ENHANCED APPROACHES TO ESTIMATES NET EMISSION REDUCTIONS FROM DEFORESTATION AND DEGRADATION OF UNDRAINED PEAT SWAMP FORESTS IN CENTRAL KALIMANTAN, INDONESIA
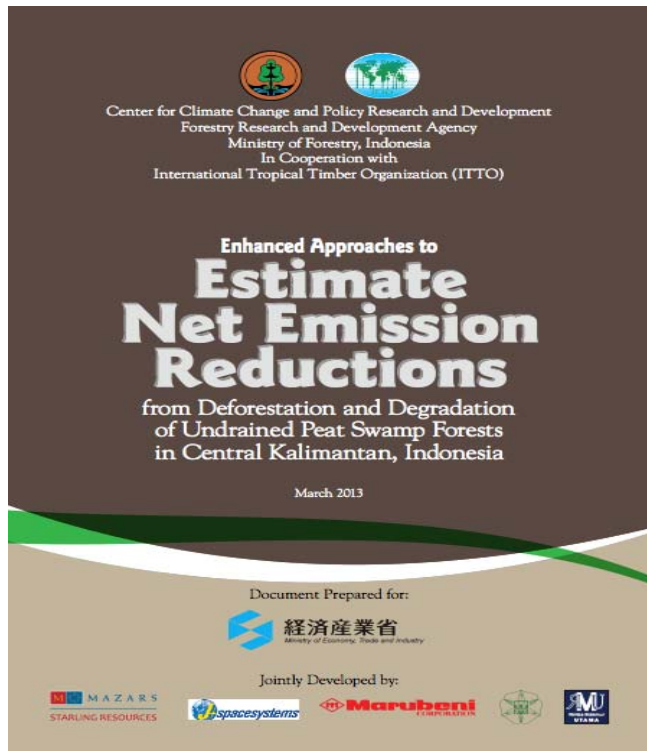
By:
I Wayan Susi Dharmawan

Research, Development and Innovation Agency
Ministry of Environment and Forestry
Republic of Indonesia

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Collaboration:

Outline

- **Introduction**
- **Experiences from the Study**
- **Forest Stratification and Definitions**
- **Key Findings**

Introduction

Peatland characteristics such as vegetation types, peat depths, water table levels and soil organic carbon contents are highly variable from location to location, **caused** the variability of carbon stocks and CO_2 emissions is also considered high.

In order to minimize uncertainty and geostatistical errors as a result of high variability, it was deemed necessary to estimate emission factors based on detailed land cover and forest stratification in several locations.

