K&C Phase 4 – Status report

Utilising L-Band SAR Data for Natural Resource Management in the Philippines

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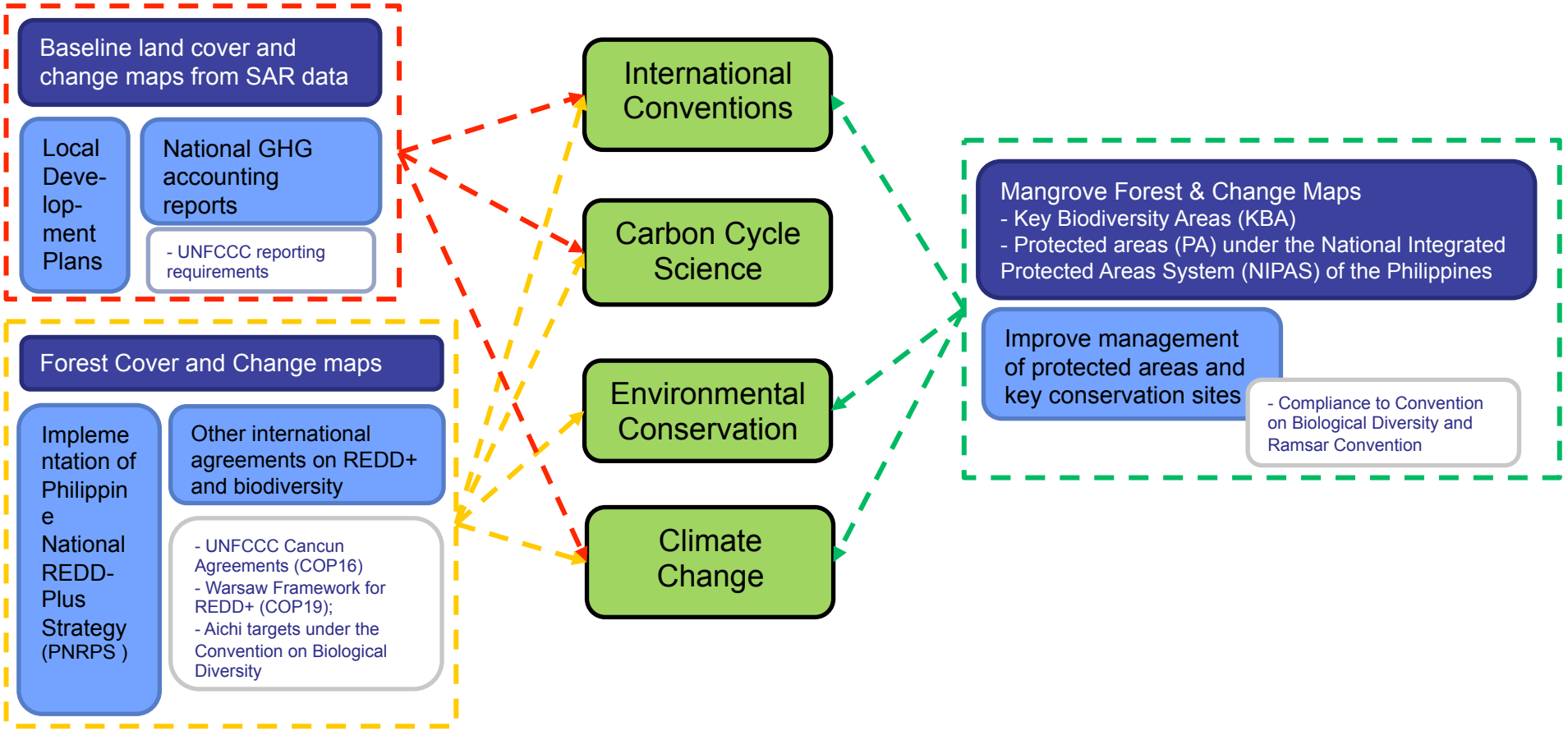
Science Team meeting #23
Hatoyama, Japan, January 18-20, 2017

Contribution to K&C thematic drivers

The project in the Philippines, through the envisioned outputs, can contribute to achieving the ff K&C objectives:

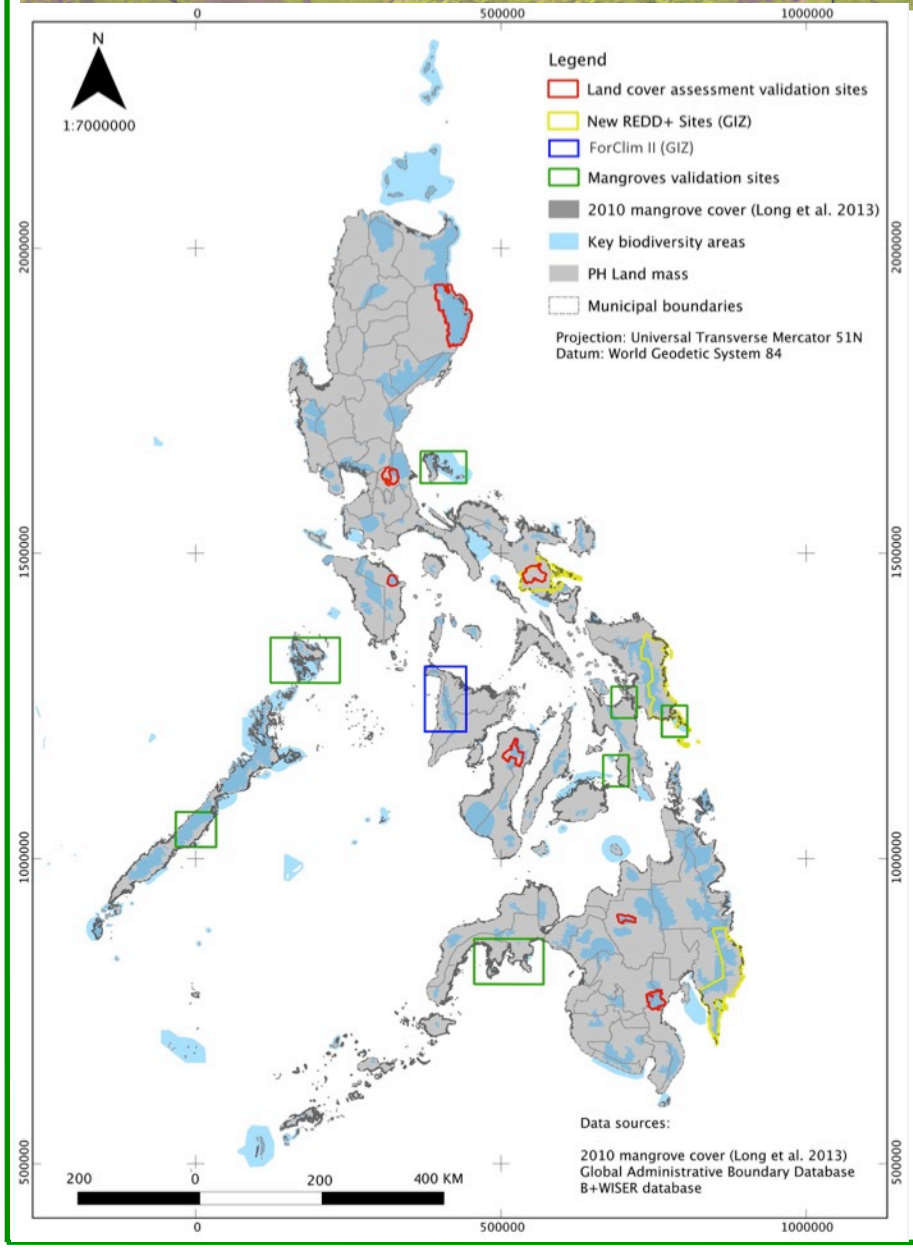


Project Objectives

- **TA1 - Land cover mapping and change detection**: assess the ability of spaceborne L-band SAR systems to support the generation of national baseline land cover and forest cover and change maps

- **TA 2 - REDD+ and forest management**: for REDD+ initiatives - baseline mapping of forest area changes, and estimation of forest biomass and carbon stocks.

- **TA 3 - Mangrove forest mapping and change monitoring**: map the country's mangrove cover extent and detect changes.



Project areas: Philippines

TA 1: protected areas (7 sites; red)

TA 2: REDD+ sites (3 sites; yellow)
ForClim II (1 site; blue)

TA 3: mangrove sites (6 sites; green)

*TA – thematic area

Why is it significant for the Philippines?

Local

- Forest Land use plans, water shed management plans, protected area plans

Nat'l

- Develop forest cover maps which are consistent with REDD+ reporting requirements
- Transparent and fast assessment of major DENR programs (reforestation, forest protection and forest land tenure management)

Int'l

- International reporting requirements (GHGI, REDD+, NatCom, BUR)

Progress and intermediate results (GIZ)

