6. Species diversity index - H (Shannon index) and Concentration of Dominance index - Cd

1. Species diversity index - H (Shannon index

$$H = \sum_{i=1}^{n} \frac{Ni}{N} * Ln(\frac{Ni}{N})$$

H – Biodiversity index or Shannon index; Ni – number of individuals of species i; N – total number of individuals of all species in the field.

2. Concentration of Dominance index - Cd

$$Cd = \sum_{i=1}^{n} \left(\frac{Ni}{N}\right)^2$$

Cd – Concentration of Dominance index; Ni – number of individuals / IVI of species I; N – total number of individuals/IVI of all species in the field (Simpson, 1949).

Table 10: H and Cd indices of 37 standard plots

No	Standard plot	Number of species	Total individuals	H	Cd
1	H29	24	48	2.962	0.063
2	H16	23	39	2.953	0.064
3	D2	21	28	2.948	0.059
4	D6	22	55	2.913	0.062
5	H7	25	51	2.910	0.075
6	H13	22	34	2.909	0.069

No	Standard plot	Number of species	Total individuals	H	Cd
7	H17	21	31	2.906	0.066
8	D4	23	43	2.853	0.078
9	D7	22	36	2.844	0.079
10	H20	21	42	2.843	0.069
11	H3	22	45	2.828	0.080
12	H4	21	37	2.825	0.074
13	H25	21	43	2.822	0.076
14	H2	20	37	2.819	0.069
15	H18	21	42	2.776	0.082
16	H21	21	43	2.761	0.088
17	H19	18	32	2.751	0.072
18	H26	20	49	2.744	0.081
19	D1	20	43	2.739	0.082
20	D8	22	48	2.726	0.092
21	D9	20	43	2.713	0.085
22	H14	19	34	2.654	0.095
23	H12	20	41	2.651	0.103
24	H1	17	29	2.644	0.089
25	H6	17	30	2.627	0.091
26	H27	17	34	2.617	0.090
27	D10	18	52	2.603	0.092
28	D5	19	44	2.566	0.104
29	H15	16	30	2.561	0.093
30	H11	14	27	2.531	0.086
31	H10	16	28	2.511	0.110
32	D3	14	29	2.435	0.106
33	H9	13	25	2.391	0.107
34	D11	14	25	2.332	0.142
35	H5	17	40	2.301	0.174
36	H28	12	33	2.144	0.152
37	H8	2	19	0.576	0.612
Mean		18.78	37.54	2.64	0.10
SD		4.26	8.66	0.40	0.09
Max		25.00	55.00	2.96	0.61
Min		2.00	19.00	0.58	0.06

Remarks

The species diversity index (Shannon) of the standard plots fluctuated 2.64 ± 0.4, indicating an average level of biodiversity, i.e. the species diversity among the standard plots is relatively even.

The Concentration of Dominance index (Cd) fluctuated 0.1 ± 0.09, indicating a inter-dependent relationship among species within a community. This result proves that the watershed ecosystem (310.7 ha) is growing harmoniously and stably.

V.7. Formulas applied[46] to measure and calculate biomass and carbon stock

Belows are four formulas from four different sources that have been applied to measure and calculate biomass and carbon stock in the 37 standard plots representing the entire watershed area of 310,7 ha: Brown (1997); Chave et al (2009); Natural Resources Wales[47]; and Bao Huy (2012).

V.7.1. Brown (1997)[i] formula

Brown (1997) proposed a function to calculate the biomass of standing trees above ground for tropical rainforests with an average annual rainfall of 1,500 – 4,000 mm as follows:

$$\boldsymbol{AGB = exp(-3,1141 + 0,9719\ x\ ln(DBH^2\ x\ H))}$$

Where:

AGB[48] is the above-ground biomass of each tree (kg/tree)
exp[49] is a function that returns the value of the exponent of the base e
DBH[50] is the diameter at breast height (cm)
H[51] is the clear bole height

- **Determine total above ground biomass in each standard plot (kg):**

$$\boldsymbol{AGB_{OTC} = \sum_i AGB_i\ (kg)}$$

Where:

$\boldsymbol{AGB_{OTC}}$ is the total above-ground biomass for each standard plot (kg)
i is the total number of trees in the standard plot

- **Convert average above-ground biomass for each standard plot (t/ha):**

$$\boldsymbol{AGB_{OTC}tb = (AGB_{OTC}\ x\ 10,000/S_{otc})/1,000\ (t/ha)}$$

Where:

$\boldsymbol{AGB_{OTC}tb}$ is the average above-ground biomass for each standard plot (t/ha)
S_{otc} is the standard plot's area. In HEPA, the value of S_{otc} is 500m^2
10,000: Conversion from hectare to m^2
1,000: Conversion from ton to kg

- **Calculate average above-ground biomass (t/ha)**

$$\boldsymbol{AGB_{tb} = (\sum_n (AGB_{otc}tb)_n)/n}$$

[46] Method of analysis, comparison and screening based on practice and application data
[47] https://naturalresources.wales.
[48] Average Ground Biomass
[49] Exponential function
[50] Diameter at breast height
[51] Height

Where:

AGB_{tb} is the average above-ground biomass (t/ha)
n is the number of calculated standard plots

- **Calculate average carbon content in the above-ground biomass (t/ha)**

$$C\_AGB_{tb} = AGB_{tb} \; x \; CF$$

Where:

C_AGB_{tb} is the average carbon content in the above-ground biomass (t/ha)
CF is the default coefficient between carbon content and above-ground dry biomass. According to the Inter-governmental Panel on Climate Change (IPCC) in 2006, CF = 0.47.

V.7.2. Chave et al (2005)[ii] formula

In 2005, Chave et al. synthesized data from a dataset of 2,410 trees with diameters of 5 cm or more, collected directly at 27 study sites in the tropics of the America, Asia, and Oceania, to establish allometric equations for estimating biomass for different types of tropical forests. Among these, the most suitable formula for moist tropical forests is the following:

$$AGB = exp\{-1.499 + 2.148\, ln(DBH) + 0.207(Ln(DBH))^2 - 0.028(Ln(DBH))^3 + LN(WD))\}$$

Where:

AGB is the above-ground biomass of each tree (kg/tree)
exp is a function that returns the value of the exponent of the base e
DBH is the diameter at breast height (cm)
H is the clear bole height (m)
WD is the wood density of the tree species. In this calculation, WD (g/cm³) is taken as the average wood density of tree species in Southeast Asia, which is 0.574[52] (±0.151) (Chave et al. 2009).

- **Determine total above-ground biomass in each standard plot (kg):**

$$AGB_{OTC} = \sum_i AGB_i \; (kg)$$

Where:

AGB_{OTC} is the total above-ground biomass for each standard plot (kg)
i is the number of trees in the standard plot

- **Convert average above-ground biomass for each standard plot (t/ha):**

$$AGB_{OTC}tb = (AGB_{OTC} \; x \; 10,000/S_{otc})/1,000 \; (t/ha)$$

[52] 0.55 is chosen in this research

Where:

$AGB_{OTC}tb$ is the average above-ground biomass for each standard plot (t/ha)
Sotc is the standard plot's area. In HEPA, the value of S_otc is 500m^2
10,000: Conversion from hectare to m^2
1,000: Conversion from ton to kg

- **Calculate average above-ground biomass (t/ha)**

$$AGB_{tb} = (\sum_{n}(AGB_{otc}tb)_n)/n$$

Where:

AGB_{tb} is the average above-ground biomass (t/ha)
n is the number of the calculated standard plots

- **Calculate average carbon content of above-ground biomass (t/ha)**

$$C\_AGB_{tb} = AGB_{tb} * CF$$

Where:

C_AGB_{tb} is the average carbon content of the above-ground biomass (t/ha)
CF is the default coefficient between carbon content and above-ground dry biomass. According to the Inter-governmental Panel on Climate Change (IPCC[53]) in 2006, CF = 0.47.

V.7.3. Natural Resources Wales[iii] formula

The calculation method is provided by Natural Resources Wales (NRW). NRW is the natural resources management agency for Wales, funded by the government and responsible for licensing, assessing, and enforcing when necessary.

