Impact of Land Use Change on Carbon Stock and GHG Emissions in New Oil Palm Plantings

- Case Studies from Musim Mas Group -

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Introduction

- Over the past few decades the oil palm has been one of the most rapidly expanding tropical crops in the world. It has become the driver of land use change leading to degradation of habitats for biodiversity and ecological services (Koh & Wilcove 2008).

- Oil palm is reported to be responsible for 16% of total GHG emissions from land use change and peat oxidation in Indonesia (Agus *et al*. 2013).

- Expansion of oil palm is expected to continue to feed increasing world population: an additional 12 million hectares will be needed by 2050 (Corley, 2009).

- It is an imminent RSPO requirement that new plantation developments must estimate land use change, identify major potential sources of emissions and develop a land use plan to minimize net GHG emissions.
  - The revised P&C 2013 requires new plantation developments to conduct land use change (C 7.3.2) and estimate the carbon stock of the proposed development area (C. 7.8.1).
  - Major potential sources of emissions that may result directly from the development be identified and estimated (C. 7.8.1).
  - A plan to minimize net GHG emissions by avoidance of land areas with high carbon stocks and /or by sequestration options must be developed (C 7.8.2).

RSPO Carbon Assessment Procedure for New Plantings

- Provides a practical methodology to growers.
- For estimating the carbon stock changes (above and below ground) and GHG emissions in new oil palm development.
- Developing plans to minimise loss of carbon stocks and GHG emissions with land conversion.

- Two case studies are reported in this presentation.

- Case study 1 is a new oil palm plantation located in West Kalimantan. This was reported in NPP on 7 January, 2011.

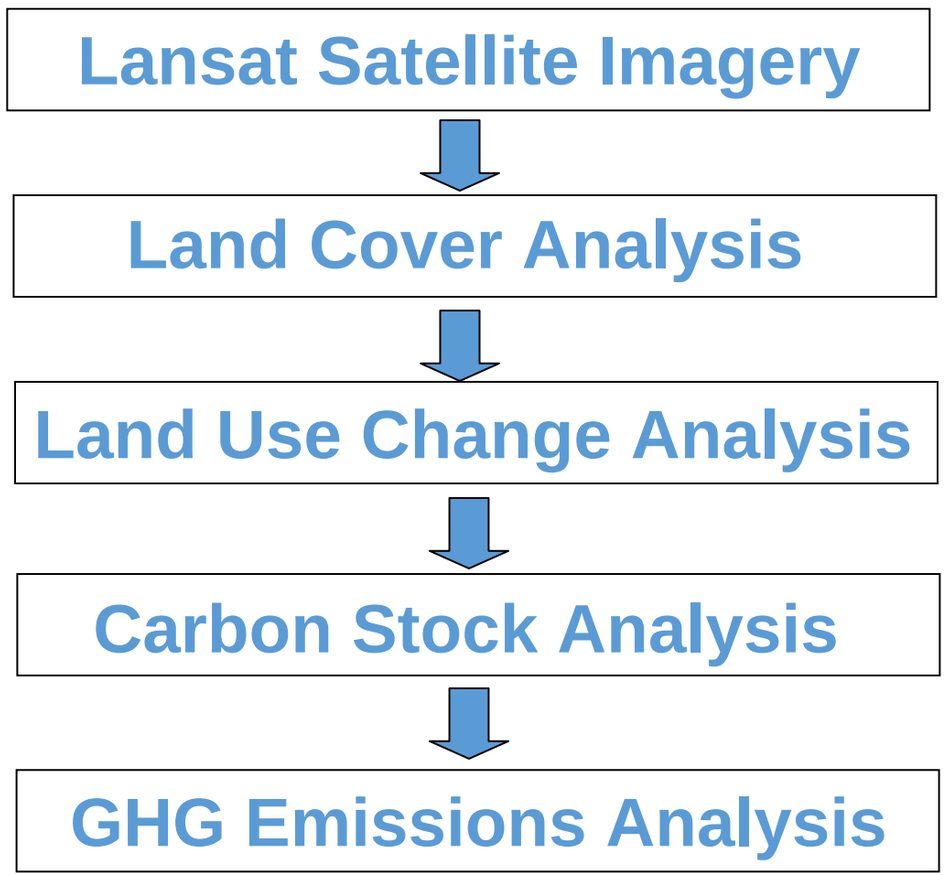
    - The land use change analysis is based on a 2010 Landsat 7 ETM+ satellite image for the before commencement of planting data and after oil palms have been planted from 2012 – 2014 using 8 TTM+ satellite imagery 2014.

