K&C Phase 3 – Brief project essentials

LOS

K&C Initiative

An international science collaboration led by JAXA

Aboveground Biomass and Carbon Stock Mapping and Changes Monitoring in the Forest of Peninsular Malaysia Using L-Band ALOS Palsar and JERS-1

Khali Aziz Hamzah & Hamdan Omar Forest Research Institute Malaysia (FRIM)

Science Team meeting #16 – Phase 3 Kick-off JAXA TKSC/RESTEC HQ, Tsukuba/Tokyo, October 17-21, 2011

MALAYSIA – FOREST AREA

K&C Initiative

An international science collaboration led by JAXA

Malaysia total land area - about 328,300 km²

ALOS

• About 59.5% (19.52 million ha) is still under forest cover

Region	Land area	Na	atural Forest	Types	Plantation forest	Total Forested	% of total
	(mil ha)	Dry inland	Swamp forest	Mangrove forest	. 101000	land	land Area
Pen. Malaysia	13.16	5.40	0.30	0.10	0.08	5.88	44.7
Sabah	7.37	3.83	0.12	0.34	0.11	4.40	59.7
Sarawak	12.30	7.92	1.12	0.14	0.06	9.24	75.1
Total (Malaysia)	32.83	17.15	1.54	0.58	0.25	19.52	59.5

K&C Initiative An international science collaboration led by JAXA



FOREST TYPES

ALOS

Inland ForestPeat Swamp forestMangrove Forest



K&C Initiative An international science collaboration led by JAXA

Project objectives and schedule

K&C Initiative

An international science collaboration led by JAXA

Objectives:

LOS

- (i) to establish empirical relationship between aboveground biomass and L-Band signals for tropical forest ecosystem,
- (ii) to determine aboveground biomass by using L-band SAR data, and
- (iii) to map the current status and identify changes of aboveground biomass and carbon stocks in the forest in Peninsular Malaysia.

Deliverables:

- (i) Current status of forest cover in the study area (Peninsular Malaysia)
- (ii) Current pattern of spatial distribution of above ground biomass & carbon stocks in the forest
- (iii) Changes of biomass and carbon stocks from 1995 to 2010.

K&C Initiative An international science collaboration led by JAXA

Project milestones

No.	Key-milestone	Date of completion
i	Forest inventory data	March 2012
ii	Map of current forest cover in the study area	September 2012
iii	Spatial distribution map of biomass and carbon stock (2010)	February 2013
iv	Spatial distribution map of biomass and carbon stock (1995)	February 2014
V	Spatial distribution map of biomass and carbon stock changes over 15 years (1995 - 2010)	March 2014
vi	Project report	March 2014

ALOS An international science collaboration led by JAXA

Project Schedule

Japanese Fiscal Year 2011 (April) – 2014 (March)

X : Activities

O : Planned milestone

Project Activities					20	11/	12					-			20	12/	13								ļ	20)13	/14	Ļ			_					20)14	/15	_		_	_
	A	۱M	J	J	۱S	0	N	DJ	F	Μ	I A	M	J	J	A S	<u>s 0</u>	N	D	J	F	М	Α	М	J	J	A	slo		NC	<u>)</u> ,	JF	: N	Λ	۱M	J	J	Α	S	01	ND) J	JF	Μ
Agreement signing & ALOS Palsar D ollection	ata	٢X	х																																								
Secondary data collection	X	٢X	X		Τ					Γ	Τ					Τ	Γ											Τ	Τ	Τ		Τ	Τ				Π				Τ	Τ	
Ground data collection/Plot Sampling			Π	x	٨V	х	X	x			T		Π		T	\top	Γ											Τ	T	╈		T	╈				ΓŤ				T	T	Γ
Ground data analysis		T	H	+	╀	H	╡	Tx	x	0	,			1	╈	╈	┢								1	1	╈	╈	╈	╈		╈	╈	╈			\square		╈		╈	╈	F
 ALOS Palsar Image pre-processing: Topographic normalization DN to NRCS (dB) Conversion 				x	< x	x	x																					T		T													
ALOS Palsar Image processing: - Forest classification - Biomass modeling								xx	x	x	×	x	х	x	x	×	x	x	x	0																							
Mapping of Current AGB & Carbon Stoo (2010)	cks																			х	0																						
JERS-1 Image pre-processing: - Image Mosaic - Topographic normalization - DN to NRCS (dB) Conversion				x	< x	x	x																																				
JERS-1Image processing: - Forest classification								T			T				T							х	х	х	x	x	×	T	T	T		T	1	T			Π				T	T	ſ
Mapping of AGB & Carbon Stocks in 1995																								х	x	x	x	>														Τ	
Mapping of AGB & Carbon Stocks Changes (1995-2010)				T				T																			,	$\langle \rangle$	x	$\langle \rangle$	$\langle \rangle$	(0											
Validation and verification			Π				┓	╈			Τ						Γ								╡			T	T	1,	$\langle \rangle$		5				\square		╈	╈		T	T
Project completion report			H	╈	┢	\square	╡	╈	╞	┢	┢					╈	┢								1	\uparrow	╈	╈	╈	Ť	1		5				\square	1	╈	╈	╈	\uparrow	F

Support to JAXA's global forest mapping effort

OS

K&C Initiative

An international science collaboration led by JAX.

