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Agriculture and forestry Hue

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Summary of Master Thesis in Forestry

"Assessment fixed carbon dioxide capability of some protection afforestation types in up-stream regional of Bo river in Thua Thien Hue province"

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I. Introduction

Climate change has strongly effected most of countries in the world. Humankind is facing with impacts of climate change such as: plague, poverty, lose biodiversity, lack of cultivated land, ect…

Scientist estimated that essential causes of climate change are over industrial gas emission, especially carbon dioxide (CO_2) and forest destruction in the world. Decreasing forest areas declined ecological function of forest for accumulating carbon dioxide. According to Christopher Field "Low of carbon accumulation level in forest ecosystem impulses more increasing of carbon dioxide in atmosphere and process heater on the earth" and according to report of the Antarctic Statistics Organization, the Great Britain (2006), there war nearly 10 milliard tone of carbon dioxide in atmosphere in 2006, creased 35 percent in comparison with 1990.

Researching carbon becomes a central field in science when increases omount of carbon dioxide emission in our planet. In reality amount of absorbs carbon dioxide depends on forest type, forest age, dominant species, different seasons, ect. Greenhouse effect reduction requests researches, assessment about absorption abilit of forest categories, forest types as well as forest structure to quantify economic and ecological values that forests bring back.

The Kyoto Protocol with clean development mechanism (CDM) has opened up chance for developing countries receive investment of developed countries to implement projects in afforestation, regeneration, natural forest management and protection agro-forestry, sustainable natural resources management, ect…Reduce emission with deforestation and forest degradation is also new trend which will replace the Kyoto Protocol in the future. Research fixedcarbon dioxide capability in woody vegetation to detemine economic value for protective function and ecological environment of forest is a new trend need to study and develop in Thua Thien Hue province, Vietnam particularly. The study "Assessment fixed carbon dioxide capability of some protection afforestation types in up-stream regional of Bo river in Thua Thien Hue province" with general objective is to identify the role of protection forest types in process of climate change on the earth and suggest some solutions about policy in protection forest management and utilization

II. Research Objectives, contents and methods

II1. Research Objectives

- Investigating and assessing the biomass of some protective forest states along the Bo river valley.
- Identifying the accumulating ability and quantifying amount of fixed carbon dioxide of protective forest states along the Bo river valley for decreasing climate change effects.
- Proposing some solutions to contribute information for improving policies suitably to manage sustainably protective forest of the river basin in Vietnam.

II2. Research Contents

- Estimating the socio-economic condition and forest resources for the head of Bo river valley.
- Estimating the growth of forest states along the Bo river valley.
- Evaluating the amount of born biomass (log of wood, non-xyloic plant, things faller forest) in the component of the forest,
- Calculating the amount of carbon accumulated in the forest component and states.
- Analyzing and proposing some solutions to manage the forests sustainably.

II3. Research methods

Research latitude: Hong Ha commune represent for essential protective natural forest with poor forest state and Huong Van commune represent for planting forest (forestry faculty research camp)

- **Data collecting methods:**

- Select the location, establish 3 sample areas 1.000m^2 (40x25) and conduct counting the perimeter and height of trees of the forest states.
- Then, establish sample area 200m^2 to dertermine the weight of fresh forest cover, things faller

forest and roots. Cut the non-xyloic plant, take the sample of fresh forest cover, identify fresh weight, put the sample into the bag to the laboratory.

- Each part of log of wood, non-xyloic plant and mulch will be taken out with different proportions to dry in the laboratory.

- After drying in 2 hours, the sample is tested one time, if after 3 times test, the weight of sample does not change, that is the dry weight of sample.

- Analyzing sample, determine amount of carbon in the component, calculating based on forestry phyletic brocade bag containing secret formula.

- Determining economic efficiency based on current market value.

- Predicting economic efficiency from the reality which CO2 stored in the forest state of Bo river.

I. Research result

II1. The general assessment the growth situation of 3 plantation forest models.

At Huong Van, the forest model has been planted in different periods, consist of: *Acacia magium*: 8 years old, *Eucarlyptus camaldulensis*: 26 years old, *Acacia hybris*: 10 years old. Besides, planting density and factors influenced in them are different so the growth situation at models are different. However, these models are stable relatively, many of them have shown appropriate grow advantages on the condition of camp.