NRW provides a table of the relationship between breast height diameter (cm) and estimated dry weight - DW[54] (kg/tree) as follows:

Table 11: Conversion from breast height circumference (cm) to estimated dry weight (kg)

Breast Height Diameter DBH (cm)	Estimated Dry Weight DW (kg/tree)	Notes
1.5	0.009	
2.5	0.04	
5	0.23	
10	1.40	
20	9	
30	27	
40	82	

[53] Intergovernmental Panel on Climate Change
[54] Dry Weight

Breast Height Diameter DBH (cm)	Estimated Dry Weight DW (kg/tree)	Notes
50	106	
75	310	
100	668	
125	1,208	
150	1,964	
175	3,253	
200	4,221	

- Using the table above, apply the linear interpolation method to determine the estimated dry weight (DW) (kg/tree) for each tree. The dry weight of a tree is approximately equal to its above-ground biomass. Therefore:

- **Total above-ground biomass is equal to total dry weight within each standard plot (kg), and is calculated as follows:**
  $$AGB_{OTC} = DW_{OTC} = \sum_i DW_i \ (kg)$$

Where:

AGB_{OTC} is the total above-ground biomass for each standard plot (kg)
DW_{OTC} is the total dry weight for each standard plot (kg)
i is the total number of trees in the standard plot

- **Convert average above-ground biomass for each standard plot (t/ha):**

$$AGB_{OTC}tb = (AGB_{OTC}\ x\ 10,000/S_{otc})/1,000\ (t/ha)$$

Where:

$AGB_{OTC}tb$ is the average above-ground biomass for each standard plot (t/ha)
S_{otc} is the standard plot's area. In HEPA, the value of S_{otc} is 500m^2
10,000: Conversion from hectare to m^2
1,000: Conversion from ton to kg

- **Calculte average above-ground biomass (t/ha)**

$$AGB_{tb} = (\sum_{n}(AGB_{otc}tb)_n)/n$$

Where:

AGB_{tb} is the average above-ground biomass (t/ha)
n is the number of the calculated standard plots

- **Calculate average carbon content in above-ground biomass (t/ha)**

$$C\_AGB_{tb} = AGB_{tb} x\ CF$$

According to the Natural Resources Wales's guidebook, the carbon content of trees is approximately half of their dry weight. Here, to maintain the consitancy with the remaining methods, the research team adopted the CF value of 0.47 as recommended by the IPCC in 2006.

V.7.4. Bao Huy[iv] formula

Bao Huy (2012) established a system of models for estimating forest biomass and carbon using the felling method for evergreen broadleaf forests in the Central Highlands.

Bao Huy formula is used for direct calculation of the above-ground biomass carbon content as follows:

Đetermine carbon in above-ground biomass for each tree by applying the formula:

$$C\_AGB = exp(-3.40031 - 0.819475\ x\ ln(DBH) + 0.787115\ x\ ln(H\ x\ DBH^2) + 0.673237\ x\ ln(WD\ x\ DBH^2))$$

Where:

C_AGB is the carbon in the above-ground biomass for each tree (kg/tree)
exp is a function that returns the value of the exponent of the base e;
DBH is the diameter at breast height (cm);
H is the clear bole height (m).
WD is the wood density of the tree species. In this calculation, WD (g/cm³) is taken as the average wood density of tree species in Southeast Asia, which is 0.574[55] (±0.151) (Chave et al. 2009).

- **Determine total carbon in above-ground biomass in each standard plot (kg):**

$$C\_AGB_{OTC} = \sum_i C\_AGB_i\ (kg)$$

Where:

C_AGB_{OTC} is the total carbon in the above-ground biomass for each standard plot (kg)
i is the number of trees in the standard plot

- **Convert average carbon in above-ground biomass for each standard plot OTC (t/ha):**

$$C\_AGB_{OTC}tb = (C\_AGB_{OTC}\ x\ 10,000/S_{otc})/1,000\ (t/ha)$$

Where:

C_$AGB_{OTC}tb$ is the average carbon in the above-ground biomass for each standard plot (t/ha).
Sotc is the standard plot's area. In HEPA, the value of Sotc is 500m^2
10,000: Conversion from hectare to m^2

[55] 0.55 is adopted in this research.

1,000: Conversion from ton to kg

- **Calculate average carbon content in above-ground biomass (t/ha)**

$$C\_AGB_{tb} = (\sum_n (C\_AGB_{otc}tb)_n)/n$$

Where:

C_AGB_{tb} is the average carbon content in the above-ground biomass (t/ha)

n is the number of the calculated standard plots

Table 12: Results of average C_AGB (t/ha) from the above four formulas

Formula	Brown (1997)	Chave et al (2005)	Natural Resources Wales	Bao Huy (2012)
Average C_AGB (t/ha)	97.36	151.00	133.54	110.25
Standard deviation (t/ha)	40.87	71.51	54.01	48.26
Min (t/ha)	43.76	64.25	58.14	49.37
Max (t/ha)	249.19	420.97	332.11	297.11

Below-ground biomass is estimated by the ratio of above-ground biomass and root biomass applying the VM0015 method:

$$BGBtb = AGBtb \; x \; R$$

Where, R is the ratio of the root biomass and above-ground biomass. According to IPCC, the ratio for tropical forests is:

R = 0.20 when AGBtotal < 1 25 t/ha

R = 0.24 when AGBtotal > 125t/ha

Applying the default coefficient between carbon content and above-ground dry biomass C_AGB = AGB x CF with the CF value of 0.47.

R = 0.20 when C_AGB total < 58.75 t/ha

R = 0.24 when C_AGB total > 58.75 t/ha

The average total carbon stock Ctb_total (t/ha) is calculated by:

$$Ctb\_total = C\_AGB + C\_BGB$$

The results of average C_AGB, C_BGB and Ctb_total (t/ha) are as below:

Table 13: Average C_AGB, C_BGB, and Ctb_total

Formula	Brown (1997)	Chave et al (2005)	Natural Resources Wales	Bao Huy (2012)
Average C_AGB (t/ha)	97.36	151.00	133.54	110.25
Average C_BGB[56] (t/ha)	23.37	36.24	32.05	26.46
Average Ctb_total (t/ha)	120.73	187.24	165.58	136.71

[56] Corresponding to carbon biomass in the roots of timber trees.

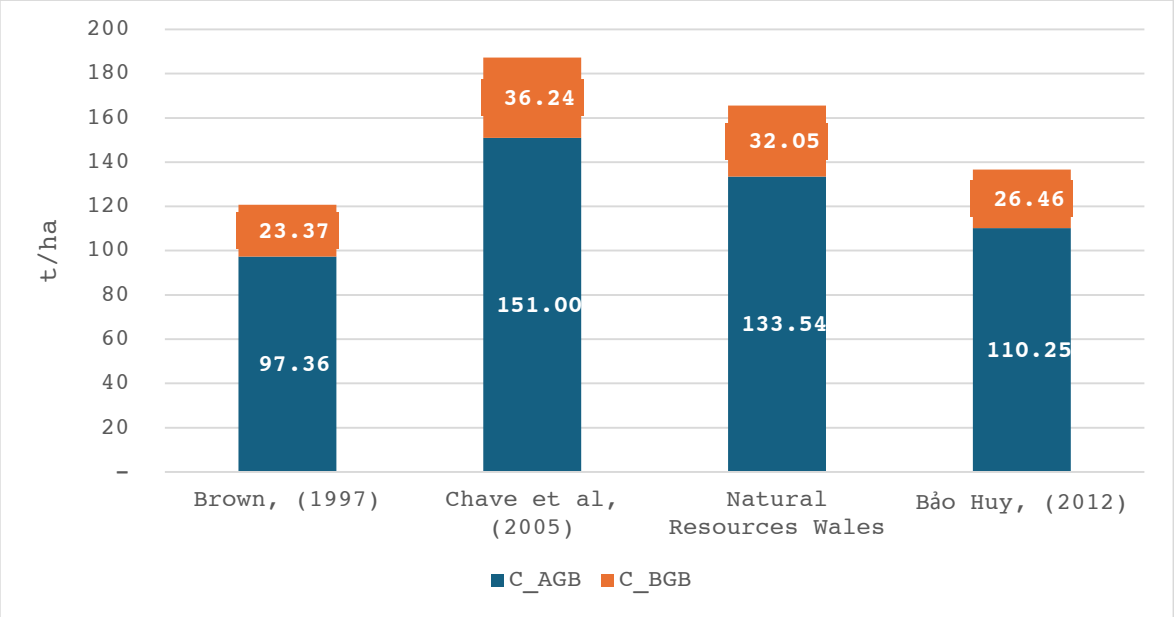


Figure 7: Average carbon biomass C_AGB, C_BGB (t/ha)

From Table 13, it can be seen that the method that gives the lowest value is the Brown 1997 with the C_AGB value of 97.36 t/ha and the Ctb_total is 120.73 t/ha, while the method that gives the highest value is the Chave et al (2005) with the C_AGB is 151.00 t/ha and Ctb_total is 187.24 t/ha.

VI. Analysis of the appropriateness among the applied formulas

Table 14: Analysis of appropriateness among the applied formulas

No	Formula	Input variable	Appropriateness	Inadequacies
1	Brown (1997)	DBH (cm) and H (m) (Dimeter at breast heigh and Height of tree)	Two simple inputs are popularly applied in carbon calculation (all over the world).	It has not been applied for measuring and calculating both biomass and carbon stock in Vietnam. **Low realiability in terms of practical application**. It only stops at analyzing 168 tree species, and does not include species in Vietnam. The data source is limited.
2	Chave et al (2005)	DBH (cm), WD (g/m^3)	The data source is quite diverse (from Asia, Pacific and Latin-America).	The data source has no representation in Vietnam. There is no basis for accessing the appropriateness and realiability for tropical forests in Vietnam. **Low realiability in terms of practical application.**

No	Formula	Input variable	Appropriateness	Inadequacies
3	Natural Resources Wales	DBH	Simple, can be used for guiding forest owners who are farmers.	The research method, location and data source are unclear. **Low realiability in terms of practical application.**
4	Bao Huy (2012)	DBH (cm), H (m), WD (g/m^3)	Designed for the evergreen broadleaf forests in the Central Highlands, this model is well-suited to the specific ecological conditions and timber species composition in the study area. The inclusion of DBH, H, and WD as input variables improves the accuracy of biomass estimation for mixed-species forests. By directly estimating carbon in forest biomass, this model offers more accurate estimation compared to models by Brown (1997), Chave et al. (2005, 2014), which only estimate biomass and indirectly estimate carbon using CF=0.47 of IPCC (2006)	The modeling data source is unavailable in the study ecosystem, even though there are quite similarities in terms of ecology and species composition between the modeling region and the applied research area.

