

THE SOCIALIST REPUBLIC OF VIETNAM
Independence - Freedom - Happiness

Subject/SPERI - SMART1 M3 01/ECO-ANTH/2024-2050

“Carbon storages in the rain-forest biomass is a across cutting foundation of all living being, therefore, commodification of Carbon is impossible”!. tlanh@nurturingnature1992!

INDEPENDENT REPORT

**RESULTS OF FOREST AND FORESTRY LAND SURVEY, INSPECTION
AND ASSESSMENT, AND CALCULATION OF CARBON STOCK IN
BIOMASS AND CONVERSION INTO CO2 EQUIVALENT IN ZANG
VILLAGE, UPPER CATCHMENT OF KUANG SI WATERFALL,
LUANG PRABANG CITY, LUANG PRABANG PROVINCE, LAO PDR**

Luang Prabang 2024

THE SOCIALIST REPUBLIC OF VIETNAM

Independence - Freedom - Happiness

Subject/SPERI-SMART1 M3 01/ECO-ANTH/2024-2050

INDEPENDENT MONITORING REPORT

RESULTS OF FOREST AND FORESTRY LAND SURVEY, INSPECTION AND ASSESSMENT, AND CALCULATION OF CARBON STOCK IN BIOMASS AND CONVERSION INTO CO2 EQUIVALENT IN ZANG VILLAGE, UPPER CATCHMENT OF KUANG SI WATERFALL, LUANG PRABANG CITY, LUANG PRABANG PROVINCE, LAO PDR

<i>Luang Prabang, Date 09 Month 12 year 2024</i> CONSULTING UNIT		<i>Luang Prabang, Date 09 Month 12 Year 2024</i> SPERI
PROJECT LEADER	DIRECTOR	
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Luang Prabang 2024

Research results

The results of carbon measurement in above-ground biomass (AGB) of 1,778.94 ha - tropical rainforests in Zang village, upper catchment of Kuang Si Waterfall in Luang Prabang city, Luang Prabang province of LPDR over the period of the enriching natural diversity for livelihood sovereignty over decades between local community, DAFO¹, PAFO² and CHESH³/SPERI⁴ of this research demonstrates the crucial role of Lao tropical rainforests in mitigating emissions and climate change.

As of October 2024, a total carbon stock accumulated by Zang village's forests is 296,362.57 tons. A total average carbon stock (ABG) is 166.60 tons per ha with WD = 0.55 (g/cm³), equivalent to 1,087,650.13 tons of CO₂-e absorbed by the total area of 1,778.94 ha of forests in Zang village.

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² Provincial AGRO-FOREST ORGANIZATION

³ Centre for Human Ecology Study of Highland

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CATCHMENT OF KUANG SI WATERFALL, LUANG PRABANG CITY,
LUANG PRABANG PROVINCE, LAO PDR**

(In accordance with the Agreement signed on 30 August 2024 between the independent consultant and SPERI, this document references the activities undertaken as part of the SODI Project No. 2011-VN311 (2021-2025) in Laos)

I. LEGAL BASIS:

Forest Law (amended and supplemented) No. 64/QH dated 13 June 2019 of Lao People's Democratic Republic.

II. OBJECTIVES AND TASKS:

- Conduct a field survey, verification, and comprehensive assessment of the current status of forests and forestry land in Zang village, upper catchment of Kuang Si Waterfall, Luang Prabang City, Luang Prabang Province, Lao PDR; Support the digitalization and mapping.

- Conduct a field verification of 30% (equivalent to 25 plots) of a total of established 83 standard plots with an area of 500 m² per each; Support the calculation of timber volume for each forest type of current status.

- Conduct a field verification of boundaries and markers, with 30% of a total 400 concrete markers (equivalent to 120 markers) to be checked on-site.

- Develop formulas to estimate carbon stock in biomass and convert it into CO₂ equivalent

- Cross-check, verify, and analyze data trends related to the use and management of forest and forestry land in Zang village, upper catchment of Kuang Si Waterfall in Luang Prabang City, Luang Prabang Province, Lao PDR; Identify root causes and propose solutions.

