

Cambodia
Mr. Sum Thy

Technical Issues Related to the Preparation of the Cambodian GHG inventory: LULUCF

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Outlines

- ⌚ **Brief Introduction to the First Cambodian GHG Inventory**
- ⌚ **GHG inventory for Land Use, Land Use Change and Forestry (LULUCF)**
 - ↓ **Why improve the GHG inventory in LULUCF?**
 - ↓ **Methodology for improving LULUCF activity data**
 - ↓ **Methodology for improving emission factors**
 - ↓ **Result of GHG inventory for LULUCF**
- ⌚ **Conclusion and Recommendations**

I. Brief Introduction to the First Cambodian GHG inventory (1)

- ↓ Base year: 1994
- ↓ Based on the Revised 1996 IPCC Guidelines
- ↓ Used IPCC Emission Factors
- ↓ Greenhouse gases (GHGs): carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O)
- ↓ Major sectors: Energy, Industrial Processes, Agriculture, Waste, and LUCF.

I. Brief Introduction to Cambodian GHG Inventory (2)

↓ Summary of 1994 Cambodian GHG emissions and uptakes

Sectors and Sinks	CO ₂ uptake	Emissions				
		CO ₂	CH ₄	N ₂ O	NO _x	CO
ENERGY		1,272.08	24.13	0.33	16.69	456.56
INDUSTRIAL PROCESSES		49.85			0.01	0.03
AGRICULTURE			339.25	11.08	2.7	95.76
WASTE			6.77	0.42		
LAND USE CHANGE AND FORESTRY	64,850.23	45,214.27	74.77	0.51	18.58	654.2
TOTAL NATL GHG EMISSIONS/UPTAKE	64,850.23	46,536.20	444.92	12.35	37.98	1,206.55

III. GHG inventory for LULUCF:

Why improve the GHG inventory in LULUCF?

- ↓ **Importance of LULUCF in contribution to National GHG inventory (79%)**
- ↓ **The previous estimation may accompany with high uncertainty, due to complexity of biological factors and lack of reliable data**
- ↓ **The new study is aiming at (1) development of local emission factors through field survey, (2) improvement of activity data, and (3) conducting uncertainty analysis**

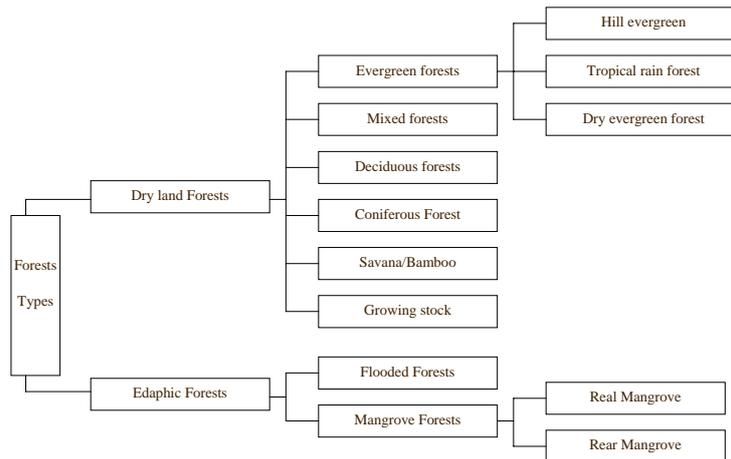
III. GHG inventory for LULUCF:

Methodology for improving LULUCF activity data (1)

- ↓ **Activity data play an important role in the GHG estimation**
- ↓ **The improvement of activity data (land use and forest cover) was done through satellite image analysis**
- ↓ **Cambodia land use is divided into two categories (Wood land and non-wood land)**
- ↓ **These land categories are considered in the preparation of GHG inventory**
- ↓ **In 1998, the total Cambodian forest was about 10.5 Million hectare (58% of the total country land area)**
- ↓ **About 10 million hectare (96%) is dry land forests and 0.5 million hectare (4%) is edaphic forests**

III. GHG inventory for LULUCF: Methodology for improving LULUCF activity data (2)

Forest classification in Cambodia



III. GHG inventory for LULUCF: Methodology for improving LULUCF activity data (3)

- ↓ Cambodian forest has been disturbed by human activities, such as logging, shifting cultivation, and conversion to agriculture
- ↓ The Forest Cover Assessment of the Department of Forestry and Wildlife was done up to district level
- ↓ However, the National GHG inventory for the First National Communication used the national level. For this new study, the estimate was done up to provincial level
- ↓ In addition, the previous GHG inventory was done without separation between disturbed and undisturbed forests.