- Case study 2 is located in Central Kalimantan involving new oil palm planting, reported in NPP on 13 December, 2012.

    - The land use change analysis is determined by mapping the planned oil palm expansion areas from 2013 -2015 on the 7 ETM+ satellite imagery 2012.

- Remote sensing is used to determine land cover and land use change in new oil palm development.
- The impact of land use change on carbon stock and GHG emissions is examined using the following methods:
  - Land cover analysis is based on Lansat satellite imageries.
  - Land use change analysis is based on change in land cover arising from the new oil palm planting.
  - Carbon stock values are calculated using default values of the RSPO PalmGHG calculator.
  - GHG emissions are calculated using the RSPO PalmGHG calculator (v 1.2. and v 2).

Approach to Estimation of GHG Emissions



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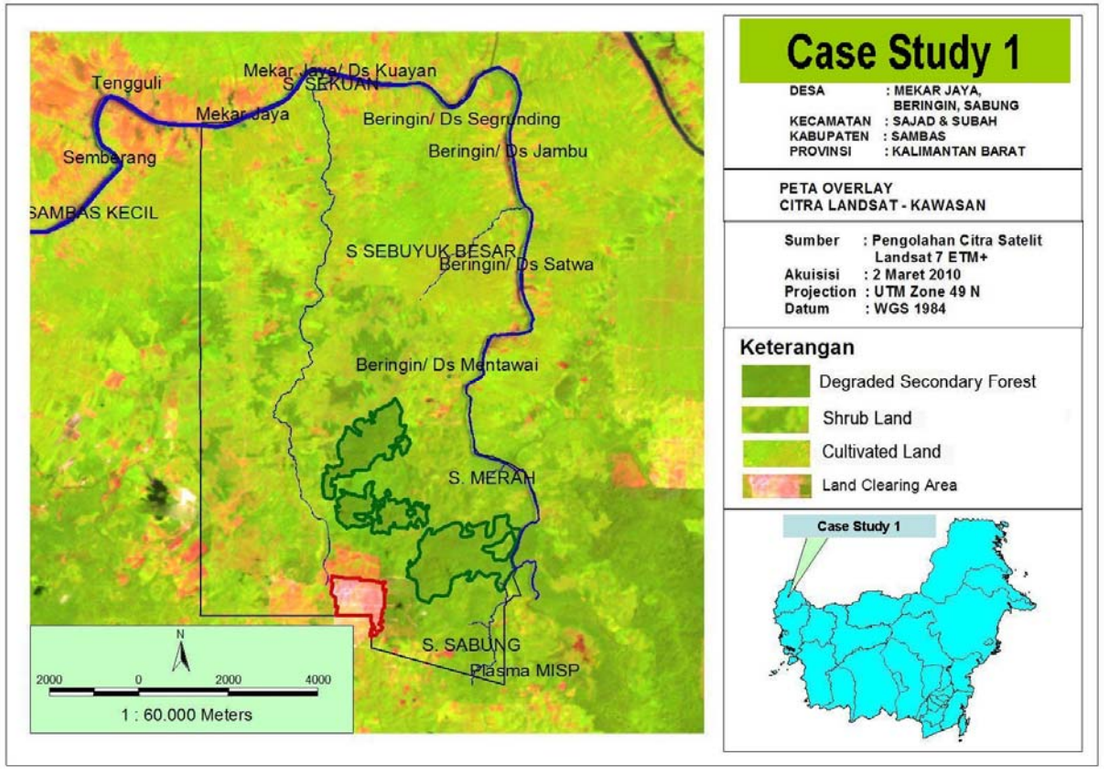
Lansat Satellite Imagery

Land Cover Analysis

An example of land cover analysis using satellite image – Case study 1



Landsat 7 ETM+ Satellite 2010

Land cover estimated from 7 ETM+ Landsat satellite

Land Cover	Ha	%
Degraded secondary forest	544.14	6.05
Mixed rubber cultivation	5,562.89	61.81
Shrub land	2,695.65	29.95
Open land	197.31	2.19
Total	**9,000.00**	**100.00**

Verification of land cover based on the data from participative survey by the Public Relation Team

Land Cover	From Landsat Data		From Survey Data	
	Ha	%	Ha	%
Degraded secondary forest	544.14	6	0	0
Mixed rubber cultivation	5,562.89	62	4,248.49	47
Shrub land	2,695.65	30	4,509.87	50
Open land	197.31	2	241.64	3
Total	**9,000.00**	**100**	**9,000.00**	**100**

Verification was carried out as follow:

- Overlaying HCV map on Landsat image.
- Overlaying Landsat images and participatory survey map.
- Overlaying the Landsat images and HCV maps over the participatory survey map.