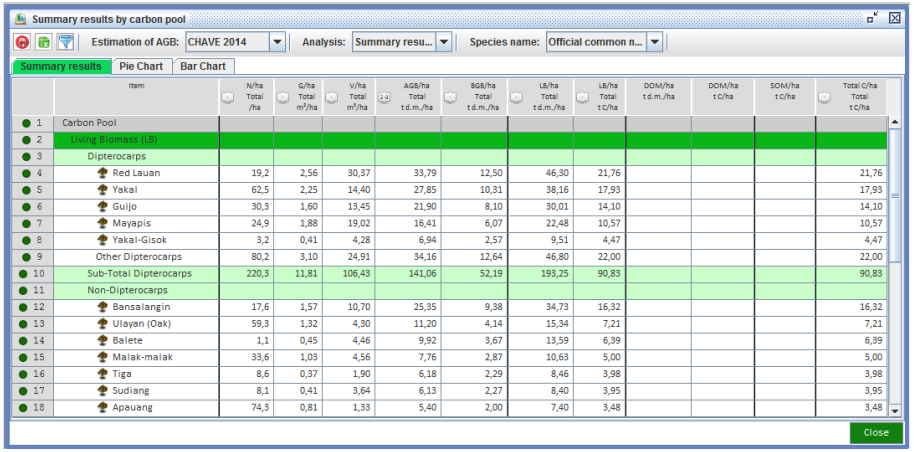
TA 1: REDD+ and Forest Management

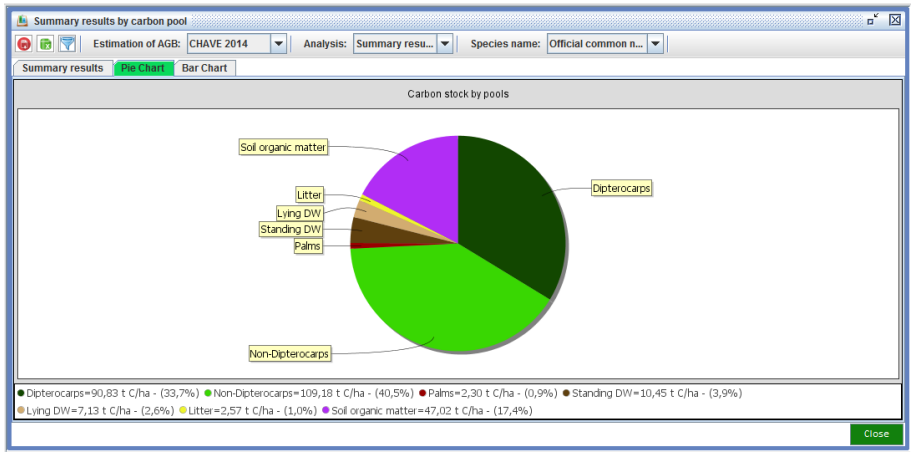
- Field data collection in all sites have been completed
  - ✓ Eastern Samar
  - ✓ Davao Oriental
  - ✓ Panay Island
- Forest resource assessment (FRA) database application was developed with all available FRA data (including Leyte Island of KC3) and will be shared to JAXA.
- The reports have been finalized and are available except for the Panay Island site.

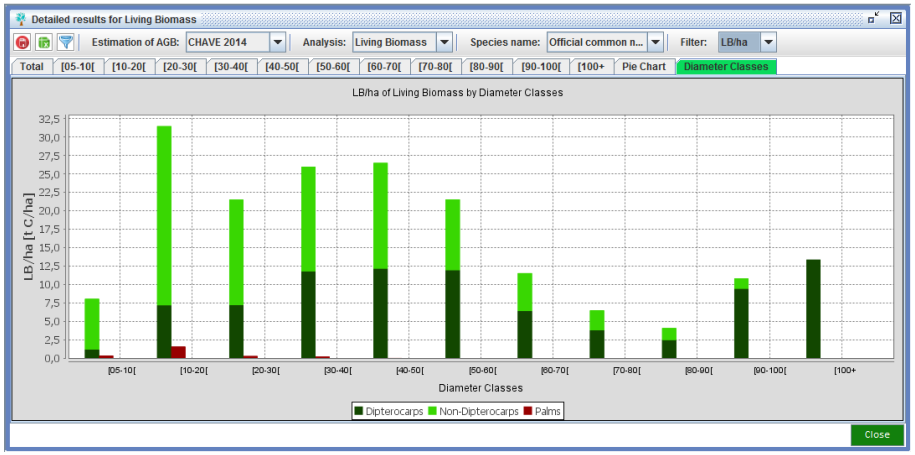
ALOS

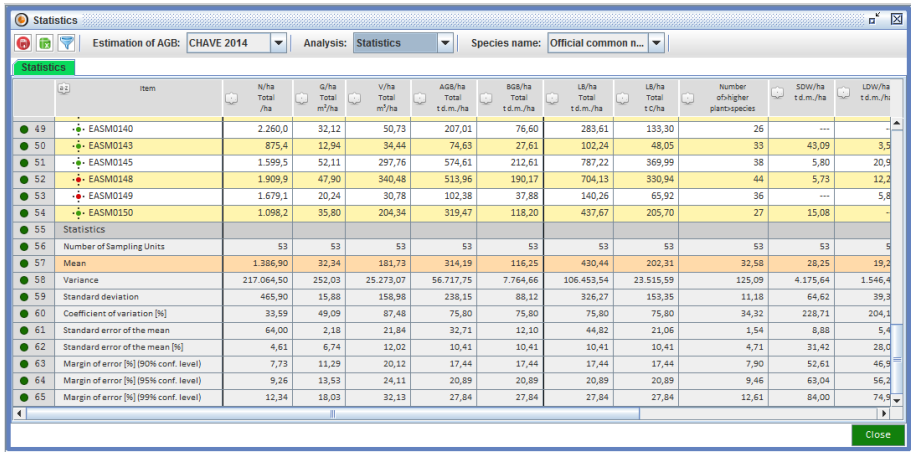
K&C Initiative
An international science collaboration led by JAXA

FRA Database (sneak peek)