- The output is a set of digital maps including: 1) A digital map of current status and forest classification; 2) A digital map of planning, use and co-management of forest and forestry land; 3) A map of boundaries and global positioning of the PuPeng crab habitat.

- Make a technical report.

III. CONTENT AND METHODOLOGY:

1. Conduct a field survey, verification, and comprehensive current status assessment; Check standard plot data, boundaries, and markers

- Current status and actual condition: Determine the current status and condition of forests and forestry land in accordance with the Forest Law (amended and supplemented) No. 64/QH dated 13 June 2019 of the Lao People's Democratic Republic, and to classify the condition of Subject/SPERI- SMART ĐỀ TÀI SMART1 M3 01/ECO-ANTH/2024-2050/Independent Report in Zang village . Page 1 of 7
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each forest and forestry land plot throughout the entire survey area.

- Area: Verify plot areas of different conditions by using GPS for measurement in combination with route-based plot demarcation.

- Timber volume: Conduct a survey and verification based on measurements in standard plots that are established using typical plot method (sampling rate for standard plot establishment with an area of 500m² is approx 0.2% of the area).

 - + Measure diameter at 1.3 m of all trees within the standard plot (using caliper or tape measure); Measured trees with DBH >= 6cm.

 - + Determine tree names.

 - + Measure clear bole height of all trees within a standard plot.

 - + Calculate timber volume by applying the formula: $M = G \times H \times F$, where: M is the tree timber volume; G is the tree basal area at breast height (1.3 m); H is the tree clear bole height. F is the tree shape factor (F=0.45 for a natural forest).

- Boundaries and markers: GPS equipment will be used to re-establish the coordinates of existing concrete markers in the field. The accuracy of marker placement will be verified by comparing the recorded coordinates with their actual field positions.

2. Estimate carbon stock in biomass and convert into CO2 equivalent

Develop a calculation formula for carbon stock in biomass and convert it to equivalent CO2 based on Professor Bao Huy's carbon calculation formula and IPCC (Intergovernmental Panel on Climate Change) indices on the basis of the data collected from standard plot survey, the current status, and classification of forest conditions.

The content of carbon stock in biomass calculation and CO2 equivalent conversion will be included in the technical report.

3. Cross-check and verify data during the management and use of forest and forestry land in Zang village, upper catchment of Kuang Si Waterfall, Luang Prabang city, Luang Prabang province, LPDR

Based on the data provided by PAFO, DAFO and CHESH Lao, and data collected from the field survey, an analysis will be conducted on the overlaps of land use boundaries, and current management practices with the aim to identify the root causes and propose solutions.

The content of cross-checking and verifying data during the management and use of forest and forestry land will be included in the technical report.

IV. RESULTS OF SURVEY AND ASSESSMENT OF FOREST STATUS

1. Location: Zang village, Luang Prabang city, Luang Prabang province, LPDR

2. Total area: 3,049.39 ha.

3. Current status:

- Area with natural forests: 1,778.94 ha including

 - + Evergreen forest: 1,672.98 ha

 - + Deciduous forest: 39.84 ha

 - + Mixed wood-bamboo forest: 66.12 ha.

- Area without forest: 1,270.45 ha including:

+ Agricultural land: 1,259.69 ha

+ Residential area: 4.79 ha

+ School: 1.25 ha

+ Temple/pagoda: 0.23 ha

+ Road: 4.49 ha

4. Functional planning by management entities:

- Land area managed by Luang Prabang province: 1,100.30 ha including

+ Protection forest land: 1,100.30 ha

- Land area managed by Luang Prabang city / Zang village: 1,928.71 ha including

+ Protection forest land: 552.30 ha

+ Use forest land: 66.12 ha

+ Grazing land: 39.84 ha

+ Agricultural land: 1,259.69 ha

+ Residential land: 4.79 ha

+ Education land: 1.25 ha

+ Religious land : 0.23 ha

+ Road land: 4.49 ha

- Land area managed by Zang village: 20.38 ha including:

+ Cultural land (sacred forest): 20.38 ha

5. Timber volume:

- Evergreen forest:

+ Average timber volume: 275.09 m³/ha

+ Timber volume of the total area: 460,220.06 m³

- Deciduous forest:

+ Average timber volume: 759.09 m³/ha

+ Timber volume of the total area: 30,242.15 m³

- Mixed wood-bamboo forest:

+ Average timber volume: 161.34 m³/ha

+ Timber volume of the total area: 10,667.80 m³.