Reconciled Land Use Classification in 2010

Land Cover	Ha	%
Degraded secondary forest	544.14	6
Mixed rubber cultivation	4,248.49	47
Shrub land	3,965.73	44
Open land	241.64	3
Total	**9,000.00**	**100**

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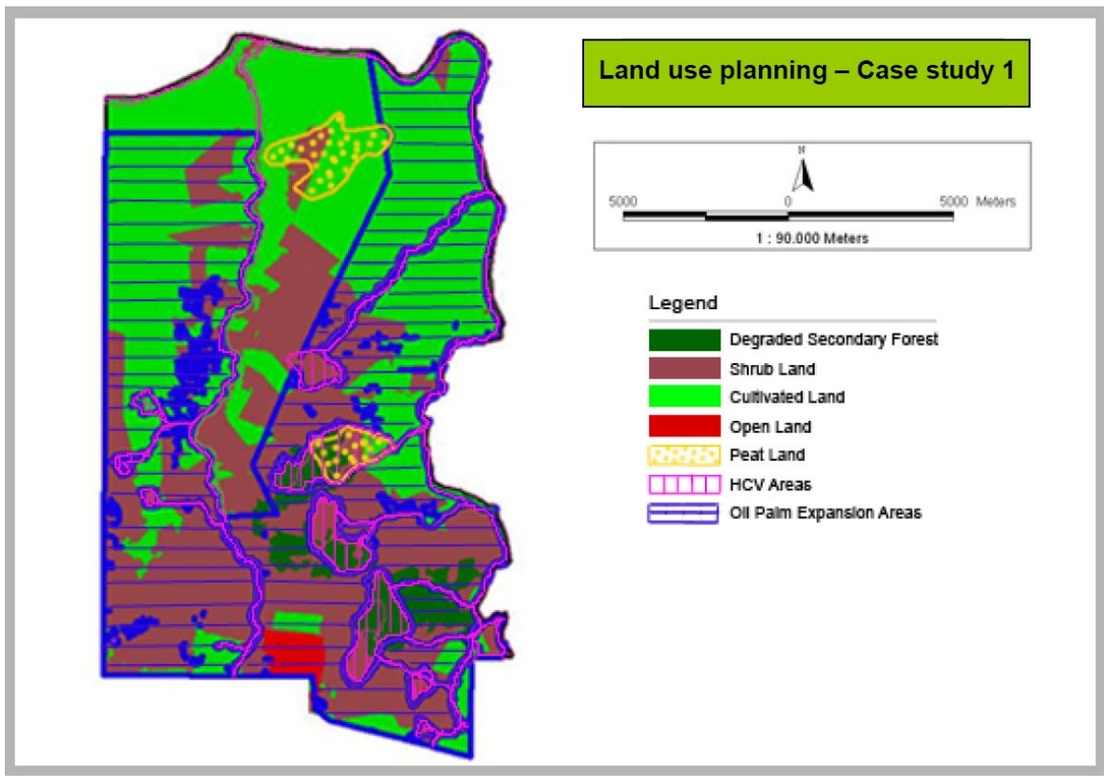
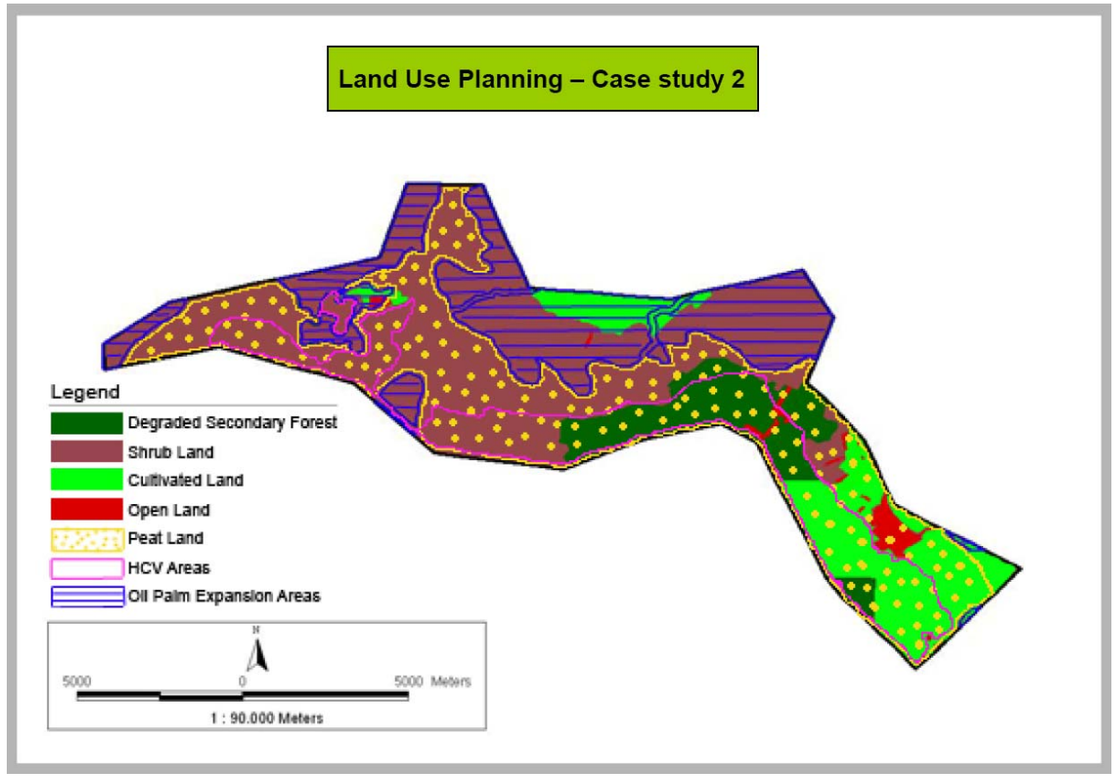
Approach to Estimation of GHG Emissions