Table 1: The average growth targets of plantation forest models

Model	Value				
	$D_{1.3}$ (cm)	H_{vn} (m)	D_t (m)	S_t (m^2/ha)	V (m^3/ha)
Acacia magium	10,74 ± 3,0	13,33 ± 1,8	2,67 ± 0,8	5.213,65	100,41
Eucarlyptus camaldulensis	16,38 ± 5,2	12,73 ± 2,8	1,47 ± 0,7	1.441,86	93,40
Acacia hybris	16,75± 4,4	18,75 ± 2,6	3,80 ± 1,4	18.703,41	335,80

2. The CO_2 fixed and accumulating ability of forest states

a. Biomass of fresh forest cover under forest umble in forest planting model and natural forest

For branches, leaves, roots take rate 20%, mulch take rate 10% compared with fresh weight dried in the laboratory to determine dry biomass. The results are as follows:

Table 2: Biomass in shrubs components under planting forest canopy

Model	Biomass (tons/ha)	On the ground				Under the ground	Total
		Woody stem Plant	Shrubs	Grass	Mulch	Root	
Eucarlyptus camaldulensis	**Fresh**	8,52	3,85		57,90	3,00	73,27
	Dry	3,49	1,66		36,92	1,42	43,49
Acacia magium	**Fresh**	2,83	0,94	0,54	81,25	1,33	86,89
	Dry	1,33	0,32	0,18	32,46	0,40	34,69
Acacia hybris	**Fresh**	3,12	1,71		110,4	3,47	118,7
	Dry	1,16	0,49		42,13	1,42	45,20

Fresh biomass of each component focus mainly on the stem and branches, root. In addition, the weight of mulch change much among forest types. *Acacia hybris* with the weight about 110,4 tons/ha, the next is *Acacia magium* about 81,25 tons/ha and finally, *Eucarlyptus camaldulensis* about 57,9 tons/ha. Dry biomass of fresh forest cover of shrubs in *Acacia hybris* forest is 45,20 tons/ha. The next is in *Eucarlyptus camaldulensis* with 43,49 tons/ha and in *Acacia magium* 34,69 tons/ha. The difference about tree type, tree age and the density of forest makes biomass of each model different remarkably.

We not only research in the planting forest, but also in the natural forest, results shown in the following table:

Table 3: Biomass in shurb components under natural forest canopy.

Location	Biomass (tons/ha)	On the ground			Under the ground	Total
		Woody stem Plant	Shurbs	Mulch	Root	
foot of mountain	Fresh	5,01	2,41	9,60	1,95	18,95
	Dry	2,50	0,91	6,46	0,88	10,75
mountain side	Fresh	4,42	2,34	12,50	0,98	20,23
	Dry	2,36	0,64	7,96	0,58	11,55
Peak of mountain	Fresh	6,54	2,24	13,40	1,57	23,76
	Dry	3,33	0,76	10,29	0,78	15,16

Fresh biomass in the natural forest states mainly concentrate on branches of trees and mulch. On the peak of mountain, woody stem plant occupies 27,5% of the total of fresh biomass, mulch occupies 56,4%. On the foot of mountain, woody stem plant occupies 21,8% while mulch occupies 61,8% and on the mountain side, woody stem plant occupies 26,4% and mulch occupies 50,6%. In general, fresh biomass mainly focus on mulch from 50-62%.

The amount of fresh biomass at the planting forest and natural forest much or little will estimate the amount of carbon as well as CO_2 that the forest states will bring.

Dry biomass under the ground that mainly in the root is also occupy for a rate equivalent to the total biomass of all forest states 2,25 tons, the root accounts for from 5-8 %.

b. Carbon absorbing ability in fresh biomass under the planting forest and natural forest canopy

The amount of carbon in fresh biomass and shurbs is identified based on dry biomass of fresh forest cover and plant. The result of determining the amount of carbon and the rate of carbon in the component is reflected through the following table:

Table 4: Carbon absorbing ability under the planting forest canopy

Unit: Tons C/ha

Model	Indicator	On the ground				Under the ground	Total
		Woody stem Plant	Shrubs	Grass	Mulch	Root	
Eucarlyptus camaldulensis	Weight	1,75	0,83		18,46	0,71	21,75
	%	8,0	3,8		84,9	3,3	100
Acacia magium	Weight	0,66	0,16	0,09	16,23	0,20	17,34
	%	3,8	0,9	0,5	93,6	1,2	100
Acacia hybris	Weight	0,58	0,24		21,06	0,71	22,59
	%	2,6	1,1		93,2	3,1	100

The amount of carbon in the biomass under forest canopy mainly focus on the ground. The top is still in the mulch account for from 84-94%, Woody stem Plant account for 2-8%, shrubs 1-4%. In general, in 3 forest types, the amount of carbon in the biomass on the ground occupies for more than 95% of the total biomass.