V. ESTIMATE CARBON STOCK IN BIOMASS, AND CONVERT INTO CO₂ EQUIVALENT

1. Formulas:

a. Formula for estimating carbon stock in above-ground biomass (C_{AGB}) of each tree:

$$C_{AGB} = \text{Exp}(-3,40031 - 0,819475 \times \text{Ln}(\text{DBH}) + 0,787115 \times \text{Ln}(\text{H} \times \text{DBH}^2) + 0,673237 \times \text{Ln}(\text{WD} \times \text{DBH}^2))$$

Where:

- C_AGB is the carbon stock in 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 of 1.3 m (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 0.55

b. Formula for estimating carbon stock in below- ground biomass (C_BGB):

$$C_{BGB} = C_{AGB} \times R$$

Where:

- C_BGB is the carbon stock in below-ground biomass
- C_AGB is the carbon stock in above-ground biomass
- R is the ratio of C_stock in above-ground biomass and C_stock in below-ground biomass (R=0.20 when C_AGB/ha ≤ 58.75 tons, and R=0.24 when C_AGB/ha > 58.75 tons)

c. Formula for estimating a total carbon stock in AGB and BGB (C_{total}):

$$C_{total} = C_{AGB} + C_{BGB}$$

Where:

- C_{total} is the total C-stock in both above-ground biomass and below-ground biomass
- C_AGB is the C-stock in above-ground biomass
- C_BGB is the C-stock in below-ground biomass

d. Formula for converting into CO₂ equivalent (CO_{2e}):

$$CO_{2e} = C_{total} \times CF$$

Where:

- CO_{2e} is the CO₂ equivalent absorbed by forest trees
- C_{total} is the C-stock in both AGB and BGB
- CF is the default coefficient for converting from C to CO₂ (CF=3.67)

2. Results:

By using data from standard plot survey, current area, and forest status classification, and applying the above-mentioned formulas for calculating carbon stocks in both AGB and BGB and converting into CO₂ equivalent, the results are achieved as below:

- Evergreen forest:

+ Area: 1,672.98 ha.

+ The average C-stock in the biomass per hectare (C_{total}/ha) is 163.12 t/ha; The total C-stock in the biomass of the entire area (C_{total}): 272,896.47 tons

+ The average CO₂ equivalent per hectare (CO_{2e}/ha) is 598.65 t/ha; The total CO₂

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equivalent of the entire area (CO_{2e}) is 1,001,529.50 tons.

- Deciduous forest:

+ Area: 39.84 ha.

+ The average C-stock in the biomass per hectare (C_{total}/ha) is 428.09 t/ha; The total C-stock in the biomass of the entire area (C_{total}) is 17,055.11 tons.

+ The average CO₂ equivalent per hectare (CO_{2e}/ha) is 1,571.08 t/ha; The total CO₂ equivalent of the entire area (CO_{2e}) is 62,591.83 tons.

- Mixed wood-bamboo forest:

+ Area: 66.12 ha.

+ The average C-stock in the biomass per hectare (C_{total}/ha) is 96.96 t/ha; The total C-stock in the biomass of the entire area (C_{total}) is 6,410.99 tons.

+ The average CO₂ equivalent per hectare (CO_{2e}/ha) is 355.85 t/ha; The total CO₂ equivalent of the entire area (CO_{2e}) is 23,528.80 tons.

Our survey and assessment of the total 3,049.39-hectare forest area in Zang Village, Luang Prabang City, Lao PDR, reveals that 1,778.94 hectares are covered by the natural forests which store a total of 296,362.57 tons of carbon in its biomass, and have the capacity to sequester a total of 1,087,650.13 tons of CO_{2e}.