Impact to the Forest Management Bureau

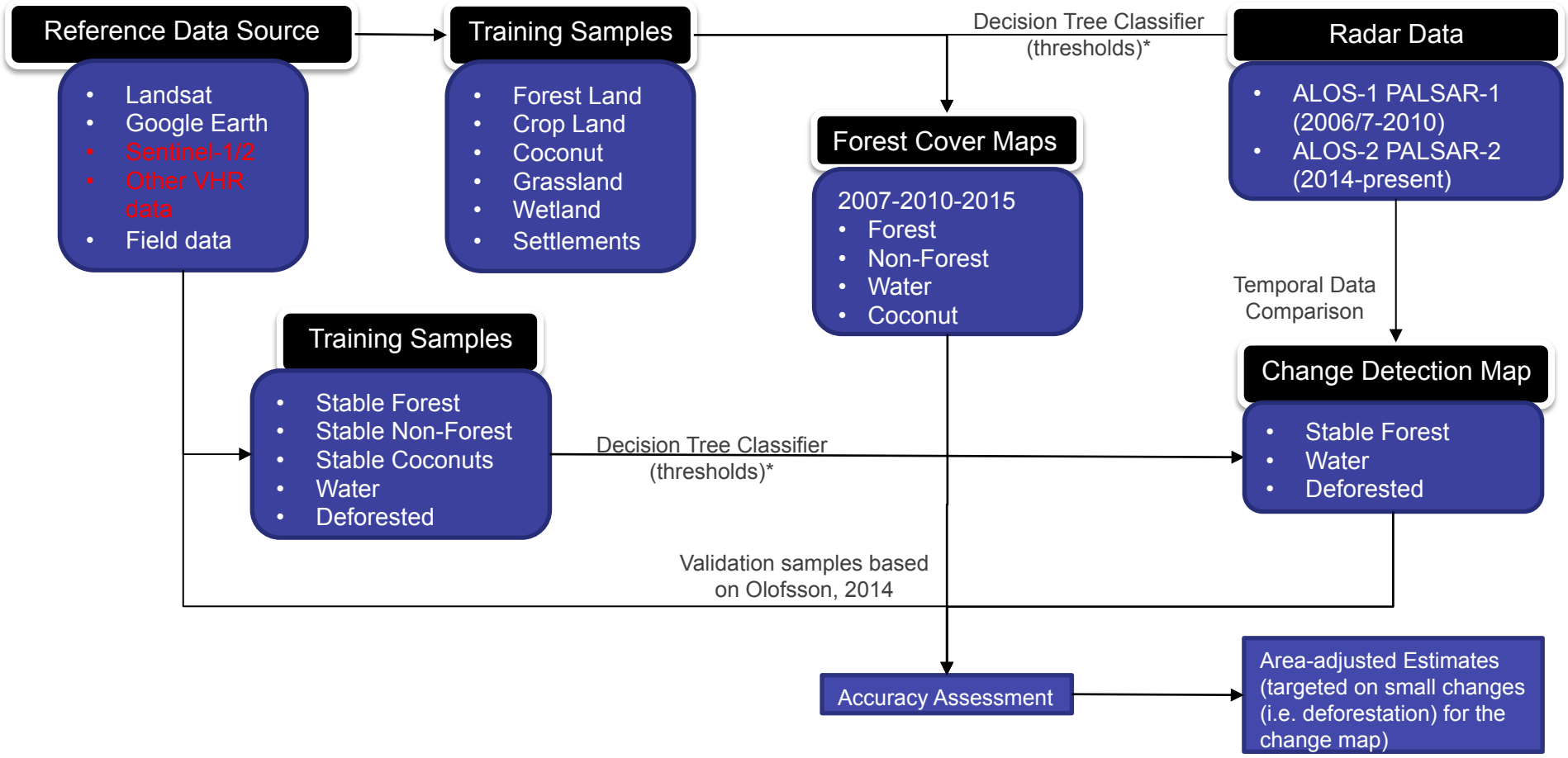
Forest Resources Assessment:

- currently looking into the database and all the data available in it.
- also looking at revising its FRA sampling design (rectangular plot)
- results of this project can be used as a model for the circular plot design and sampling intensity.

Forest cover and change maps

- Currently being developed for their National Forest Monitoring System (NFMS)
- These project level researches can be inputs for the national framework and methodologies.

Forest Cover and Change Detection Maps



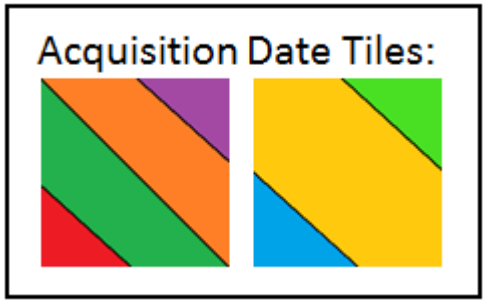
*Based on Reiche, et al., 2013

More information available in Congalton & Green, 2009 and Olofsson, 2014

Datasets used

ALOS PALSAR 25m mosaic (2007 and 2010)

ALOS-2 PALSAR-2 25m mosaic (2015)