During the period from 2000 to 2015, the biomass stock measurement tools and tree height meters were not yet professional, leading to limitations in estimating the tree's clear bole height. Therefore, estimating the above-ground biomass using tree diameter was an easy-to-apply solution, thus simplifying the variables needed in the calculations.

However, according to Chave et al (2005)[v], for tropical forests, it is necessary to use a multi-species regression model like Chambers et al. (2001b) to estimate above-ground tree biomass, rather than relying solely on diameter at breast height (DBH). Bao Huy (2012) formula shows that the estimation function that includes all three variables DBH, H, and WD has the highest reliability.

Accordingly, using Bao Huy (2012) formula for calculating carbon stock in above-ground biomass in the analytical report of 310.7-ha HEPA is the most appropriate compared to Brown (1997), Chave et al (2005) and Natural Resources Wales. Why:

- Firstly, the HEPA's 310.7 ha area belongs to the evergreen mixed forest type, and the data used for calculation was collected from wood groups I to VII. This is similar and reliable to the formula proposed by Bao Huy (2010) for evergreen broadleaf forest areas in the Central Highlands.

- Secondly, Bao Huy's formula (2010) provides a 3-variable function: DBH (cm), H (m), WD (g/m^3) which is more suitable for application in HEPA compared to 1-variable and 2-variable formulas as analyzed above in this report.

Accordingly, the total C-stock in the above-ground and below-ground biomass of the entire HEPA forest area (calculated using Bao Huy's formula (2012)) is the most appropriate option for implementation.

Total C-stock of the entire HEPA Forest area:

$$C\_total = Ctb\_total \; x \; A$$

Where:

C_total is the total carbon stock over the entire area (t)

A is the total project area (ha)

C_total = 136.71 x 310.7 = 42,475.8 (t)

Total CO2-equivalent (CO_2eq) over the entire area is calculated by:

$$CO2_{eq} = C\_total \; x \; 44/12 = 42{,}475.8 \text{ x } 3.67 = 155{,}886.19 \text{ (t)}$$

Where:

CO2eq_total is the total CO2-equivalent captured by the entire HEPA forest area (t)

44/12 is the conversion rate from C to CO2

Thus, the total carbon stock over the entire HEPA forest area of 310.7 ha, as of the research time, is 42,475.8 tons of C which is equivalent to 155,886.19 tons of CO2 absorbed by the entire HEPA forest area of 310.7

VII. Uniqueness of the research

The research on carbon stock calculation targets forest owners within the 310.7-hectare area of the watershed biodiversity conservation area (HEPA) managed by CHESH. This area is located in the Ngan Pho River watershed which is characterized by a unique rainforest ecosystem with specific terrain, climate, and annual rainfall patterns[57]. The methodology for conducting forest field trips is a collaborative approach that bring together experts[58], forest owners and young eco-farmers from the different watersheds: Ngan Pho River, Huong Son district, Ha Tinh province; Nan River, Tuyen Hoa district, Quang Binh province; Chay River, Sapa District and Bao Yen District, Lao Cai Province; Da River, Ba Vi District, Hanoi.

[57] A practical basis for identifying, analyzing, and comparing carbon quality, stock, and sequestration potential towards financial analysis and carbon credit benchmarking strategies

[58] In the fields of cadastre, mapping, forestry, medicinal herbs and carbon

The hands-on practice with five skills is exercised by each group of six members, which is rotated among the groups after each fieldwork in the total 37 standard plots. The professional functions essential for field trips are:1*) Compass and maps (cadastral, planning, forest current status and classification), forestry and energy flow directions*[59]*; 2) fieldwork tools, measuring, counting, staking, routing, pulling ropes and positioning standard plots; 3) using GPS devices, reading information displayed on the GPS device; 4) writing information from the GPS into a field notebook according to templates, double-checking the information (by reading aloud, clearly, slowly for the whole group for listening to and cross-checking) between the reader and the writer before using laser to measure tree height; 5) taking photos of mother trees, sacred trees, trees listed in the Red Book, and medicinal herbs and specimen photos (this function is stable throughout the field research period).* The training methodology employs a rotational and cross-exchange approach, incorporating four key skills and tasks. Through hands-on field experiences in 37 standard plots, forest owners will gain the knowledge and confidence to: identify age, circumference, and height, wood group of trees; estimate timber volume and carbon stock; convert sequestrated CO2-equivalent into monetary value through practicing directly on trees and standard plots. ("This iron tree after 22 years will become an ATM"[60]). The forest owners participating in the field trip are the elderly women from the northwestern ethnic groups[61]: Ms. Trieu Thi Khang, a traditional herbal healer from Dao minority in Ba Vi district (Da River watershed); Ms. Hoang Thi Lien from Tay minority in Bao Yen; Ms. Ly May Chan, a community entrepreneur from Dao minority in Sapa (Chay River watershed), Ms. Cao Thi Thiu from Ma Lieng minority in Ke village, Lam Hoa Commune, Tuyen Hoa District (Danh River watershed); Mr. Nguyen Van Su and Ms. Mai Thuy Huyen from Cao Quang commune (Nan River watershed).

Participants in this applied research are young key farmers who are pursuing the philosophy of nurturing nature and agro-ecological practices, and traditional herbal healers - village elders who are the owners of the tropical rainforests in the watershed areas. As we can see in the research report, the information about tree names, family names and wood groups shown in the table are not as synchronized and professional as the scientific information. It is because the forest owners are of the different ethnic groups with the different languages, and they came from the different watersheds across the country, resulting in the differences between local names and common names as shown in the list of individual species names. Especially, forest owners were not able to identify the Latin names. For instance, in 37 standard plots, up to 762 individuals (54.8%) have not been fully identified by scientific names, and 171 individuals (12.31 %) have not been identified by family. The Latin names in this research report have been collated and named by senior experts from CODE and SPERI.

The results of the practical research on carbon stock calculation in HEPA represent a crucial opportunity for forest owners[62] to come together, engage, share experiences, apply technology, and directly identify in the standard plots, which brings about more confidence and practical significance not only for the forest owners[63], but above all, these are practical actions and efforts towards the realization of the Netzero commitment proposed by Vietnamese Prime Minister at COP 26, starting from the real owners of the legal forests.

[59] Sun, Water, Wind
[60] Said by Ms. Dao, the forest owner in Khe 5 village, Son Kim 1 during her field trip in HEPA.
[61] See photos at: www.co2justice.org
[62] Evaluation form from forest owners
[63] Forest owner field survey footage

Forest owners participating in this applied research understand the importance of natural forests, how to estimate the value of each forest tree according to age, circumference, height and wood group, and they are aware of the invaluable benefits from natural forests in daily livelihood, annual seasonal food security, protecting and maintaining freshwater sources for daily life and production, and for household economic development based on carbon credit trading.

VIII. Limitations of the field research team

There are incomplete Latin names in the biomass and carbon stock calculation results, namely: 1) some of trees have been identified by local names, but their common and scientific names remain unknown; 2) there is absence of professional taxonomists[64] in species identification.

The incomplete Lantin names of species result in incomplete biodiversity indicators, unknown WD indicator or indicators of IVI, H, and Cd, affecting the comprehensive assessment of wood and carbon stock within the total of 310,7 ha of HEPA forest.

The comparison between the three-variable formula (DBH, Hvn and WD) and three other formulas (Table 3) indicates Bao Huy (2012) formula provides more accurate results than the formulas using only one variable (DBH) or two variables (DBH and H).

A complete scientific identification for all individuals in the standard plots, enabling the determination of WD for each species will significantly enhance the accuracy of carbon calculation for mixed-species forests.

IX. Forest management status in Vietnam from 2001 to present

According to Global Forest Watch data, in Vietnam from 2001 to 2023[65], 31% of tree cover loss occurred in areas where the dominant drivers of loss resulted in deforestation. The dataset below (Vizzuality, n.d.) shows the dominant drivers of tree cover loss from 2001-2023: 1) Replacement of natural forests for industrial plantations (rubber, acacia, industrial cassava) towards the national industrialization through planting industrial trees; 2) replacement of natural forests for small and medium hydropower projects towards modernization; 3) replacement of natural forests for rural urbanization and transportation; 4) replacement of natural forests for monoculture of high-tech agriculture; 5) replacement of natural forests due to the need of mineral exploitation for industrialization, and forest fires.

[64]The primary motivation and objectives of this applied research are the training of forest owners in the watersheds. The presence of professional taxonomists would cause confusion and a lack of confidence among forest owners. An in-depth session on cross-referencing local names, common names, and Latin names will be conducted in HEPA during the next carbon stock verification and calculation.