VI. ANALYSE BOUNDARY CHANGES AND CURRENT STATUS OF FOREST AND FORESTRY LAND MANAGEMENT AND USE OVER TIME IN ZANG VILLAGE, UPPER CATCHMENT OF KUANG SI WATERFALL, LUANG PRABANG CITY, LUANG PRABANG PROVINCE, LPDR

1. Discrepancy in the total natural forest area:

According to the data recorded in 2017, the total natural area in Zang village is 3,053,68 ha. At present, the actual total area is 3,049.39 ha.

As a result, the total natural area of the village has been reduced by 4.29 ha as of now.

*** Reasons:**

- The area data in 2017 was not calculated correctly according to the geodetic map projection regulations. The area was calculated using an ellipsoidal coordinate system. Currently, the area has been re-calculated correctly according to the regulations by using a planar coordinate system (WGS84/UTM Zone 47N).

2. Discrepancy in the forest area:

- According to the data recorded in 2017, the total area with natural forests is 2,196.42 ha including:

+ Natural forest area managed by the provincial authority: 1,284.21 ha

+ Natural forest area managed by the district/village authority: 871.36 ha

+ Natural forest area (sacred forest) managed by the village: 40.85 ha.

- According to the currently actual data, the total area with natural forests is 1,778.94 ha including:

+ Natural forest area managed by the provincial authority: 1,100.30 ha

- + Natural forest area managed by the district/village authority: 658.26 ha
- + Natural forest area (sacred forest) managed by the village: 20.38 ha.

The data indicates that there has been a significant change in the boundaries and areas of natural forests managed by different entities since 2017. Most of these areas have experienced a decrease in size.

*** Reasons:**

- In 2017, the field survey and mapping processes were conducted inadequately. The absence of on-site verification and measurement by technical staff resulted in significant inaccuracies in the forest cover maps. Comparison with satellite and aerial images from 2016 to 2017 reveals that large areas classified as forest on the maps were actually agricultural land, particularly in the foothills of Phu Huoi Luc and Phu Huoi Oi.

- Due to ongoing encroachment of forest land for shifting cultivation, forest areas bordering local people's upland fields are being destroyed, causing a reduction in forest cover.

3. Discrepancies in names of mountains, rivers and streams:

- There are area discrepancies between the map and the field regarding the names and locations of mountain (Phu) and streams (Huoi) on the 2017 map.

*** Reasons:**

- A lack of field verification and investigation by technical staff during the survey and editing process resulted in incorrect location names on the 2017 map.

4. Independent consultant's assessment and recommendations:

a. Assessment:

Based on the field survey, data verification, and review of existing documents and legal frameworks, the Independent Consultant has concluded that the discrepancies identified above can be attributed to both subjective and objective factors.

- Subjective reasons:

+ There has been a lack of organization and coordination between the investigation team, mapping team, and management agencies during the investigation process, leading to the discrepancies in boundaries among management entities, and the actual forest conditions.

+ The survey and mapping team lacks thorough field investigations.

- Objective reasons:

+ The encroachment of forest land by locals for cultivation of cash crops driven by the demand from companies such as industrial cassava for a factory in Muong Nan District, is a major factor contributing to deforestation.

+ Due to the limited adoption of technical software and satellite/aerial image data sources in 2016-2017, the inheritance and development of technology for building database and maps have not been fully assured.

b. Recommendations:

Given the identified inadequacies, the independent consultant recommends:

- Relevant management agencies invest in technologies such as map-building software,

geographic data management systems, and high-quality satellite and aerial image to effectively monitor forest changes and improve forest and forestry land protection.

- Train professionals at district level and promote campaigns to educate and encourage local communities to stop encroaching forest land and clearing forests for farming.

Field investigation has revealed that residents of Zang village and neighboring villages continue to engage in cross-border agricultural encroachment, making land management and land user management challenging. Therefore, we strongly recommend the relevant authorities pay closer attention to this issue and raise awareness of local communities through dissemination and propaganda campaigns./.