Furthermore, the quantification of emission factor and carbon stock values derived from land-use change and vegetation growth on each land cover stratum was necessary in order to accurately estimate net emission reduction (NER) amounts from the locations.
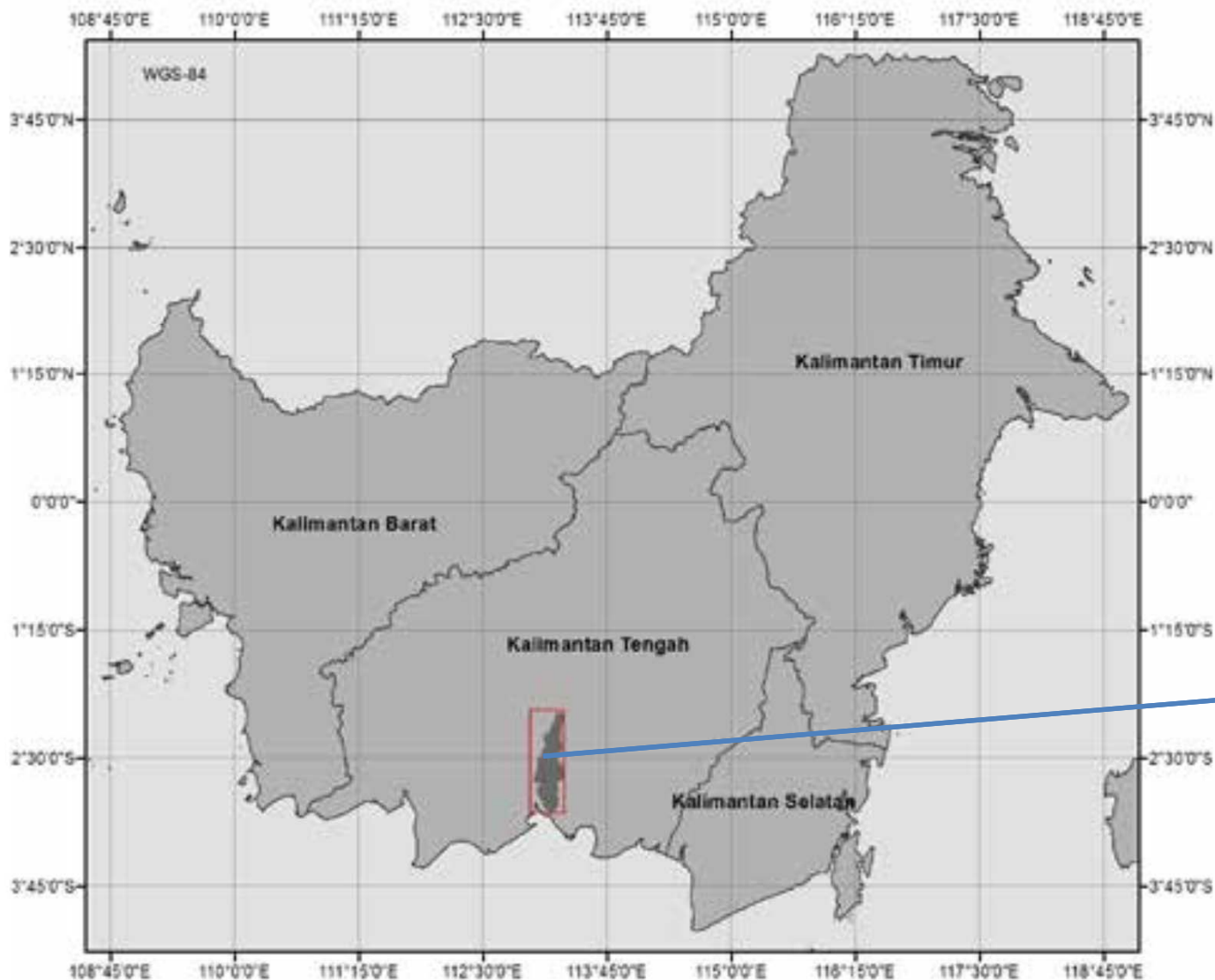
Peatland Ecosystem Values:

❑ **High biodiversity: flora, fauna and microbes**

❑ **High environmental servise: hydrological and carbon stock functions**
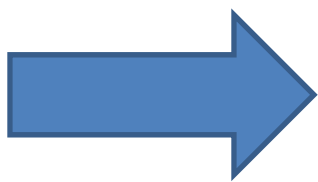
➡️ **Function of peatland ecosystem is very important**

The location of Katingan Project Site

Covering a total area of 203,570 ha, the area is home to some of the world's endangered species, including the Bornean orangutan (Pongo pygmaeus) and proboscis monkeys (Nasalis larvatus). Approximately 90% of the total area is identified as forest land.

EXPERIENCES FROM THE STUDY

Peat land emission factor is determined strongly by:

❑ the precision in the analysis of satellite imagery and

❑ details in the establishment of peat swamp forest stratification.

Nett emissions reductions in peat swamp forest is determined strongly by :

❖ the level of deforestation rate,

❖ level of peat depth drainage maximum-minimum lead emissions

❖ and the rate of deforestation caused by forest fires

Deforestation rate in Katingan Project Site during 1994-2012

Year	Deforestation (ha)
(1) 1985-1997	138208,00
(2) 2000-2003	126508,72
(3) 2003-2006	240612,58
(4) 2006-2009	386225,99
(5) 2009-2010	128648,10
AVERAGE	204040,68

Annual rate deforestation as 1,083.49 ha/year or 0.53% from total area (in Katingan Project Site).