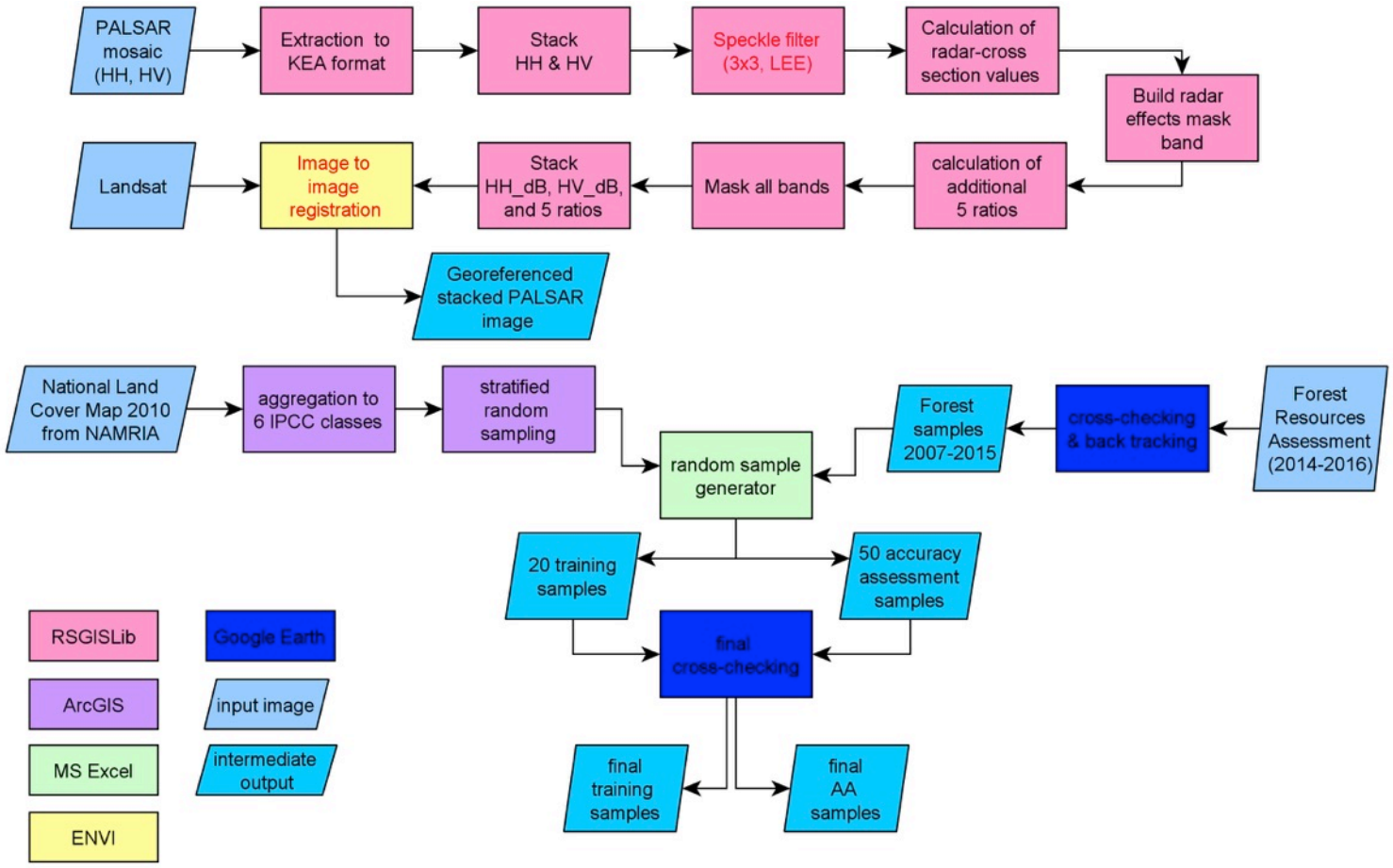


Site	Tile	2007	2010	2015
Eastern Samar	N12 E125	Jun11,Jun28, Jul10, Sep23	Jul06, Jul18, Sep19, Oct01	Jul04, Jul13, Oct10
Davao Oriental	N08 E126	Jun09, Jul09, Sep22	Jul13, Sep14, Sep28	Jul4, Jul13, Oct10
Albay	N14 E123	Jun15, Jun27, Jul15, Aug17	Jul06, Aug24, Sept07, Sept27	Jun25, Jul18, Jul23

Methods

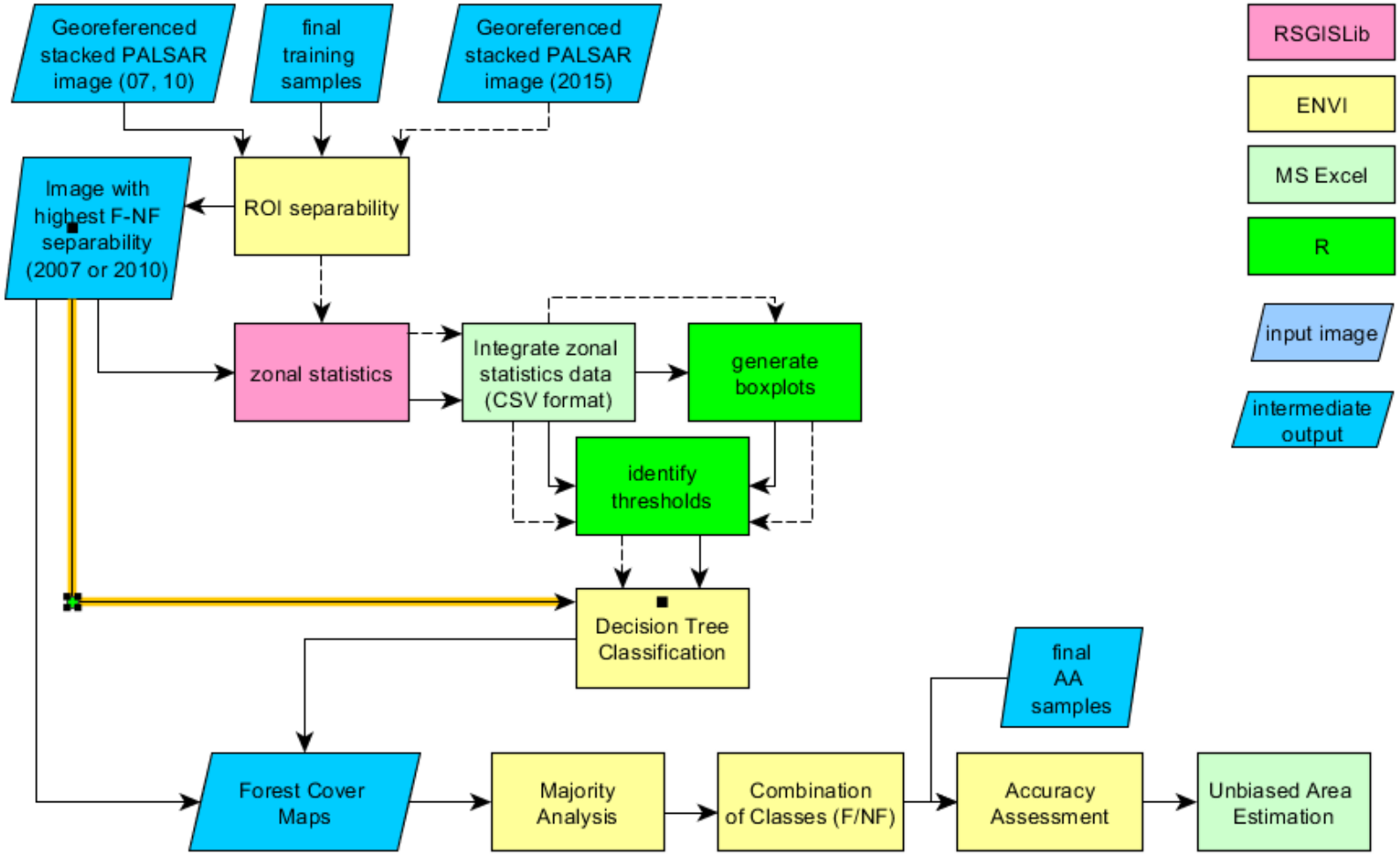
1. Automated pre-processing in RSGISLib
2. Manual image to image registration (PALSAR to Landsat)
3. Sampling scheme and sample selection
4. Zonal statistics analysis
5. ROI separability, boxplots, thresholding
6. Decision Tree Classification and Post-Classification
7. Accuracy Assessment
8. Unbiased Area Estimation