In the different investigating positions in the natural forest, through analyzing samples and calculating, the amount of carbon that the parts of fresh forest cover absorb is shown in the following table:

Table 5: Carbon absorbing ability under the natural forest canopy

Unit: TonsC/ha

Location	On the ground			Under the ground	Total
	Woody stem Plant	Shrubs	Mulch	Root	
Foot of mountain	1,179	0,323	3,98	0,292	5,775
Mountain side	1,252	0,454	3,23	0,442	5,380
Peak of mountain	1,665	0,378	5,15	0,392	7,585

On the peak of mountain, the amount of carbon is 7,585 tons C/ha and at the forest foot, it is less and less reduced only about 5,380 tons C/ha. It means that the distribution of some trees in the forest state is not equal with a lot of spaces so it's nessessary to have appropriate methods aimed to protect regenerated trees and help forest state develop sustainably. The total amount of carbon absorbing for all forest states IIb in Hong Ha is about 18,7 tons.

3. Biomass and the amount of carbon in log of wood

a. Biomass and the amount of carbon in log of wood in the planting forest model

From wood reserves and wood density of each tree, we can define body biomass and use the formula (Brown, 1997) is based on the forest biomass density, the result is in the following table:

Table 6: The amount of accumulating CO_2 of some planting forst models

Model	Capacity (m^3/ha)	Density (tons/m^3)	Level of models (tons/ha)	Level of CO_2 (tons/ha)
Acacia hybris	335,85919	0,595	199,83622	366,69946
Acacia magium	100,41632	0,475	47,697750	87,52537
Eucarlyptus camaldulensis	93,3625	0,600	56,01750	102,79211

Because of the difference about density, growth situation and age of models, carbon absorbing ability and the amount CO_2 from this model cannot be similar. Among 3 forest models, *Acacia hybris* absorbs CO_2 with the highest amount, 367 tons/ha, the next is *Eucarlyptus camaldulensis* 103 tons/ha and the lowest is *Acacia magium* 88 tons/ha.

Table 7: Collect biomass and the amount of carbon of trees in Huong Van

Indicator	On the ground				Under the ground	Total
	Wood trunk	Branches	Leaves	peel	Root	
Fresh biomass (t/ha)	612,25	337,90	29,45	75,95	279,00	**1.334,55**
%	45,88	25,32	2,21	5,69	20,91	**100**
Dry biomass (t/ha)	370,45	170,50	13,00	43,478	51,305	**648,733**
%	57,10	26,28	2,00	6,70	7,91	**100**
Humidity (%)	39,50	49,50	55,90	42,80	81,60	
Amount of carbon (tonsC/ha)	185,225	85,250	6,500	21,739	25,653	**324,367**

The level of water in the tree parts has significantly difference from 39-82%, the highest is in the root with the humidity up to 81,60%, the lowest is in the trunk with the humidity 39,5%

Besides, in order to use some Eucarlyptus roots availlable in the research area to determine wood biomass and the amount of carbon under the ground, we conduct to dug with 3 different roots, these are big, medium and small Eucarlyptus root. The result has showed that the amount of carbon under the ground is rather large, on average 1 ha Eucarlyptus forest is 12,54 tons C/ha. This is also a significant amount of evaluating and calculating environmental service cost if you don't want to cut trees

Table 8: Biomass and the amount of carbon for Eucarlyptus root

Sample name	Fresh biomass (tons/ha)	Dry biomass (tons/ha)	humidity (%)	Level of carbon (tonsC/ha)
Big *Eucarlyptus root*	83,30	48,45	41,80	24,23
Medium *Eucarlyptus* root	36,89	21,12	42,70	10,56
Small Eucarlyptus root	10,54	5,68	46,10	2,84
Average	**43,58**	**25,08**		**12,54**

b. Biomass and CO_2 absorbing ability of natural log of wood

The amount of carbon accumulated in the tree is identified by analyzing chemical components in dry biomass. Through calculating the level of CO_2 accumulated in natural log of wood, results are collected as follows:

Table 9: Level of CO_2 that trees absorb of forest state IIb

Trees	Reserves (m^3)	Fresh biomass (kg)	Dry biomass (kg)	Level of C (kg)	Level of CO_2 absorbed (kg)
Peak of mountain	15,40606	11.635,37394	5.282,45977	2.641,229884	9.693,313674
mountain side	16,22570	10.940,34919	4.977,247958	2.488,623979	9.133,250002
foot of mountain	10,21081	9.047,51946	4.105,208965	2.052,604483	7.533,058451
Average	**13,94752**	**10.547,0809**	**4.788,305564**	**2.394,153**	**8.786,541**

The amount of CO_2 that trees absorb depends on types of trees, change with the trunk parts and size, its biomass. Average amount of CO_2 for entire forest state is 87,87 tons.