Land Use Change Analysis

Land use planning



Case study 1



Case study 2

Land Use Change Analysis – Case Study 1

Land Cover	Total Area (ha) 2010	Changes in 2014			
		Degraded secondary forest	Mixed rubber cultivation	Shrub land	Planted area (Oil palm)
Degraded secondary forest	544.14	401.76	0	56.35	86.03
Mixed rubber cultivation	4,248.49	0	1,006.95	2,677.49	564.06
Shrub land	3,965.73	0	10.57	1,993.57	1,961.59
Open land	241.64	0	25.52	192.78	23.34
Total	**9,000.00 (100%)**	**401.76 (4.5%)**	**1,043.04 (11.6%)**	**4,920.18 (54.7%)**	**2,635.02 (29.2%)**

275 ha of peat land and 402 ha of degraded secondary forest were left unplanted and set-aside.

Land Use Change Analysis – Case Study 2

Land Cover	Area in 2012 (Ha)	%	Land use change from oil palm planting 2013 -2015 (Ha)				
			Degraded secondary forest	Shrub land	Cultivated land	Planted area (oil palm)	Open land
Degraded secondary forest	739.88	5%	739.88	0	0	0	0
Shrub land	11,002.49	68%	0	6,049.39	0	4,953.10	0
Cultivated land	1,466.91	9%	0	0	920.43	546.48	0
Open land	382.86	2%	0	0	0	258.94	123.92
Planted area (oil palm)	2,470.71	15%	0		0	2,470.71	0
Total	**16,062.85**	**100%**	**739.88**	**6,049.39**	**920.43**	**8229.23**	**123.92**
Percentage			**5%**	**37%**	**6%**	**51%**	**1%**

7,637.35 ha of peat land and 740 ha of degraded secondary forest are left unplanted and set-aside

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Approach to Estimation of GHG Emissions

Carbon Stock Analysis

Above and Below Ground Carbon Stock (Ton C) – Case Study 1

Land Cover	Total Area (ha)		Carbon Stock/ ha (Ton ha^{-1})*	Total Carbon Stock (Ton C)	
	2010	2014		2010	2014
Degraded secondary forest	544.14	401.76	128	69,649.92	51,425.28
Mixed rubber cultivation	4,248.49	1,043.04	75	318,636.75	78,228.00
Shrub land	3,965.73	4,920.18	46	182,423.58	226,328.28
Open land	241.64	0.00	0.00	0.00	0.00
Planted area (Palm Oil)	0.00	2,635.02	50	0.00	131,751.00
Total	**9,000.00**	**9,000.00**		**570,710.25**	**487,732.56**
C Stock/Ha				**63.41**	**54.19**