[65] https://www.globalforestwatch.org/blog/data-and-tools/2023-tree-cover-loss-data-explained

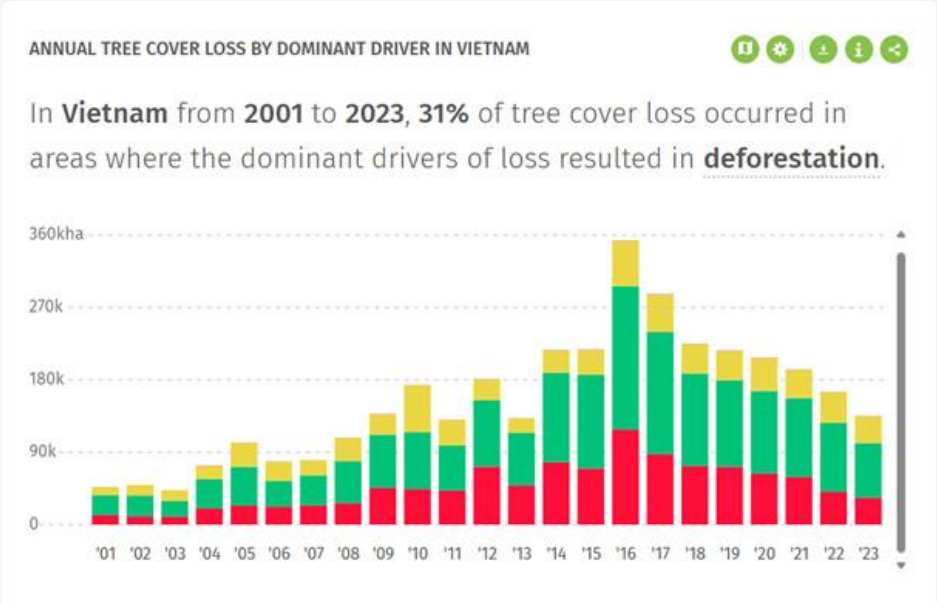


Figure 8: Annual forest cover loss (Global Forest Watch data)[66].

Notes: Colours represent the main drivers of deforestation. Green represents forestry deforestation. Red represents commodity-driven deforestation. Yellow represents shifting agriculture.

Limited approach to natural forest data of high accuracy has been found in Ha Tinh province. Through continuous observations over 22 years, there are several changes in natural forest stock in the Ngan Pho River watershed, and the natural forest area has been heavily replaced by acacia plantations for processing wood by the companies located in Son Truong commune, Huong Son district.

The most recent report from MARD on the national forest cover in 2023 is that Ha Tinh provincial forest cover is 52.58%[67].

The forest areas surrounding HEPA and in HEPA have been highly protected and regenerated.

The measurement of C-stock in HEPA was conducted from October 2023 to May 2024. The need for awareness and practice of skills in measuring and calculating carbon stocks in natural forest trees and within a forest of forest owners in the upper watershed of Huong Son district is very high. Accordingly, HEPA will continue to conduct specialized training courses, following up this pilot/empirical research over expected 120 standard plots in favorable weather conditions in the future, to meet the needs of neighboring forest owners in the Ngan Pho River protection watershed, Huong Son District, Ha Tinh Province.

X. Quantification of GHG absorption (equivalent conversion):

The measurement of C-stock in the HEPA forest was conducted from October 2023 to May 2024. The HEPA forest ensures the GHG absorbtion (CO2_equivalent) over the entire natural regenerated and protected forest area for 22 years with wood groups from I to VIII. HEPA is

[66] Vietnam Deforestation Rates & Statistics | GFW (globalforestwatch.org)
[67] https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quyet-dinh-816-QD-BNN-KL-2024-cong-bo-hien-trang-rung-toan-quoc-604807.aspx

committed to continueing forest protection, management and stable growth in both quantity and quality over the entire managed area as stated.

- **Total C-stock (AGB and BGB) for the entire HEPA forest is :**
  - **= 136.71 x 310.7 ha = 42,475.8-t C.**

- **The CO2_equivalent, which is the amount of GHG (CO2) absorbed by HEPA forest that contributes to (overall emission reduction).**

- **Total of the CO2-e (AGB) absorbed/captured by HEPA forest at the research time:**
  - **= 42,475.8t x 3.67 = 155,886.19 tCO_2-e.**

The empirical process and procedures through measurement and calculation of forest carbon stocks in this research report ensure the compliance with technical procedures from measurement, recording, data checking, data processing and reporting to organizing seminars to review feedback with field trip participants and verification (MRV[68]). Finalize the results of the carbon stock calculation over the HEPA forests at the time of 2023 - 2024 (**by equivalent conversion, HEPA forests have absorbed 155,886.19 tons of CO2 as of 12 June 2024)**. This result contributes to the Vietnam's commitment to emissions reduction in the forestry sector by 129.8 million tons of CO2 of MARD[69] according to NDC[70].

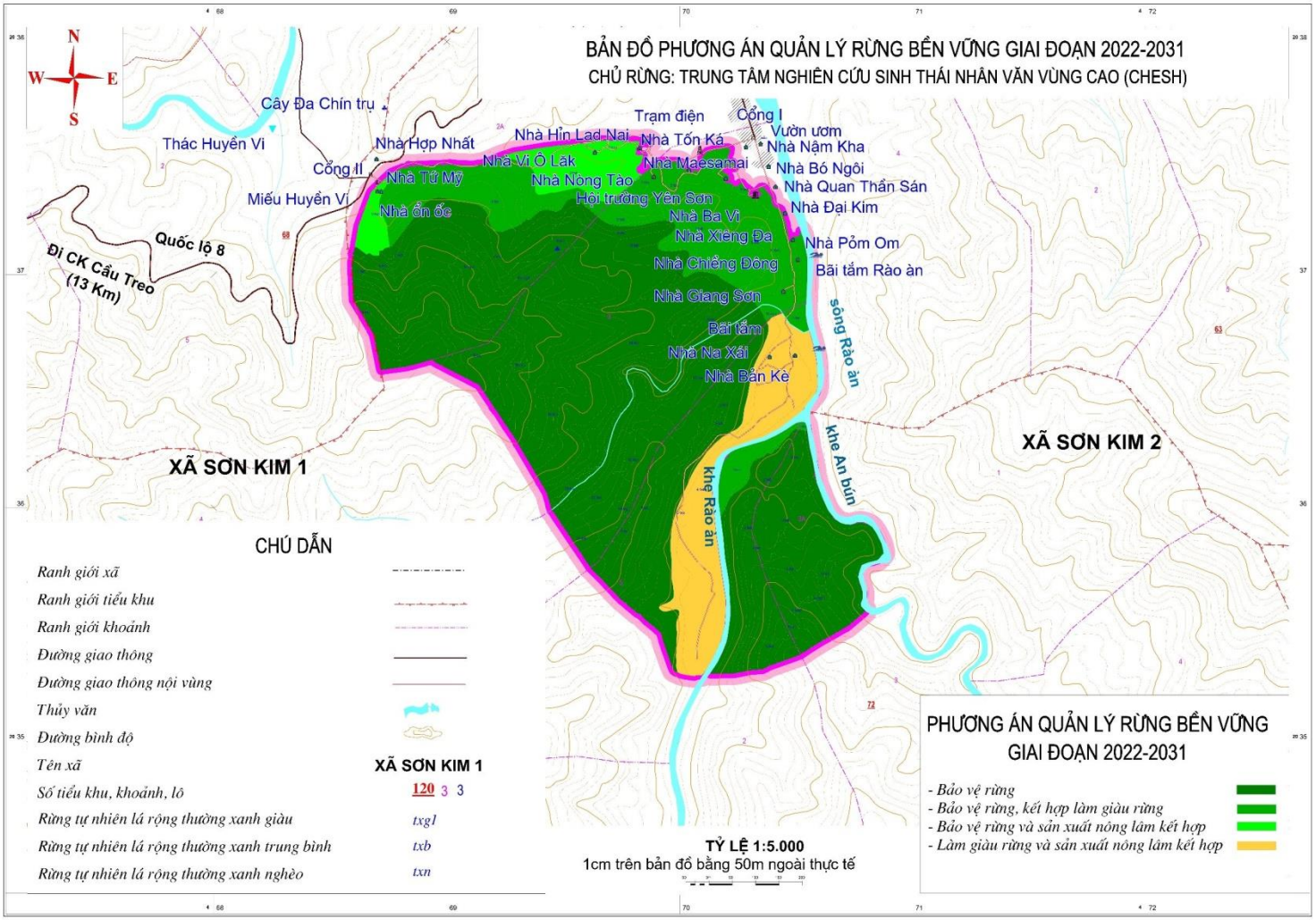
DIRECTOR OF CODE Signed and stamped	**DIRECTOR OF SPERI** Signed and stamped
Dr. Le Xuan Nghia	**PhD. Tran Thi Lanh**
Head of research team Signed	**Researchers** Signed
Master Dang To Kien	**Nguyen My Linh, Le Hong Giang**

[68] Measurement – Reporting – Verification
[69] https://storage-vnportal.vnpt.vn/sla-ubnd/5323/a1234/2815-2.pdf
[70] Clause 6, Article 3 of Decree 06/2022/NĐ-CP on national commitments to the climate change response.