Forest Stratification and Definitions

Definitions were adopted from :

- Miyamoto, et al. (2007) Forest structure and primary productivity in a Bornean heath forest;

- Page, et al. (1999) Peat and vegetation interdependence;

- Anderson (1964) The structure and development of peat swamp forest of Sarawak and Brunei.

- Those definitions were then reviewed by the Ministry of Forestry agencies including Forestry Planning Agency and Forestry Research and Development Agency.

Ecosystem	Forest stratum	Definition
Peatland	Primary peat swamp forest, high density	A high density intact mixed swamp forest which occurs on peat land with no traces of logging tracks or history of forest fires. It is a tall forest with uneven canopy, and consists of mixed plant species.
	Primary peat swamp forest, medium density	A low diversity, low pole primary forest which accurs on constantly inundated deep peat. Trees in this forest type are characterized with short structure and low diversity. They are typically small with the average DBH of 10 cm
	Primary peat swamp forest, low density	A low diversity and low density primary forest which occurs on constantly inundated deep peat. Trees in this forest type are thinly distributed and markedly small and short.
	Secondary peat swamp forest, high density	Also known as logged-over forest, it is a disturbed high density, old mixed swamp forest which occurs on peat land with traces of past or current logging tracks. Few in this forest type are smaller and sparsely distributed.
	Secondary peat swamp forest, low density	Also known as logged-over forest, it is a disturbed low density, young mixed swamp forest which occurs on peat land with traces of past or current logging tracks. Trees in this forest type are smaller and sparsely distributed.
	Peat non-forest	An open area with canopy cover less than 30%, which occurs on peatland. This stratum includes grassland, cropland, wetlands, sttlements and other-land (based on Forest Planning Agency - MoF classes). Some areas have been fire damaged, and are prone to peat fires during the dry season. It is typically occupied with ferns, kelakai grasses and other shurbs. Some areas may have sparsely distributed trees such as Melaleuca sp. and Combretocarpus.
Heath (Kerangas)	Primary heath forest	An intact forest characterized by trees with short structure, low diversity and slender trucks, which occurs on nutrient-poor white sands and has no traces of logging tracks or history of forest fires.

Ecosystem	Forest stratum	Definition
	Secondary heath forest, high density	Mosaic of disturbed old forest which occurs over nutrient-poor white sand with traces of past or current logging tracks. Trees in this forest type are densely distributed with short structure and low diversity, and understory vegetation is abundant.
	Secondary heath forest, low density	Mosaic of highly disturbed young forest which occurs over nutrient-poor white sand with traces of past or current logging tracks. Trees in this forest type are sparsely distributed with short structure and low diversity, and understory vegetation and ferns are abundant.
	Heath non-forest	Open scrubby vegetation occurs on nutrient-poor white sands. It is an open mosaic, with small and short trees scattered with canopy cover less than 30% and shrubs and saplings grown in clumps.
Freshwater swamps	Primary freshwater swamp forest	An intact forest which occurs on permanently or seasonally inundated freshwater swamps.
	Secondary freshwater swamp forest	A disturbed forest with traces of logging trails, which occurs on permanently or seasonally inundated freshwater swamps.
	Non-forest	An open area with canopy cover less than 30%, which occurs on permanently or seasonally inundated freshwater swamps.
Water body		This class contains open water (including rivers, lakes, and canals).