Pre-Processing (automated in RSGISLib)
Sampling (based on Reiche et. al., 2013)



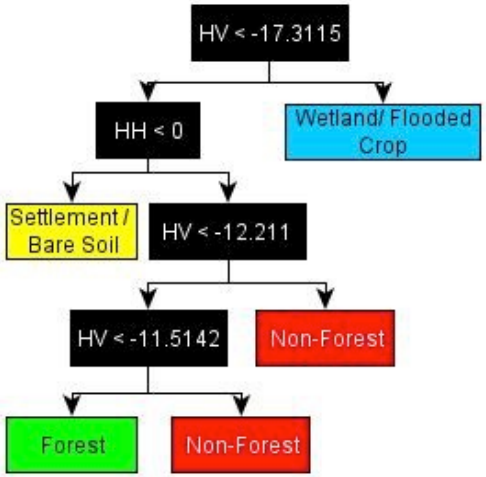
*NAMRIA - National Mapping and Resource Information Authority

Zonal Statistics, Thresholding, Classification, Post Classification, Accuracy Assessment

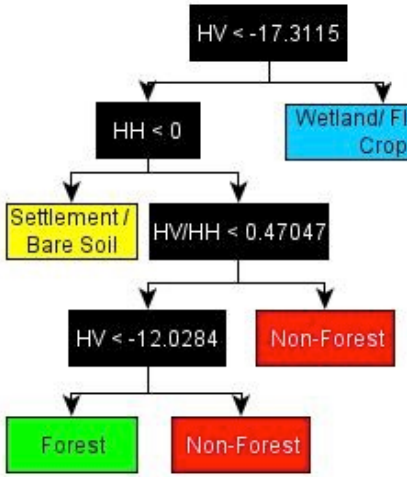


Decision Tree Classifiers
(Davao Oriental & Eastern Samar)

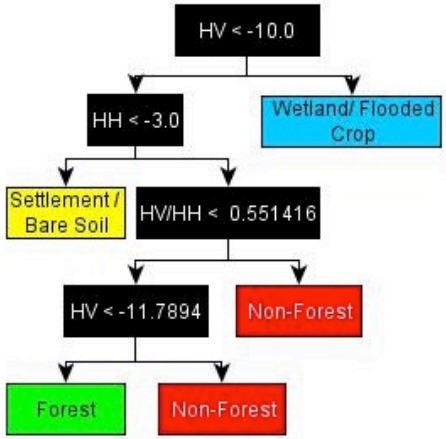
Davao Oriental (2007 & 2010)



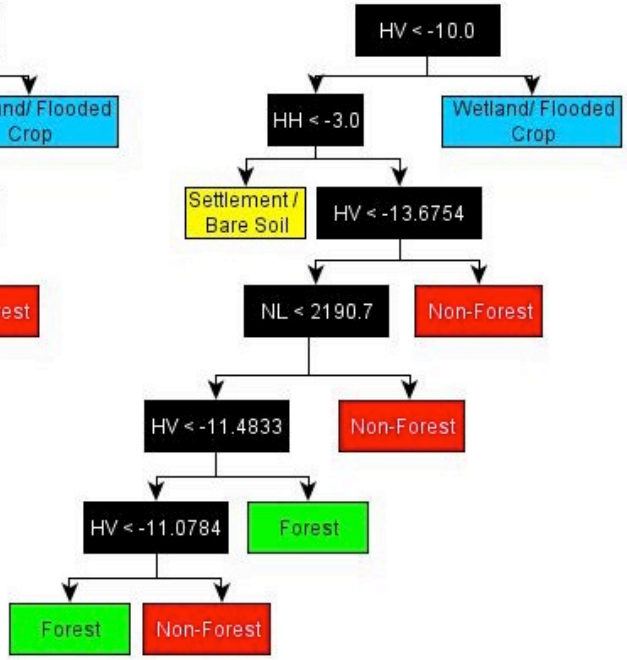
Davao Oriental (2015)