XI. Annexes:

Annex 1: Map of Sustainable Forest Management Plan 2022-2031
Annex 2: Location of each standard plot and detailed coordinates (Projection VN2000)
Annex 3: How to calculate IVI (Important Value Index)
Annex 4: Trees counted, and parameters measured in each and all standard plots. Excel file attached.
Annex 5: Latin names of trees and other scientific details of trees, wood density
Annex 6: List of members participating in measurement in each standard plot

Annex 1: Map of Sustainable Forest Management Plan 2022-2031



Annex 2: Location of each standard plot and detailed coordinates (Projection VN2000)

No	Date of measurement	Standard plot	Coordinate x (center)	Coordinate y (center)	Elevation (m ASL)	x1	y1	x2	y2	x3	y3	x4	y4	Functional zoning	Position	Direction of plot
1	2023-12-12	H1	470371	2037309	79	470365	2037299	470352	2037318	470366	2037333	470376	2037323	Enrichment zone	Mountain foot	East
2	2023-12-13	H2	470322	2037148	153	470326	2037131	470311	2037125	470308	2037144	470323	2037149	Spiritual zone	Mountain slope	East
3	2023-12-13	H3	470302	2037059	164	470288	2037062	470308	2037053	470316	2037059	470299	2037082	Spiritual zone	Mountain peak	Multi-Direction
4	2023-12-15	H4	470430	2037043	94	470436	2037051	470444	2037034	470438	2037032	470420	2037053	Enrichment zone	Mountain foot	East
5	2023-12-16	H5	470293	2036889	117	470288	2036899	470301	2036898	470292	2036877	470277	2036883	Enrichment zone	Mountain foot	South
6	2023-12-16	H6	470249	2036921	154	470243	2036915	470250	2036940	470268	2036941	470257	2036912	Enrichment zone	Mountain slope	East
7	2023-12-18	H7	470115	2037304	119	470097	2037307	470111	2037287	470125	2037310	470120	2037318	Enrichment zone	Mountain slope	North
8	2023-12-18	H8	470270	2037479	89	470275	2037497	470290	2037496	470279	2037476	470265	2037475	Enrichment zone	Mountain slope	North
9	2023-12-21	H9	470115	2036939	164	470115	2036930	470106	2036942	470125	2036949	470132	2036934	Spiritual zone	Mountain slope	Multi-Direction
10	2023-12-21	H10	470170	2036810	116	470180	2036823	470194	2036807	470161	2036827	470171	2036817	Enrichment zone	Mountain foot	North
11	2023-12-22	H11	470039	2037255	159	470036	2037244	470049	2037227	470059	2037246	470047	2037257	Spiritual zone	Mountain slope	North
12	2023-12-22	H12	470186	2037182	122	470180	2037190	470199	2037190	470192	2037163	470179	2037170	Spiritual zone	Mountain foot	North
13	2023-12-23	H13	469921	2037275	110	469915	2037277	469932	2037287	469941	2037272	469921	2037267	Spiritual zone	Mountain slope	North
14	2023-12-25	H14	469917	2037181	163	469922	2037190	469928	2037171	469907	2037170	469898	2037183	Spiritual zone	Mountain peak	Multi-direction
15	2023-12-25	H15	469954	2037086	225	469939	2037078	469957	2037075	469962	2037097	469939	2037093	Spiritual zone	Mountain peak	Multi-direction
16	2023-12-26	H16	470087	2037099	130	470099	2037083	470097	2037104	470074	2037115	470076	2037096	Spiritual zone	Mountain peak	Multi-Direction
17	2023-12-26	H17	470090	2037055	153	470098	2037054	470071	2037047	470068	2037030	470096	2037048	Enrichment zone	Mountain slope	East
18	2023-12-26	H18	470040	2036876	188	470047	2036889	470051	2036876	470029	2036872	470026	2036888	Spiritual zone	Mountain slope	South
19	2023-12-27	H19	469971	2036719	163	469979	2036728	469966	2036732	469961	2036713	469970	2036718	Enrichment zone	Mountain slope	South
20	2023-12-27	H20	470036	2036693	82	470040	2036695	470030	2036685	470027	2036695	470042	2036709	Enrichment zone	Mountain foot	South
21	2023-12-28	H21	469895	2037386	86	469905	2037396	469885	2037395	469883	2037381	469905	2037379	Enrichment zone	Mountain foot	North
22	2024-04-06	H25	470022	2037402	99	470033	2037417	470017	2037410	470016	2037400	470037	2037400	Enrichment zone	Mountain foot	North
23	2024-04-07	H26	469538	2037584	100	469550	2037592	469527	2037598	469529	2037581	469553	2037580	Enrichment zone	Mountain foot	North
24	2024-04-07	H27	469532	2037445	114	469546	2037449	469525	2037439	469533	2037422	469543	2037443	Enrichment zone	Mountain slope	North
25	2024-04-08	H28	469554	2037220	195	469561	2037222	469543	2037234	469541	2037206	469566	2037210	Spiritual zone	Mountain slope	North

No	Date of measurement	Standard plot	Coordinate x (center)	Coordinate y (center)	Elevation (m ASL)	x1	y1	x2	y2	x3	y3	x4	y4	Functional zoning	Position	Direction of plot
26	2024-04-08	H29	469546	2037354	141	469542	2037358	469531	2037340	469552	2037340	469558	2037363	Spiritual zone	Mountain slope	North
27	2024-04-07	D1	470357	2036438	92	470347	2036451	470371	2036445	470366	2036425	470342	2036432	Enrichment zone	Mountain slope	East
28	2024-04-07	D2	470338	2036040	104	470327	2036052	470352	2036048	470349	2036028	470324	2036033	Spiritual zone	Mountain slope	North
29	2024-04-07	D3	470410	2035634	210	470399	2035645	470424	2035643	470422	2035623	470397	2035625	Spiritual zone	Mountain peak	Multi-direction
30	2024-04-08	D4	469794	2035980	233	469803	2035993	469805	2035968	469785	2035967	469783	2035992	Spiritual zone	Mountain peak	Multi-direction
31	2024-04-08	D5	469998	2036269	203	469994	2036284	470012	2036277	470003	2036253	469984	2036261	Spiritual zone	Mountain peak	Multi-direction
32	2024-04-08	D6	470049	2036426	198	470046	2036442	470064	2036432	470052	2036410	470034	2036420	Spiritual zone	Mountain slope	North
33	2024-04-08	D7	469778	2036784	223	469788	2036797	469788	2036772	469768	2036772	469768	2036797	Spiritual zone	Mountain slope	North
34	2024-04-08	D8	470160	2037140	137	470173	2037151	470173	2037131	470148	2037130	470148	2037150	Spiritual zone	Mountain slope	North
35	2024-04-09	D9	469324	2036943	296	469330	2036958	469340	2036940	469317	2036928	469308	2036946	Spiritual zone	Mountain slope	North
36	2024-04-09	D10	468872	2036929	395	468872	2036945	468888	2036933	468873	2036913	468857	2036925	Spiritual zone	Mountain slope	North
37	2024-04-09	D11	469360	2037411	134	469369	2037425	469375	2037406	469351	2037398	469345	2037417	Enrichment zone	Mountain slope	North

Annex 3: How to calculate IVI (Important Value Index)

The IVI of each species is determined by the following formula:
IVI = RD + RF + RBA, (Mishra, 1968)
Where:

Relative Density (RD)

$$RD\ (\%) = \frac{Denstity\ (D)\ of\ the\ study\ species}{Total\ density\ of\ all\ species} \times 100$$

Density of a study species (D)

$$D = \frac{Total\ individual\ of\ a\ study\ species\ occur\ in\ all\ study\ quadrats}{Total\ study\ quadrats}$$

Relative Frequency (RF) (%)

$$RF\ (\%) = \frac{Frequency\ (F)\ of\ occurence\ of\ a\ study\ species}{Total\ frequency\ of\ occurence\ of\ all\ species} x100$$

Frequency F

$$F = \frac{Number\ of\ quadrats\ wich\ species\ occurence}{Total\ study\ quardrats}$$

Relative Basal Area (RBA) (%)

$$RBA\ (\%) = \frac{\text{Basal area (BA) of species}}{\text{Total basal area of all species}} \times 100$$

Basal area (BA) (m^3)

$$BA = \frac{3.14 * (diameter)\text{^}2}{4 * 10000}$$

Annex 4: Tree counted, and parameters measured in each and all standard plots. Excel file attached.