**Source : RSPO Carbon Assessment Tool for New Oil Palm Planting, June 2014.*

Above and Below Ground Carbon Stock (Ton C) – Case Study 2

Land Cover	Total Area (Ha)		Carbon Stock/ ha (Ton C/ Ha)*	Total Carbon Stock	
	2012	2015		2012	2015
Degraded secondary forest	739.88	739.88	128	94,704.64	94,704.64
Shrub land	11,002.49	6,049.39	46	506,114.54	278,271.94
Cultivated land	1,466.91	920.43	75	110,018.25	69,032.25
Open land	382.86	123.92	0	0.00	0.00
Planted area (oil palm)	2,470.71	8,229.23	50	123,535.50	411,461.50
Total	**16,062.85**	**16,062.85**		**834,372.93**	**853,470.33**
C Stock/Ha				**51.94**	**53.13**

**Source : RSPO Carbon Assessment Tool for New Oil Palm Planting, June 2014.*

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Approach to Estimation of GHG Emissions

GHG Emissions Analysis

Sources of GHG emissions from new oil palm planting – Case Study 1 (PalmGHG v 1.21)

No	Plantation/Field Emissions and Sinks		
	Emissions Sources	Emissions	
		tCO2e	tCO2e/ha
1	Land Conversion	21,053.92	9.18
2	Fertilizer (mineral) manufacture & transport	762.64	0.33
3	Fuel Consumption	944.04	0.41
4	Peat Oxidation	-	-
	Sinks		
5	Crop Sequestration	-36,342.90	-15.84
6	Sequestration in Conservation Area	-	-
Total**		**-13,582.25**	**-5.92**

Sources of GHG emissions from new oil palm planting – Case Study 2 (PalmGHG v 1.21)

No	Plantation/Field Emissions and Sinks		
	Emissions Sources	Emissions	
		tCO2e	tCO2e/ha
1	Land Conversion	39,428.26	6.85
2	Fertilizer (mineral) manufacture & transport	6,310.82	1.10
3	Fuel Consumption	153.64	0.03
4	Peat Oxidation	-	-
	Sinks		
5	Crop Sequestration	-129,535.14	-22.49
6	Sequestration in Conservation Area	-	-
Total**		**-83,642.42**	**-14.51**

Sources of GHG emissions from new oil palm planting – Case Study 2 (PalmGHG v 2)

No	Description	tCO2e	tCO2e/ha	tCO2e/t FFB	tCO2e/tCPO
	Land Use Emission				
1	Land Conversion	39,428.26	6.85	0.27	0.94
2	Crop Sequestration	-129,535.14	-22.49	-0.90	-3.13
3	Sequestration in conservation areas	0.00	0.00	0.00	0.00
4	Peat oxidation	0.00	0.00	0.00	0.00
	Estate Operation Emission				
5	Fertiliser (mineral) manufacture transport	6,310.82	1.10	0.04	0.14
6	N2O from fertilizer (mineral) application	7,206.26	1.25	0.05	0.17
7	Fuel consumption	153.64	0.03	0.00	0.00
	Mill Operation Emission				
8	POME (Methane capture)	0.00	0.00	0.00	0.00
9	Mill Fuel Consumption	78.00	0.01	0.00	0.00
	TOTAL	**-74,358.16**	**-13.26**	**-0.53**	**-1.88**

Discussion and Conclusions

- The case studies have indicated that land cover change has a significant impact on the carbon stock values and GHG emissions in new oil palm plantings.

- Forest areas and peatland are associated with high emission factors. Avoidance of these from planting will significantly help reduce the GHG emissions in the new oil palm planting.

- Land cover change from those with a higher carbon stock value (e.g. mixed rubber areas) to those with a lower carbon stock value (e.g. shrub land) will results in lower carbon stocks in the after planting period.

- Remote sensing methods provide a quick, practical and a relatively low cost way to determine land use and analyze land use change. The method provides a good indication of outcomes.

- The PalmGHG Calculator is designed to estimate GHG emissions from oil palm cultivation and field operations.

- It is also designed to estimate GHG emissions from new oil palm plantings.

- It enables identification of the potential sources of emissions that may result directly from the development.

- Reducing GHG emissions from land use change will help mitigate climate change and contribute significantly to national emission reduction targets.

- Accounting for potential emissions from new oil palm plantation expansion is essential in arriving at a planting plan which would minimize net GHG emissions.

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