IIb forest state, the sub-268 with the square total of recovery forest is 43,7 ha so reserves total of the entire hectares are 6106,431 m^3

4. **The CO_2 absorption value of forest states**

According to trading information in the market, especially in Vietnam, we can estimate the amount of CO_2 based on forest components. The following table summarizes CO_2 absorption ability of all forest states.

Table 10: CO_2 fixed capacity of planting forest forms

Unit: TonsCO_2/ha

Model	On the ground					Under the ground	Total
	Trees			Shrubs			
	Wood trunk	Root	Another parts	Shrubs	Mulch	Root	
Eucarlyptus camaldulensis	102,79	46,02		9,45	67,75	2,6	**228,607**
Acacia magium	87,53		0,323	3,02	59,56	0,734	**151,172**
Acacia hybris	366,70	94,15	416,505	3,01	77,29	2,59	**960,245**

Among 3 researched models, *Acacia hybris* has the biggest amount of CO_2 under forest umbel with 80,3 tons/ha, it's means that Acacia hybris can improve climate, land best among 3 models. Besides, although in *Eucarlyptus camaldulensis* forest model, the amount of CO_2 under forest canopy which is 77,2 tons CO_2/ha is higher in *Acacia magium* which is 62,58 tons/ha; if searching in growth time, effects from *Eucarlyptus camaldulensis* forest model are not much because this model is built longer before *Acacia magium* model.

Table 11: The amount of CO_2 trees absorb of the entire naural forest states

Type	Fresh biomass (tons)	Dry biomass (tons)	Level of CO_2 (tons)	%
Trees	407,22	143,65	263,58	79,3
Vegetational Rug	22,96	10,50	19,27	5,8
Mulch	35,50	24,71	45,36	13,7
Root	4,51	2,25	4,15	1,2
Total	**470,19**	**181,26**	**332,36**	**100**

Natural forest, IIb state, the amount of CO_2 concentrates much on the trunk of tree, occupy for about 79% in the total amount of CO_2 our topic researching, the mulch is about 14%, the rest is in stem, branch and root. This forest is in the period of regeneration and rehabilitation, if we have good protection ways, it annually will retain a large number of CO_2, contributing to preserve the environment.

In order to guess the amount of CO_2 that natural and planting forest states absorb, the following is the table of converting CO_2 into money based on the lowest price is 9USD/tons from vietnamnet.

Type	Price (USD)	Natural forest	Planting forest
Trees	9	2.372	5.013
Shrubs	9	173	139
Mulch	9	408	1842
Root	9	37	54
Total		**3.990**	**7.048**

According to price from vietnamnet, with 9USD/ton CO_2, we can get from planting forest 7.048USD and natural forest 3.990USD, in which trees get the highest rate from 59-71% in the total CO_2 price. With the current USD price, we can get Bo river protection forest from 70-123 million VND.

When researching, planting forest can absorb CO_2 more than natural forest, but in reality natural forest not only absorbs more carbon but also store carbon longer because natural forest is always protected while planting forest is exploited frequently.

IV. Conclusion

- Biomass researching results in planting forest can show: 26 year old Eucarlyptus camaldulensis forest with the density 850 trees/ha can have the level of biomass 43,48 tons/ha; 8 year old Acacia magium forest with the density 1.150 trees/ha can have 34,68 tons/ha and 10 year old Acacia hybris forest with the density 1.650 trees/ha can have 45,18 tons/ha.

- Researching biomass of natural forest in the IIb forest state can get results: At foot of mountain, the level of biomass is 10,75 tons/ha; at sides, it is 11,55 tons/ha; and at the peak of mountain, it is 15,16 tons/ha.

- Acacia hybris forest model have CO_2 absorption capacity approximately 366,70 tons CO_2/ha. Acacia magium forest model have approximately 87,53 tons CO_2/ha. Eucarlyptus camaldulensis forest model have approximately 102,79 tons CO_2/ha.

- Researching results of the amount of CO_2 in the natural forest: the priority trees in the standard areas have the amount of CO_2 of IIb forest states are 263.58 tons.

- CO_2 value from protection forest states: (1) For planting forest: Eucarlyptus forest model is 229USD, Acacia magium forest model is 151USD, Acacia hybris forest model is 960USD. (2) For natural forest: the total value that all components in the forest state bring is 3,990USD.