Annex 5: Latin names of trees and other scientific details of trees, wood density

No	Local name	Full Latin name	Genus	Family	WD (VN Standard 12619-2-2019)
1	Bái bái	Not specified yet	Acronychia	Rutaceae	N/A
2	Ba bét	Mallotus paniculatus (Lam.) Müll. Arg.	Mallotus	Euphorbiaceae	0.42
3	Bưởi bung	Not specified yet	Acronychia	Rutaceae	N/A
4	Bộp bù	Not specified yet	Ficus	Moraceae	0.36
5	Bình linh	Not specified yet	Vitex	Lamiaceae	0.8
6	Bời lời	Not specified yet	Litsea	Lauraceae	0.56
7	Bộp	Ficus Championi	Ficus	Moraceae	0.89
8	Ba soi	Macaranga denticulata Muell. - Arg.	Macaranga	Euphorbiaceae	N/A
9	Bứa	Garcinia oblongifolia Champ. ex Benth., 1851	Garcinia	Clusiaceae	0.685
10	Cây chua	Not specified yet	Not specified yet	Not specified yet	N/A
11	Chân chim	Vitex parviflora Juss	Vitex	Lamiaceae	0.7

No	Local name	Full Latin name	Genus	Family	WD (VN Standard 12619-2-2019)
12	Cà ganh (Mã Liêng)	Not specified yet	Not specified yet	Not specified yet	N/A
13	Chay	Not specified yet	Artocarpus	Moraceae	N/A
14	Chẩn	Not specified yet	Microdesmis	Pandaceae	N/A
15	Chẹo	Not specified yet	Engelhardtia	Juglandaceae	0.68
16	Chènh chènh	Cinamomum burmannii (Nees et T. Neess) Blume, 1826	Cinamomum	Lauraceae	N/A
17	Chua ke	Not specified yet	Microcos	Tiliaceae	N/A
18	Chua lụy	Not specified yet	Not specified yet	Meliaceae	N/A
19	Chẹo trắng	Not specified yet	Engelhardtia	Juglandaceae	0.68
20	Chua	Not specified yet	Chukrasia	Meliaceae	N/A
21	Chua khét	Not specified yet	Chukrasia	Meliaceae	N/A
22	Cà Lồng (Mã Liêng)	Not specified yet	Not specified yet	Not specified yet	N/A
23	Cồng sữa	Not specified yet	Castanopsis	Fabaceae	0.48
24	Cóc	Not specified yet	Not specified yet	Not specified yet	0.38
25	Cồng	Castanopsis cerebrina (Hick. et A. Camus) Barnett, 1944	Castanopsis	Fabaceae	0.77
26	Cà ổi	Not specified yet	Castanopsis	Fabaceae	0.68
27	Côm	Elaeocarpus griffithii A. Gray	Elaeocarpus	Elaeocarpaceae	0.55
28	Cỏ sữa	Not specified yet	Not specified yet	Not specified yet	N/A
29	Cu thìa	Not specified yet	Not specified yet	Not specified yet	N/A
30	Cu vẹ	Not specified yet	Not specified yet	Not specified yet	N/A
31	Da bò	Not specified yet	Not specified yet	Not specified yet	N/A
32	Đái bò	Not specified yet	Archidendron	Fabaceae	N/A
33	Dâu da	Not specified yet	Baccaurea	Euphorbiaceae	N/A
34	Đá deng	Not specified yet	Not specified yet	Not specified yet	N/A
35	Đung	Not specified yet	Not specified yet	Not specified yet	N/A
36	Dành dành	Not specified yet	Not specified yet	Not specified yet	N/A
37	Đung dung	Not specified yet	Not specified yet	Not specified yet	N/A

No	Local name	Full Latin name	Genus	Family	WD (VN Standard 12619-2-2019)
38	Dẻ đỏ	Lithocarpus ducampii (Hickel & A. Camus) A. Camus	Lithocarpus	Fagaceae	0.84
39	Dè	Not specified yet	Cinamomum	Lauraceae	N/A
40	De gừng	Not specified yet	Cinamomum	Lauraceae	N/A
41	Dẻ bộp	Castanopsis lecomtei Hickel & Camus	Castanopsis	Fagaceae	0.89
42	Dẻ	Not specified yet	Not specified yet	Fagaceae	0.84
43	De tanh	Not specified yet	Cinamomum	Lauraceae	0.484
44	De vàng	Not specified yet	Cinamomum	Lauraceae	0.484
45	De	Not specified yet	Cinamomum	Lauraceae	N/A
46	Đinh	Not specified yet	Markhamia	Bignoniaceae	N/A
47	Giổi đá	Not specified yet	Michelia	Magnoliaceae	0.63
48	Giổi	Michelia gioi (A. Chev.) Sima & H. Yu	Michelia	Alismataceae	0.62
49	Giổi mít	Not specified yet	Michelia	Magnoliaceae	0.63
50	Dè ổ sâu	Not specified yet	Cinamomum	Lauraceae	N/A
51	Đập tru	Not specified yet	Not specified yet	Not specified yet	N/A
52	Dung dá	Not specified yet	Symplocos	Symplocaceae	N/A
53	Dung	Not specified yet	Symplocos	Symplocaceae	0.59
54	Ô đước	Not specified yet	Lindera	Lauraceae	N/A
55	Gác	Aphanamixis grandiflora Blume	Aphanamixis	Meliaceae	0.73
56	Gắng	Not specified yet	Not specified yet	Not specified yet	N/A
57	Gác hương	Not specified yet	Aphanamixis	Meliaceae	N/A
58	Gáo	Neolamareka cadamba (Roxb.) Bosser, 1984	Neolamareka	Rubiaceae	0.63
59	Giang máu	Not specified yet	Not specified yet	Not specified yet	0.46
60	Hiên	Not specified yet	Not specified yet	Not specified yet	N/A
61	Hoàng linh	Peltophorum pterocarpum (DC.) Backer ex K. Heyne	Peltophorum	Fabaceae	0.74
62	Kháo	Not specified yet	Cinnadenia	Lauraceae	0.71
63	Khế rừng	Not specified yet	Averrhoa	Oxalidaceae	0.46
64	Khôi	Not specified yet	Not specified yet	Not specified yet	N/A
65	Kiền kiền	Not specified yet	Hopea pierrei Hance	Dipterocarpacea e	0.68
66	Lèo heo	Not specified yet	Not specified yet	Not specified yet	N/A

No	Local name	Full Latin name	Genus	Family	WD (VN Standard 12619-2-2019)
67	Lim xanh	Erythrophleum fordii Oliv.	Erythrophleum	Fabaceae	0.93
68	Lành ngạnh	Cratoxylon cochinchinensis (Lour.) Blume	Cratoxylon	Hypericaceae	0.88
69	Lóc nác	Not specified yet	Not specified yet	Not specified yet	N/A
70	Máng chèo	Not specified yet	Not specified yet	Not specified yet	N/A
71	Máu chó	Knema conferta (King) Warb.	Knema	Myristicaceae	0.691
72	Mặt cắt	Not specified yet	Not specified yet	Not specified yet	N/A
73	Mán đỉa	Archidendron clypearia (Jack)I.C.Nielsen	Archidendron	Fabaceae	N/A
74	Mít rừng	Not specified yet	Artocarpus	Moraceae	0.46
75	Mòi	Not specified yet	Not specified yet	Not specified yet	N/A
76	Giổi mỡ	Manglietia conifera Dandy, 1930	Manglietia	Magnoliaceae	0.6
77	Màng tang	Litsea cubeba (Lour.) Pers., 1807	Litsea	Lauraceae	0.64
78	Mức	Wrightia annamensis Eberh. & Dubard	Wrightia	Apocynaceae	0.47
79	Nang	Alangium ridleyi King	Alangium	Alangiaceae	0.57
80	Nâu	Not specified yet	Not specified yet	Not specified yet	N/A
81	Nóc chuối	Not specified yet	Not specified yet	Not specified yet	N/A
82	Nang cui	Not specified yet	Not specified yet	Not specified yet	N/A
83	Ngát	Gironniera subaequalis Planch.	Gironniera	Cannabaceae	N/A
84	Ngát vàng	Not specified yet	Gironniera	Cannabaceae	N/A
85	Nhíu	Not specified yet	Not specified yet	Not specified yet	N/A
86	Núc nác	Oroxylum indicum (L.) Kurz	Oroxylum	Bignoniaceae	0.46
87	Nhọ nghẹ	Not specified yet	Diospyros	Ebenaceae	N/A
88	Nhọ nồi	Not specified yet	Diospyros	Ebenaceae	N/A

No	Local name	Full Latin name	Genus	Family	WD (VN Standard 12619-2-2019)
89	Nu	Not specified yet	Not specified yet	Not specified yet	N/A
90	Re hương	Cinnamomum parthenoxylum (Jack) Meisn.	Cinnamomum	Lauraceae	0.69
91	Ràng ràng	Not specified yet	Ormosia	Fabaceae	0.61
92	Ràng ràng mít	Ormosia balansae Drake	Ormosia	Fabaceae	0.61
93	Ràng ràng mỡ	Not specified yet	Ormosia	Fabaceae	N/A
94	Sâm cau trắng	Not specified yet	Not specified yet	Hypoxidaceae	N/A
95	Sến	Not specified yet	Shorea	Dipterocarpaceae	N/A
96	Sang mòi	Not specified yet	Not specified yet	Not specified yet	N/A
97	Sang mây	Stelechocarpus cauliflorus (Scheff.) J. Sincl.	Stelechocarpus	Annonaceae	N/A
98	Sung nước	Not specified yet	Ficus	Moraceae	N/A
99	Sông	Garcinia cochinchinensis (Lour.) Choisy, 1824	Garcinia	Guttiferae	N/A
100	SP	Not specified yet	Not specified yet	Not specified yet	0.46
101	Sang quýt	Not specified yet	Not specified yet	Not specified yet	N/A
102	Sồi trắng	Not specified yet	Not specified yet	Fagaceae	N/A
103	Sung	Ficus racemosa L.	Ficus	Moraceae	0.35
104	Săng vải	Not specified yet	Not specified yet	Not specified yet	N/A
105	Táu	Not specified yet	Vatica	Dipterocarpaceae	0.99
106	Thôi thôi	Alangium platanifolium Harms.	Alangium	Alangiaceae	N/A
107	Thắt chuột	Not specified yet	Not specified yet	Not specified yet	0.46
108	Tện	Not specified yet	Not specified yet	Not specified yet	N/A
109	Thị	Not specified yet	Not specified yet	Ebenaceae	0.83
110	Thuột luột	Not specified yet	Not specified yet	Not specified yet	N/A
111	Tai mang	Not specified yet	Not specified yet	Not specified yet	N/A
112	Thòi mòi	Not specified yet	Not specified yet	Not specified yet	N/A
113	Trường	Not specified yet	Paviesia	Sapindaceae	0.81