Forest strata were determined based on vegetation density by **using a combination of optical satellite imagery (RapidEye, Landsat and Alos Aster) and radar image data (Alos Palsar).**

In summary, approximately 40% of the Katingan Project site consist of primary peat swamp forest, 48% secondary peat swamp forest, 9% non-forested peat land, and the rest are heath and freshwater swamp forest and non-forest areas. The following map shows the detailed stratification of land cover inside the Katingan Project site.
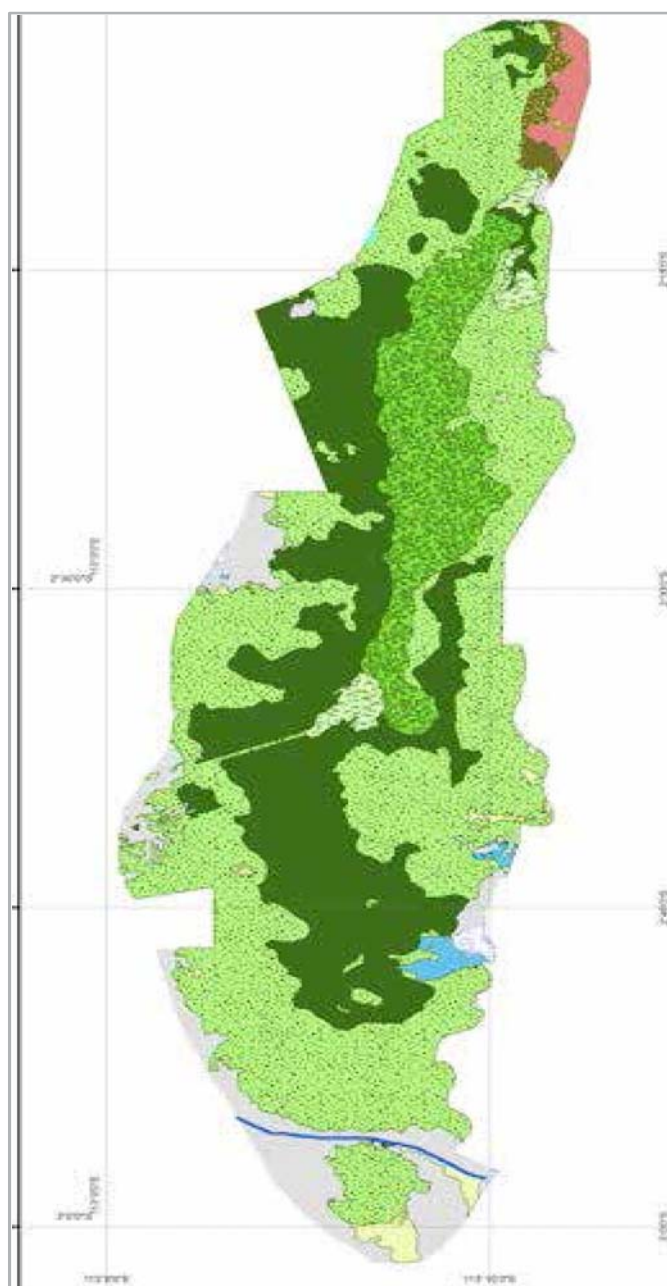
Legend