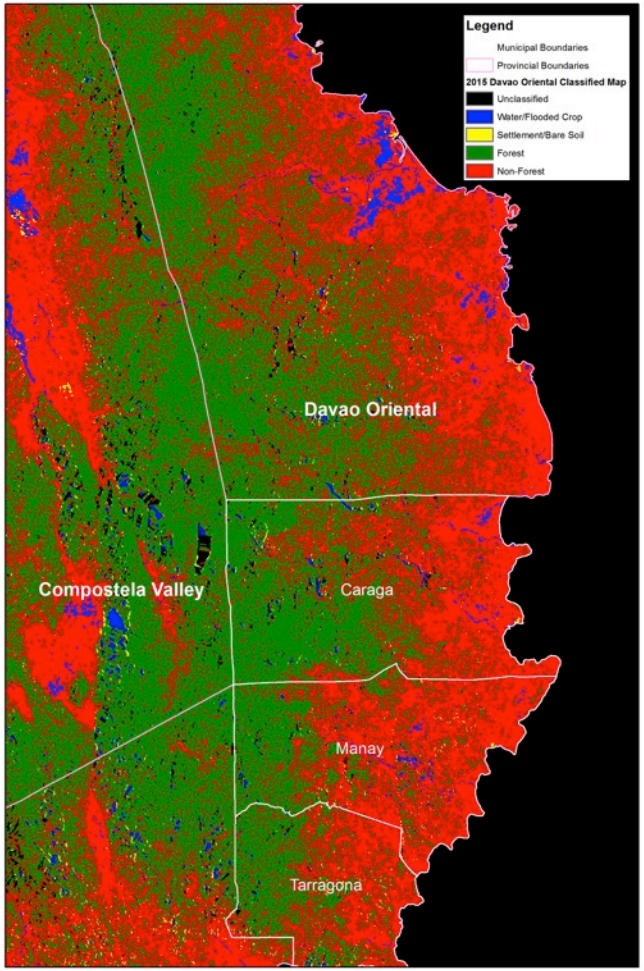
Eastern Samar (2007 & 2010)



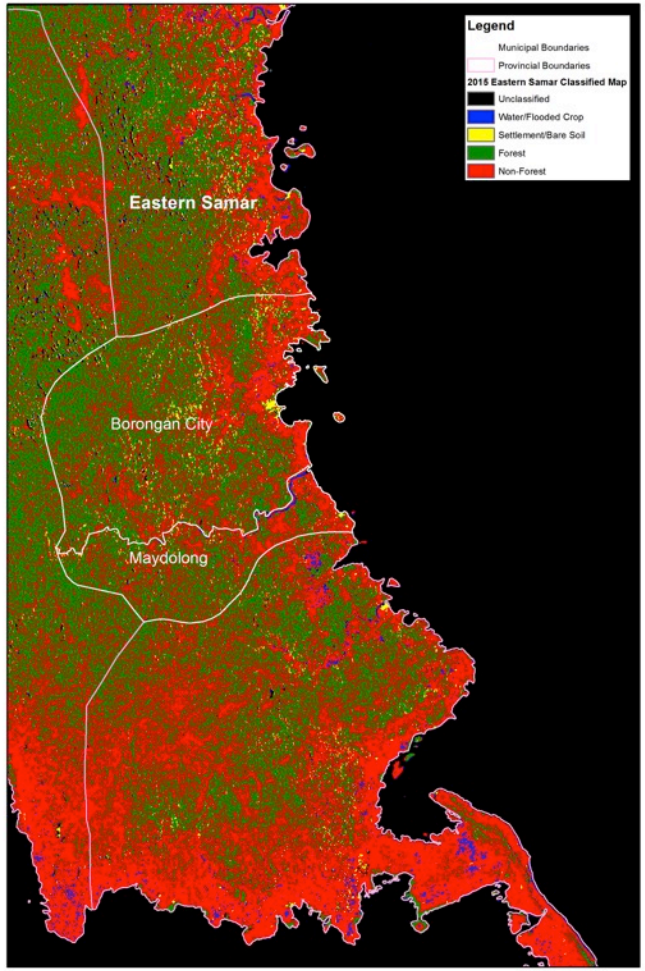
Eastern Samar (2015)



Davao Oriental 2015 Classified Map (PALSAR)



Eastern Samar 2015 Classified Map (PALSAR)



Accuracy Assessment Results

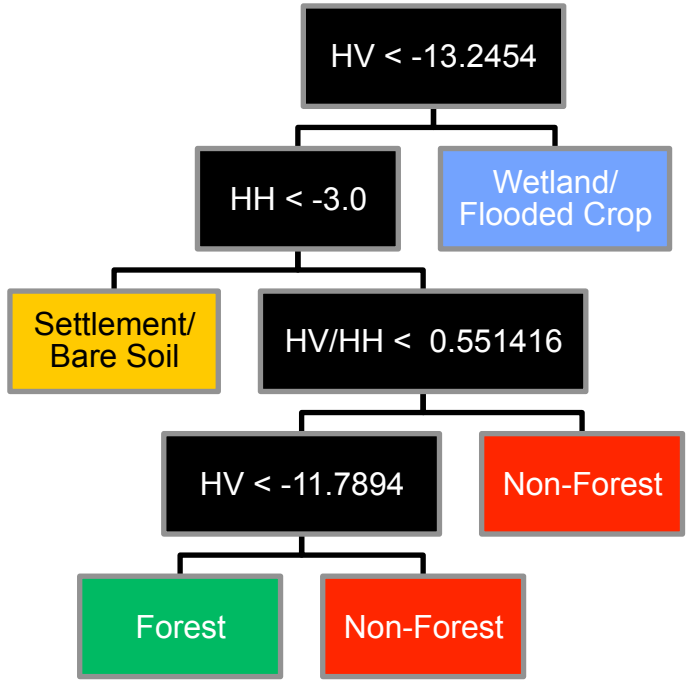
Eastern Samar		Adjusted (UAE)			original		
		PA	UA	OA	PA	UA	OA
2007	F	75.63%	75.63%	86.22%	46.67%	94.59%	82.86%
	NF	96.01%	81.00%		98.55%	81.00%	
2010	**F**	**85.83%**	**92.45%**	**89.36%**	**65.33%**	**92.45%**	**87.90%**
	NF	**92.93%**	**86.67%**		**97.69%**	**86.67%**	
2015	F	82.74%	71.32%	77.47%	61.33%	71.32%	80.24%
	NF	73.23%	84.07%		88.44%	84.07%	