No	Local name	Full Latin name	Genus	Family	WD (VN Standard 12619-2-2019)
114	Trường mật	Paviesia anamonsis	Paviesia	Sapindaceae	N/A
115	Trường nước	Not specified yet	Paviesia	Sapindaceae	0.85
116	Trồi	Not specified yet	Not specified yet	Not specified yet	N/A
117	Trai mang	Not specified yet	Not specified yet	Not specified yet	N/A
118	Trám đen	Canarium pimela Leenh., 1959	Canarium	Burseraceae	0.76
119	Trện	Not specified yet	Not specified yet	Not specified yet	N/A
120	Tròi	Not specified yet	Not specified yet	Not specified yet	N/A
121	Trâm trắng	Not specified yet	Syzygium	Myrtaceae	0.73
122	Trín	Schima wallichii Choisy	Schima	Theaceae	0.61
123	Trám	Not specified yet	Canarium	Burseraceae	0.76
124	Trâm đỏ	Not specified yet	Not specified yet	Not specified yet	0.46
125	Trâm	Syzygium cinereum	Syzygium	Myrtaceae	0.73
126	Trẩu	Vernicia montana Lour.	Vernicia	Euphorbiaceae	0.42
127	Trám trắng	Canarium album (Lour.) Raeusch.	Canarium	Burseraceae	0.61
128	Tâm thối	Not specified yet	Not specified yet	Not specified yet	N/A
129	Trâm trện	Not specified yet	Syzygium	Myrtaceae	N/A
130	Vạng	Endospermum chinense Benth.	Endospermum	Euphorbiaceae	0.5
131	Vàng mẹ	Not specified yet	Not specified yet	Not specified yet	N/A
132	Vú bò	Ficus heterophyllus L.,	Ficus	Moraceae	N/A
133	Vàng giành	Not specified yet	Not specified yet	Not specified yet	0.46
134	Vàng tâm	Manglietia fordiana Oliv.	Manglietia	Magnoliaceae	0.631
135	Vừ	Not specified yet	Not specified yet	Not specified yet	N/A
136	Xương cá	Canthium didynum Roxb	Canthium	Rubiaceae	0.42
137	Xoan đào	Prunus arborea (Blume) Kalkman	Prunus	Rosaceae	0.57
138	Xám xám	Not specified yet	Not specified yet	Not specified yet	N/A

Annex 6: List of members participating in measurement in each standard plot

No	Standard plot	Participant full name	Leader	Secretary
1	H1	Nguyễn Thành Trung	x	
2	H1	Trần Đình Khánh		x
3	H1	Nguyễn Mỹ Linh		x
4	H1	Viêng Phết		
5	H1	Lê Văn Ka		
6	H1	Nguyễn Đức Sự		
7	H1	Hoàng Văn Đước		
8	H1	Đặng Như Băng		
9	H1	Hồ Văn Huệ		
10	H1	Lộc Văn Vìn		
11	H2	Nguyễn Thành Trung	x	
12	H2	Trần Đình Khánh		x
13	H2	Nguyễn Mỹ Linh		x
14	H2	Viêng Phết		
15	H2	Lê Văn Ka		
16	H2	Nguyễn Đức Sự		
17	H2	Hoàng Văn Đước		
18	H2	Đặng Như Băng		
19	H2	Hồ Văn Huệ		
20	H2	Lộc Văn Vìn		
21	H3	Nguyễn Thành Trung	x	
22	H3	Trần Đình Khánh		x
23	H3	Nguyễn Mỹ Linh		x
24	H3	Viêng Phết		
25	H3	Lê Văn Ka		
26	H3	Nguyễn Đức Sự		
27	H3	Hoàng Văn Đước		
28	H3	Đặng Như Băng		
29	H3	Hồ Văn Huệ		
30	H3	Lộc Văn Vìn		
31	H4	Nguyễn Thành Trung	x	
32	H4	Trần Đình Khánh		x
33	H4	Nguyễn Mỹ Linh		x
34	H4	Viêng Phết		
35	H4	Lê Văn Ka		
36	H4	Nguyễn Đức Sự		
37	H4	Hoàng Văn Đước		
38	H4	Đặng Như Băng		
39	H4	Hồ Văn Huệ		
40	H4	Lộc Văn Vìn		
41	H5	Hoàng Văn Đước	x	

No	Standard plot	Participant full name	Leader	Secretary
42	H5	Trần Đình Khánh		x
43	H5	Đặng Như Băng		x
44	H5	Viêng Phết		
45	H5	Nguyễn Đức Sự		
46	H5	Hồ Văn Huệ		
47	H5	Lộc Văn Vìn		
48	H6	Hoàng Văn Đước	x	
49	H6	Trần Đình Khánh		x
50	H6	Đặng Như Băng		x
51	H6	Viêng Phết		
52	H6	Nguyễn Đức Sự		
53	H6	Hồ Văn Huệ		
54	H6	Lộc Văn Vìn		
55	H7	Hoàng Văn Đước	x	
56	H7	Trần Đình Khánh		x
57	H7	Đặng Như Băng		x
58	H7	Viêng Phết		
59	H7	Lê Văn Ka		
60	H7	Nguyễn Đức Sự		
61	H7	Hồ Văn Huệ		
62	H7	Lộc Văn Vìn		
63	H7	Nghiêm Minh Lương		
64	H8	Hoàng Văn Đước	x	
65	H8	Trần Đình Khánh		x
66	H8	Đặng Như Băng		x
67	H8	Viêng Phết		
68	H8	Lê Văn Ka		
69	H8	Nguyễn Đức Sự		
70	H8	Hồ Văn Huệ		
71	H8	Lộc Văn Vìn		
72	H8	Nghiêm Minh Lương		
73	H9	Nguyễn Thành Trung	x	
74	H9	Trần Đình Khánh		x
75	H9	Nguyễn Mỹ Linh		x
76	H9	Viêng Phết		
77	H9	Lê Văn Ka		
78	H9	Nguyễn Đức Sự		
79	H9	Hoàng Văn Đước		
80	H9	Đặng Như Băng		
81	H9	Hồ Văn Huệ		
82	H9	Lộc Văn Vìn		

No	Standard plot	Participant full name	Leader	Secretary
83	H10	Nguyễn Thành Trung	x	
84	H10	Trần Đình Khánh		x
85	H10	Nguyễn Mỹ Linh		x
86	H10	Viêng Phết		
87	H10	Lê Văn Ka		
88	H10	Nguyễn Đức Sự		
89	H10	Hoàng Văn Đước		
90	H10	Đặng Như Băng		
91	H10	Hồ Văn Huệ		
92	H10	Lộc Văn Vìn		
93	H11	Nguyễn Thành Trung	x	
94	H11	Trần Đình Khánh		x
95	H11	Nguyễn Mỹ Linh		x
96	H11	Viêng Phết		
97	H11	Nguyễn Đức Sự		
98	H11	Hoàng Văn Đước		
99	H11	Đặng Như Băng		
100	H11	Hồ Văn Huệ		
101	H11	Lộc Văn Vìn		
102	H12	Nguyễn Thành Trung	x	
103	H12	Trần Đình Khánh		x
104	H12	Nguyễn Mỹ Linh		x
105	H12	Viêng Phết		
106	H12	Nguyễn Đức Sự		
107	H12	Hoàng Văn Đước		
108	H12	Đặng Như Băng		
109	H12	Hồ Văn Huệ		
110	H12	Lộc Văn Vìn		
111	H13	Nguyễn Thành Trung	x	
112	H13	Trần Đình Khánh		x
113	H13	Nguyễn Mỹ Linh		x
114	H13	Viêng Phết		
115	H13	Nguyễn Đức Sự		
116	H13	Hoàng Văn Đước		
117	H13	Đặng Như Băng		
118	H13	Hồ Văn Huệ		
119	H13	Lộc Văn Vìn		
120	H14	Nguyễn Thành Trung	x	
121	H14	Trần Đình Khánh		x
122	H14	Nguyễn Mỹ Linh		x
123	H14	Viêng Phết		