III. GHG inventory for LULUCF: Methodology for improving LULUCF activity data (4)

Forest area (1992-1996)

Forest type		Forest area (ha)	
		1992	1996
Evergreen	Undisturbed	723468	686672
	Disturbed	3835474	3817583
Mixed	Undisturbed	123108	119425
	Disturbed	1734581	1708532
Deciduous	Undisturbed	4857745	4773911
	Disturbed	447314	454915
Mangrove		77669	72835
Inundated		349475	335304
Forest regrowth		440939	379305
Plantation		86664	96783
Wood/strubland		2351735	2286613
Grassland		494968	503751
Mosaic cropping		314062	464233

III. GHG inventory for LULUCF: Methodology for improving LULUCF activity data (5)

↑ Wood product in 1994 was estimated about 1.5 million m³, excluded the illegal logging and these data were used for national GHG inventory

↑ The exclusion of illegal logging will probably make the inventory underestimated.

↑ Therefore, for the new study, this data is taken into account.

III. GHG inventory for LULUCF: Methodology for improving LULUCF activity data (6)

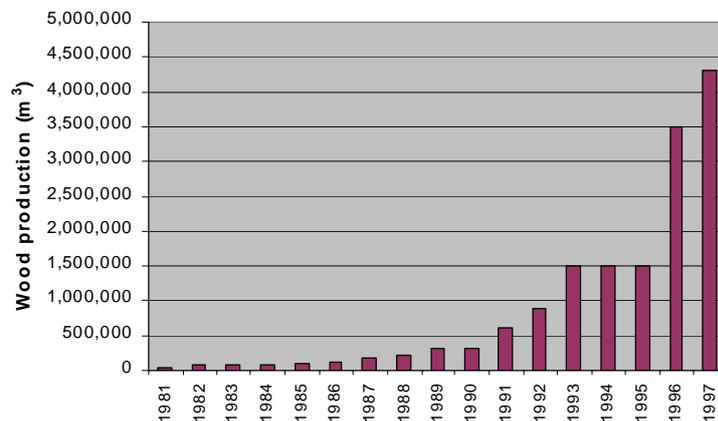


Figure 1: Wood production from 1981-1997

III. GHG inventory for LULUCF: Methodology for improving emission factors (1)

- ↓ Studies on emission factors are very limited in Cambodia. These include aboveground biomass and mean annual biomass growth rate.
- ↓ In this study, the improvement of these data was carried out through literature review and field survey
- ↓ The survey was done in 7 sites (14 plots) in 4 different provinces. The size of sample plot is 200 m²
- ↓ The ABOVEGROUND BIOMASS was estimated based on data on volume over bark (VOB), biomass expansion factor (BFF) and biomass density
- ↓ The MEAN ANNUAL INCREMENT was measured based on the measurement of diameter of tree in two different time.

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III. GHG inventory for LULUCF: Methodology for improving emission factors (2)

Plot	Understorey ¹	Necromas ²	Live tree biomass ²	Total AGB
	(1)	(2)	(3)	(1+2+3)
t/ha				
A (Semi-evergreen)	7.0 (4.5)		66.62	74
B (Semi-evergreen)	7.1 (4.7)	19.77	89.92	117
C (Mangrove)	13.5 (3.2)	-	75.75	89
D (Mangrove)	-	-	198.34	198
E (Coniferous)	4.3 (1.2)	1.22	96.93	102
F (Coniferous)	3.1 (2.3)		54.18	57
G (Inundated forest)	6.9 (9.1)	3.44	28.72	39
H (Inundated forest)	6.6 (9.5)		53.64	60
I (Secondary forest)	6.2 (8.2)		35.12	41
J (Secondary forest)	4.4 (5.1)		48.51	53
K (Rubber)	3.3 (1.0)		84.52	88
L (Rubber)	3.0 (1.0)		109.57	113
M (Teak)	5.2 (2.7)	6.54	203.25	215
N (Teak)	6.2 (0.6)		148.07	154

Not: Values in the bracket is standard deviations and calculated from field survey, (2) estimated from diameter using allometric equation

III. GHG inventory for LULUCF: Methodology for improving emission factors (3)

Forest types	Initial NatCom	Estimated from Survey data	Other studies	Used in this study
Evergreen	295 ¹		150 ²	200
Mixed (Semi evergreen)	370 ¹	95	n.a	250
Deciduous	120 ¹	n.a	n.a	100
Forest Regrowth	190 ¹	47	32-230 ^{3,4}	120
Inundated	70	50	15-342 ^{4,5}	70
Mangrove	175	144	152-443 ⁴	150
Plantation	80	142	60-153 ⁴	100
Shrubland	70	n.a	~78 ⁷	70
Non-Forest/Agroforestry	n.a	n.a	30-207 ⁶	100
Wood-/Shrubland	n.a	n.a	n.a	70
Evergreen				
Wood-/Shrubland dry	n.a	n.a	n.a	50
Wood-/Shrubland Inundated	n.a	n.a	n.a	40
Mosaic of cropping <30%	n.a	n.a	~30 ⁸	30
Mosaic of cropping >30%	n.a	n.a	~100 ⁸	75
Grassland	n.a	n.a	2-7.6 ^{5,9}	5

Source: ¹IPCC (1997); ²FAO (1997); ³Kiyono and Hastaniah (1997); ⁴Wasrin *et al.*, (2000); ⁵Utomo (1996); ⁶Tomich *et al.* (1998); ⁷ Van Noordwijk *et al.*, (2000); ⁸Murdiyarto & Wasrin (1996); ⁹Palm *et al.*, (1999); ¹⁰Hairiah and Sitompul (2000). Note: ~ means around that value.