- ■ Primary Peat Swamp Forest, Hi Density
- ▦ Secondary Peat Swamp Forest, Hi Density
- ▦ Primary Peat Swamp Forest, Medium Density
- ▦ Primary Peat Swamp Forest, Low Density
- ▢ Secondary Peat Swamp Forest, Low Density
- ▢ Peat Swamp, Non Forest
- ■ Primary Heath Forest
- ▦ Secondary Heath Forest, Hi Density
- ▦ Secondary Heath Forest, Low Density
- ■ Heath, Non Forest
- ▦ Secondary Freshwater Swamp Forest, Hi Den
- ■ Secondary Freshwater Swamp Forest, Low De
- ▢ Freshwater Swamp, Non Forest
- ■ Water Body
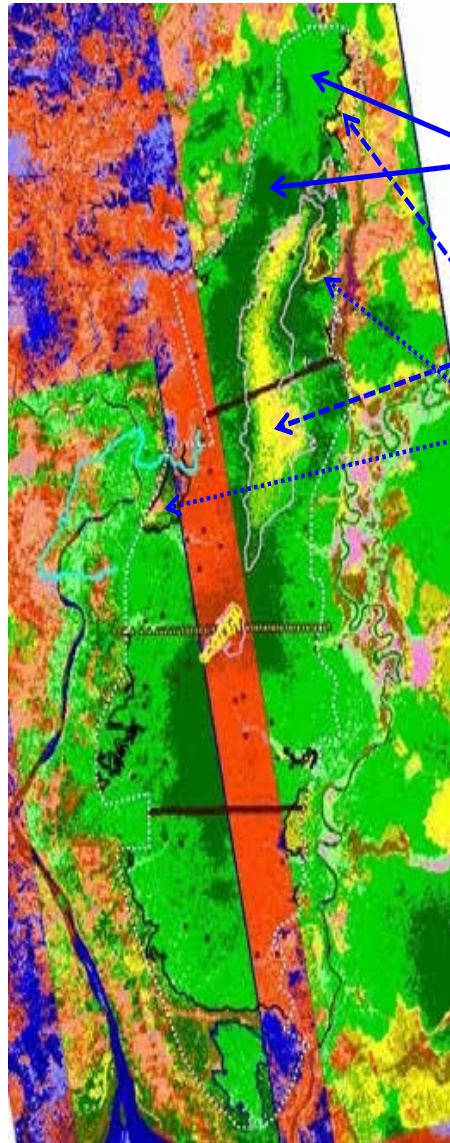
Zone	Target	Example
Z1	High entropy multiple scattering	High density forest, large tree stems and well-developed crown structure, etc.
Z2	High entropy vegetation scattering	Scattered forest canopy, etc.
Z3	None	—
Z4	Medium entropy multiple scattering	Low biomass forest, etc.
Z5	Medium entropy vegetation scattering	Thin vegetation and forest, etc.
Z6	Medium entropy surface scattering	Rough surface, short vegetation, etc..
Z7	Low entropy multiple scattering	Scattering 2 dimensional objects
Z8	Low entropy dipole scattering	Scattering vegetation with strong directional characteristics
Z9	Low entropy surface scattering	Sea and ground surface, etc.

Entrophy (H) and alpha angle (α)
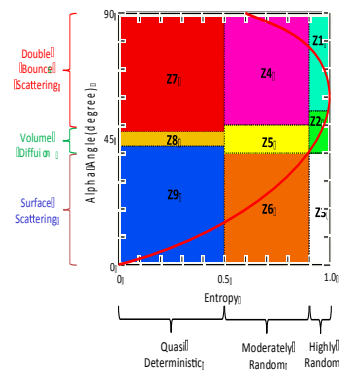
The low density forest area indicated with light green color by PALSAR generally matched the area identified as secondary high density and low density peat swamp forest by the optical satellite imagery analysis. Similarly, the dark green area identified as high density forest by PALSAR overlapped with many areas indicated as primary high density forest.

Although the analysis of remote sensing imageries and PALSAR polarimetric data largely resulted in similar interpretations, they returned slightly different classification information in some areas within the study site.

ALOS PALSAR 2010 classification by color code

Key findings-1

◆ **This study had important implications for land cover stratification, the estimation of above- and below-ground biomass and carbon stocks, and potential net emission reductions for the Katingan Project site.**

◆ **The combined use of SAR imagery and different optical satellite images proved to be mutually beneficial to conduct these analyses. Areas which were difficult to be interpreted with optical satellite images, were compared with PALSAR data and clarified. Similarly, multiple optical satellite images were used to determine and verify PALSAR polarimetric classification results.**

Key findings-2

◆ **Structural information obtained from PALSAR data could also provide an additional angle to be considered for the estimation of aboveground biomass in further research.**

◆ **By drawing a relationship between backscattering parameters and aboveground biomass, it is possible to estimate aboveground carbon stored in each structural type.**

◆ **By adding field data of peat depth and water table levels, a PALSAR- based biomass analysis would enhance the interpretation level of carbon stock estimation.**

Thank you for your attention

Contact Person

Research and Development Center of Forest

Research, Development and Innovation Agency

Ministry of Environment and Forestry

Republic of Indonesia

Email: salifa03@yahoo.co.id

Mobile phone: + 62 821 730 73981