No	Standard plot	Participant full name	Leader	Secretary
124	H14	Nguyễn Đức Sự		
125	H14	Hoàng Văn Đước		
126	H14	Đặng Như Băng		
127	H14	Hồ Văn Huệ		
128	H14	Lộc Văn Vìn		
129	H15	Nguyễn Thành Trung	x	
130	H15	Trần Đình Khánh		x
131	H15	Nguyễn Mỹ Linh		x
132	H15	Viêng Phết		
133	H15	Lê Văn Ka		
134	H15	Nguyễn Đức Sự		
135	H15	Hoàng Văn Đước		
136	H15	Đặng Như Băng		
137	H15	Hồ Văn Huệ		
138	H15	Lộc Văn Vìn		
139	H16	Nguyễn Thành Trung	x	
140	H16	Trần Đình Khánh		x
141	H16	Nguyễn Mỹ Linh		x
142	H16	Viêng Phết		
143	H16	Lê Văn Ka		
144	H16	Nguyễn Đức Sự		
145	H16	Hoàng Văn Đước		
146	H16	Đặng Như Băng		
147	H16	Hồ Văn Huệ		
148	H16	Lộc Văn Vìn		
149	H17	Nguyễn Thành Trung	x	
150	H17	Trần Đình Khánh		x
151	H17	Nguyễn Mỹ Linh		x
152	H17	Viêng Phết		
153	H17	Lê Văn Ka		
154	H17	Nguyễn Đức Sự		
155	H17	Hoàng Văn Đước		
156	H17	Đặng Như Băng		
157	H17	Hồ Văn Huệ		
158	H17	Lộc Văn Vìn		
159	H18	Nguyễn Thành Trung	x	
160	H18	Trần Đình Khánh		x
161	H18	Nguyễn Mỹ Linh		x
162	H18	Viêng Phết		
163	H18	Lê Văn Ka		
164	H18	Nguyễn Đức Sự		

No	Standard plot	Participant full name	Leader	Secretary
165	H18	Hoàng Văn Đước		
166	H18	Đặng Như Băng		
167	H18	Hồ Văn Huệ		
168	H18	Lộc Văn Vìn		
169	H19	Nguyễn Thành Trung	x	
170	H19	Trần Đình Khánh		x
171	H19	Nguyễn Mỹ Linh		x
172	H19	Viêng Phết		
173	H19	Nguyễn Đức Sự		
174	H19	Hoàng Văn Đước		
175	H19	Đặng Như Băng		
176	H19	Hồ Văn Huệ		
177	H19	Lộc Văn Vìn		
178	H20	Nguyễn Thành Trung	x	
179	H20	Trần Đình Khánh		x
180	H20	Nguyễn Mỹ Linh		x
181	H20	Viêng Phết		
182	H20	Nguyễn Đức Sự		
183	H20	Hoàng Văn Đước		
184	H20	Đặng Như Băng		
185	H20	Hồ Văn Huệ		
186	H20	Lộc Văn Vìn		
187	H21	Nguyễn Thành Trung	x	
188	H21	Trần Đình Khánh		x
189	H21	Nguyễn Mỹ Linh		x
190	H21	Viêng Phết		
191	H21	Lê Văn Ka		
192	H21	Nguyễn Đức Sự		
193	H21	Hoàng Văn Đước		
194	H21	Đặng Như Băng		
195	H21	Hồ Văn Huệ		
196	H21	Lộc Văn Vìn		
197	H25	Nguyễn Thành Trung	x	
198	H25	Trần Đình Khánh		x
200	H25	Lê Văn Ka		
201	H25	Nghiêm Minh Lương		
202	H25	Hồ Văn Huệ		
203	H25	Trần Thị Đào		
204	H25	Cao Thị Thìu		
205	H25	Lộc Văn Vìn		
206	H25	Đặng Như Băng		

No	Standard plot	Participant full name	Leader	Secretary
207	H25	Nguyễn Đức Sự		
208	H25	Võ Văn Thế		
209	H25	Nguyễn Tiến Hồ		
210	H25	Ngô Văn Hùng		
211	H25	Nguyễn Tiến Vương		
212	H26	Trần Đình Khánh	x	x
215	H26	Lê Văn Ka		
216	H26	Nghiêm Minh Lương		
217	H26	Hồ Văn Huệ		
218	H26	Trần Thị Đào		
219	H26	Cao Thị Thìu		
220	H26	Trần Văn Sơn		
221	H27	Trần Đình Khánh	x	x
224	H27	Lê Văn Ka		
225	H27	Nghiêm Minh Lương		
226	H27	Hồ Văn Huệ		
227	H27	Trần Thị Đào		
228	H27	Cao Thị Thìu		
229	H27	Trần Văn Sơn		
230	H28	Trần Đình Khánh	x	x
233	H28	Lê Văn Ka		
234	H28	Nghiêm Minh Lương		
235	H28	Hồ Văn Huệ		
236	H28	Trần Thị Đào		
237	H28	Cao Thị Thìu		
238	H28	Trần Văn Sơn		
239	H29	Trần Đình Khánh	x	x
242	H29	Lê Văn Ka		
243	H29	Nghiêm Minh Lương		
244	H29	Hồ Văn Huệ		
245	H29	Trần Thị Đào		
246	H29	Cao Thị Thìu		
247	H29	Trần Văn Sơn		
248	D1	Trương Cao Hùng	x	
249	D1	Nguyễn Tiến Vương		x
250	D1	Nguyễn Minh Thụ		x
251	D1	Nguyễn Thành Trung		
252	D1	Ngô Văn Hùng		
253	D1	Trương Cao Hùng		
254	D1	Nguyễn Đức Sự		
255	D1	Nguyễn Tiến Hồ		

No	Standard plot	Participant full name	Leader	Secretary
256	D1	Lộc Văn Vìn		
257	D2	Trương Cao Hùng	x	
258	D2	Nguyễn Tiến Vương		x
259	D2	Nguyễn Minh Thụ		x
260	D2	Nguyễn Thành Trung		
261	D2	Ngô Văn Hùng		
262	D2	Trương Cao Hùng		
263	D2	Nguyễn Đức Sự		
264	D2	Nguyễn Tiến Hồ		
265	D2	Lộc Văn Vìn		
266	D3	Trương Cao Hùng	x	
267	D3	Nguyễn Tiến Vương		x
268	D3	Nguyễn Minh Thụ		x
269	D3	Nguyễn Thành Trung		
270	D3	Ngô Văn Hùng		
271	D3	Trương Cao Hùng		
272	D3	Nguyễn Đức Sự		
273	D3	Nguyễn Tiến Hồ		
274	D3	Lộc Văn Vìn		
275	D4	Trương Cao Hùng	x	
276	D4	Nguyễn Tiến Vương		x
277	D4	Nguyễn Minh Thụ		x
278	D4	Nguyễn Thành Trung		
279	D4	Ngô Văn Hùng		
280	D4	Trương Cao Hùng		
281	D4	Nguyễn Đức Sự		
282	D4	Nguyễn Tiến Hồ		
283	D4	Lộc Văn Vìn		
284	D5	Trương Cao Hùng	x	
285	D5	Nguyễn Tiến Vương		x
286	D5	Nguyễn Minh Thụ		x
287	D5	Nguyễn Thành Trung		
288	D5	Ngô Văn Hùng		
289	D5	Trương Cao Hùng		
290	D5	Nguyễn Đức Sự		
291	D5	Nguyễn Tiến Hồ		
292	D5	Lộc Văn Vìn		
293	D6	Trương Cao Hùng	x	
294	D6	Nguyễn Tiến Vương		x
295	D6	Nguyễn Minh Thụ		x
296	D6	Nguyễn Thành Trung		

No	Standard plot	Participant full name	Leader	Secretary
297	D6	Ngô Văn Hùng		
298	D6	Trương Cao Hùng		
299	D6	Nguyễn Đức Sự		
300	D6	Nguyễn Tiến Hồ		
301	D6	Lộc Văn Vìn		
302	D7	Trương Cao Hùng	x	
303	D7	Nguyễn Tiến Vương		x
304	D7	Nguyễn Minh Thụ		x
305	D7	Nguyễn Thành Trung		
306	D7	Ngô Văn Hùng		
307	D7	Trương Cao Hùng		
308	D7	Nguyễn Đức Sự		
309	D7	Nguyễn Tiến Hồ		
310	D7	Lộc Văn Vìn		
311	D8	Trương Cao Hùng	x	
312	D8	Nguyễn Tiến Vương		x
313	D8	Nguyễn Minh Thụ		x
314	D8	Nguyễn Thành Trung		
315	D8	Ngô Văn Hùng		
316	D8	Trương Cao Hùng		
317	D8	Nguyễn Đức Sự		
318	D8	Nguyễn Tiến Hồ		
319	D8	Lộc Văn Vìn		
320	D9	Trương Cao Hùng	x	
321	D9	Nguyễn Tiến Vương		x
322	D9	Nguyễn Minh Thụ		x
323	D9	Nguyễn Thành Trung		
324	D9	Ngô Văn Hùng		
325	D9	Trương Cao Hùng		
326	D9	Nguyễn Đức Sự		
327	D9	Nguyễn Tiến Hồ		
328	D9	Lộc Văn Vìn		
329	D10	Trương Cao Hùng	x	
330	D10	Nguyễn Tiến Vương		x
331	D10	Nguyễn Minh Thụ		x
332	D10	Nguyễn Thành Trung		
333	D10	Ngô Văn Hùng		
334	D10	Trương Cao Hùng		
335	D10	Nguyễn Đức Sự		
336	D10	Nguyễn Tiến Hồ		
337	D10	Lộc Văn Vìn		

No	Standard plot	Participant full name	Leader	Secretary
338	D11	Trương Cao Hùng	x	
339	D11	Nguyễn Tiến Vương		x
340	D11	Nguyễn Minh Thụ		x
341	D11	Nguyễn Thành Trung		
342	D11	Ngô Văn Hùng		
343	D11	Trương Cao Hùng		
344	D11	Nguyễn Đức Sự		
345	D11	Nguyễn Tiến Hồ		
346	D11	Lộc Văn Vìn		

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