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**III. GHG inventory for LULUCF:
Methodology for improving emission factors (4)**

Plot	Forest type	GRB (t/ha/year)	Plot	Forest type	GRB (t/ha/year)
A	Semi evergreen	4.74	H	Inundated forest	-
B	Semi evergreen	5.35	I	Secondary Forest	2.29
C	Mangrove	6.45	J	Secondary Forest	3.70
D	Mangrove	-	K	Rubber plantation	3.72
E	Coniferous	5.73	L	Rubber plantation	4.09
F	Coniferous	5.72	M	Tectona grandis	6.50
G	Inundated forest	-	N	Tectona grandis	6.55

Note: The estimates were the estimate of the biomass growth rate in the inventory year (2002).

**III. GHG inventory for LULUCF:
Methodology for improving emission factors (5)**

Forest types	Initial NatCom (t/ha/year)	Estimated from Survey data (t/ha/year)	Other studies (t/ha/year)	Used in this study (t/ha/year)
Evergreen	3.00 ¹		0.30 ⁷	2.5
Mixed (Semi-evergreen)	4.20 ²	5.04	1.71-2.96 ⁸	3.0
Deciduous	3.60 ²	n.a	0.17 ⁷	2.0
Forest Regrowth	2.83 ³	2.99	1.3-2.7 ⁹	2.5
Inundated	2.98 ³	n.a	n.a	2.0
Mangrove	3.00 ⁴	6.45	n.a	3.0
Plantation (rubber)	6.68 ⁵	5.20	3.3-25 ¹⁰	6.7
Shrubland	1.00 ⁴	n.a	n.a	1.0
Non-Forest/Agroforestry	5.84 ³	n.a	n.a	6.0
Wood-/Shrubland Evergreen	n.a	n.a	n.a	1.0
Wood-/Shrubland dry	n.a	n.a	n.a	0.7
Wood-/Shrubland Inundated	n.a	n.a	n.a	0.5
Mosaic of cropping <30%	n.a	n.a	n.a	1.5
Mosaic of cropping >30%	n.a	n.a	n.a	0.5
Grassland	0.50 ⁶	n.a	n.a	0.2
Bamboo	1.50	n.a	n.a	n.a

Source: ¹ IPCC (1997); ² FAO (1997); ³ LEAP RWEDP (1997); ⁴ Lasco and Pulhin (1999); ⁵ Boer *et al.*, (2001); ⁶ UNDP-ESMAP (1992); ⁷ Ashwell (in Nophea, undated); ⁸ Logged over forest (Boer *et al.*, 2001); ⁹ Sutisna (1997), and ¹⁰ Askari (2000).

III. GHG inventory for LULUCF: Result of GHG inventory (1)

- ⇒ GHG inventory for forestry sector in each province was estimated up to provincial level
- ⇒ Koh Kong Province is the highest CO₂ emitter, while Mondol Kiri province is the highest C-sequestration
- ⇒ The error of estimate of CO₂ emission is ranged between 1%-22%, while the CO₂ sequestration estimate ranges between 16%-38%
- ⇒ In term of CO₂-eqv, more than half of Cambodian province were a net emitters
- ⇒ In comparison with the National GHG inventory reported in the National Communication, the improved inventory gave lower estimate.

III. GHG inventory for LULUCF: Result of GHG inventory (2)

↓ Comparison of 1994 GHG Inventory between National Communication and the Improved Inventory

	Removal (kt)	Emission (kt)				
	CO ₂	CO ₂	CH ₄	CO	N ₂ O	NO _x
Improved	-39,451.609	31,562.585	28.984	253.610	0.199	7.20
NatCom	-64,850.230	45,214.270	74.770	654.200	0.510	18.58
% Change of Natcom	39.2	30.2	61.2	61.2	60.9	61.

IV. Conclusion and recommendations

- ↓ The area of forests and area being converted and above ground biomass and annual growth rate of tree play the most important role that will determine greatly the accuracy of GHG inventory
- ↓ The improvement of the GHG inventory was made in 3 areas: forest area and rate of conversion, biomass growth rate, and level of analysis
- ↓ However, the aboveground biomass and biomass growth rate estimated from field survey will not represent the overall condition of Cambodia forest
- ↓ Further survey should be done for improving these factors.