Tropical rainforest of Malaysia is one of the oldest and most complex ecosystems in the world. Although generally taken to mean the species rich lowland forests, other forest types include mangroves, peat swamps and montane forests are also rich with diverse species.

Forest Research Institute Malaysia (FRIM) will be responsible to **verify** and **validate** these forest cover in Peninsular Malaysia, and assess the response of SAR data on these forests. By using ground truth samples and experts knowledge, the algorithm that will be developed for forest cover mapping by using both ALOS Palsar and JERS-1 SAR products will be validated, specifically for the corresponding region in the study area.





Growth levels, health status, density and quality of each type of the forest will be taken into considerations in sampling processes.

Data will be inventoried on the ground and will be stored in digital shapefile (.shp) for analysis and image pixel sampling. This ground data will be shared together with JAXA scientist on conditions as specified in the project agreement.

Field Inventory Data

LOS

Field survey will be carried out on plots of $50 \times 50m$ size within the study area.

K&C Initiative

An international science collaboration led by JAXA

Number of sampling points according to the forest types

Types of	1	Natural Fores	Plantation	Total				
forest	Dry inland	Swamp forest	Mangrove forest	forest	samples			
No. of Sampling Points	150 (5.40 mil. ha)	35 0.30 (mil. ha)	20 0.10 (mil. ha)	15 0.08 (mil. ha)	220			

K&C Initiative An international science collaboration led by JAXA ALOS **Plots Design** NW 50 m NE 1st quarter 35.36 m Tree inside plot . Tree outside plot 50 m 4th quarter 2nd quarter C Tree inside plot Plot center Coordinate: X,Y 3rd quarter SE SW 50 m

Ground data collection

K&C Initiative An international science collaboration led by JAXA



ALOS

K&C Initiative An international science collaboration led by JAXA





High biomass & carbon concentration







Low biomass & carbon concentration

Typical tropical forest biomass in Malaysia

Biomass Allometry (dry inland forest)

Biomass equations to calculate AGB based on Kato et al. (1978). The allometric function of trees applied in the calculation of standing biomass can be expressed as

K&C Initiative

An international science collaboration led by JAXA

1/H = 1/(2.0*D) + 1/61

From the values of D and H, the dry mass values of stem, branches and leaves of the tree are estimated.

Ms	= 0.0313*(D2H)0.9733
Mb	= 0.136*Ms1.070
1/MI	= 1/(0.124Ms0.794) $+ 1/125$

where;

D

LOS

H = total tree height

= stem diameter at breast height (dbh)

Ms, Mb and Ml denote the dry mass of stem, branches and leaves respectively.

BIOMASS – MANGROVE FOREST (MALAYSIA)

K&C Initiative

An international science collaboration led by JAXA

Developed by Komiyama et. al (2007)

 $W_t = 0.251 p D^{2^{-46}}$

ALOS

 $W_r = 0.199p^{0.899}D^{2.22}$

where ; W_t = above ground biomass W_r = below ground/root biomass D = dbh

Biomass – Peat swamp forest Developed in Indonesia

K&C Initiative An international science collaboration led by JAXA

Forest Category	Biomass (t ha ⁻¹)	Carbon Stocks (t ha ⁻¹)
Small, growing stands	26 - 116	13-58
Mixed small & mature stands	130 – 155	65 - 77.5
Mature, dense stands	168 - 414	84 - 207
Mature & very dense stands	427 – 569	213.5 - 284.5

Carbon Stocks – Various reports

ALOS

K&C Initiative An international science collaboration led by JAXA

	Forest	Carbon stocks (t/ha)	Reference					
P. Malaysia	Lowland dipterocarp Pasoh FR	155 (Primary forest) 138 (Secondary forest)	Okuda, <i>et al</i> (2003)					
	Inland Air Hitam FR	104-111	Ismriah & Ahmad Fadli (2007)					
Sarawak	Mixed dipterocarp	140-202	Brown (1997)					
	Secondary forest- 10-14 yrs	16	Chai (1997)					
	Lambir, FR	245-250	Feeley <i>et al</i> (2007)					
Sabah	Lowland dipterocarp	32-324	Foody <i>et al</i> (2001)					

Relationship between biomass and L-Band ALOS PALSAR signal

K&C Initiative

An international science collaboration led by JAXA



Project Summary

K&C Initiative

An international science collaboration led by JAXA

- TITLE:Aboveground Biomass and Carbon Stock Mapping and Changes Monitoring
in the Forest of Peninsular Malaysia Using L-Band ALOS Palsar and JERS-1
- **DURATION:** Four years (2011 2014)

OS

- **EXEC. AGENCY:** Malaysian Forestry Research and Development Board, Forest Research Institute Malaysia (FRIM)
- COLLABORATIVEForestry DepartmentAGENCIES:Remote Sensing Agency Malaysia
- LOCATION: Peninsular Malaysia

OBJECTIVES

LOS

(i) To establish empirical relationship between aboveground biomass and L-Band signals for tropical forest ecosystem,

K&C Initiative

An international science collaboration led by JAXA

- (ii) To determine aboveground biomass by using L-band SAR data, and
- (iii) To map the current status and identify changes of aboveground biomass and carbon stocks in the forest in Peninsular Malaysia.

OUTPUTS

- (i) Current status of forest cover in the study area (Peninsular Malaysia)
- (ii) Current pattern of spatial distribution of above ground biomass & carbon stocks in the forest
- (iii) Changes of biomass and carbon stocks from 1995 to 2010