Davao Oriental		Adjusted (UAE)			original		
		PA	UA	OA	PA	UA	OA
2007	F	77.75%	94.07%	88.34%	67.68%	94.07%	87.21%
	NF	96.31%	85.20%		97.44%	85.20%	
2010	F	82.06%	89.05%	88.91%	76.73%	89.05%	88.89%
	NF	93.39%	88.82%		95.15%	88.82%	
2015	**F**	**88.68%**	**94.00%**	**92.07%**	**81.98%**	**97.06%**	**91.63%**
	NF	**95.04%**	**90.55%**		**94.00%**	**90.55%**	

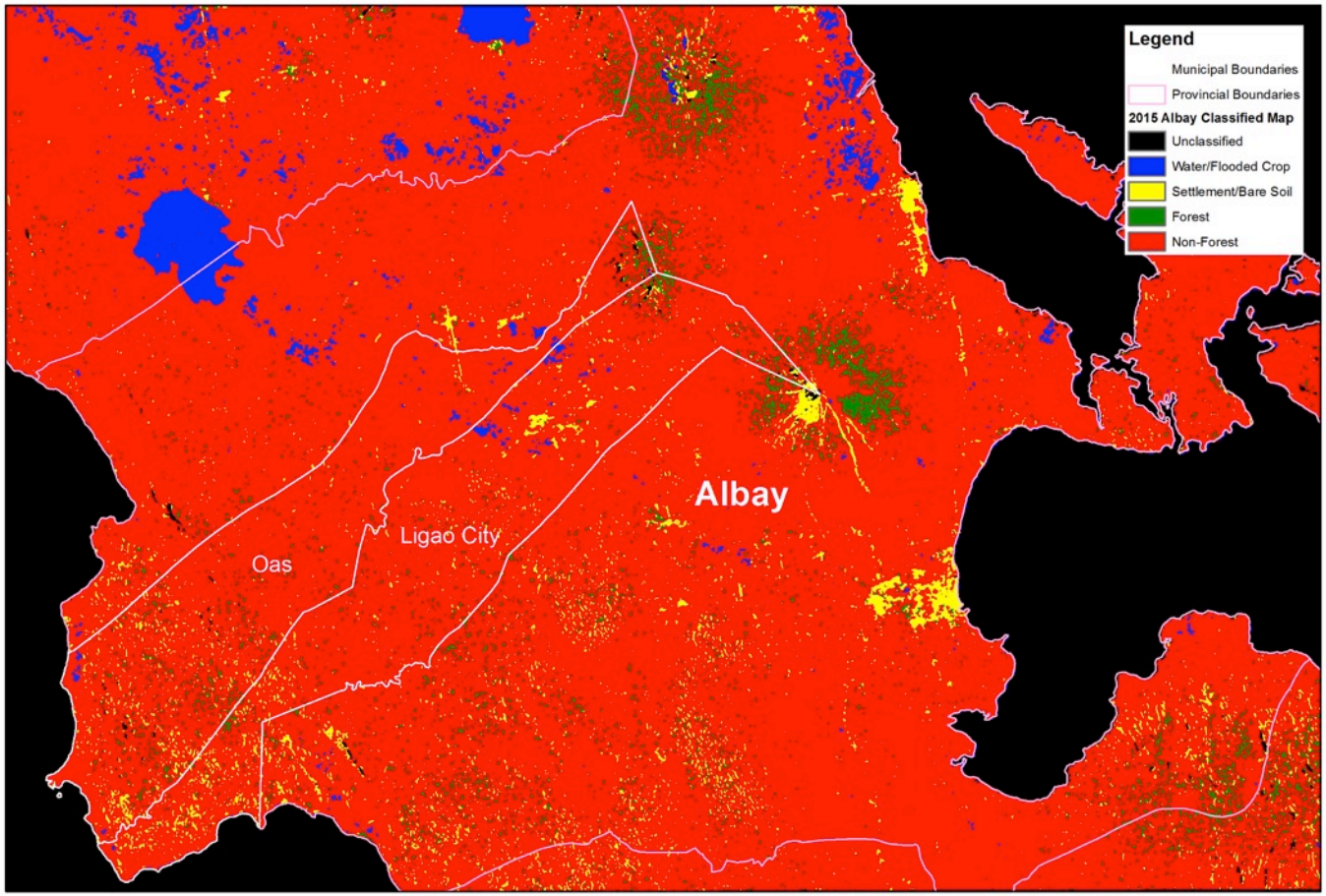
Albay		adjusted			original		
		PA	UA	OA	PA	UA	OA
2007	**F**	**75.63%**	**75.63%**	**90.28%**	**46.67%**	**94.59%**	**88.25%**
	NF	**96.01%**	**81.00%**		**98.55%**	**81.00%**	
2010	F	85.83%	92.45%	88.90%	65.33%	92.45%	87.44%
	NF	92.93%	86.67%		97.69%	86.67%	
2015	F	82.74%	71.32%	84.87%	61.33%	71.32%	83.52%
	NF	73.23%	84.07%		88.44%	84.07%	

Albay Decision Tree Classifier

- Severe under-classification of forest in Albay for all PALSAR images
- Only threshold for wetland/flooded crop gave reasonable classification result.
- Thresholds used for the Decision Tree Classifier for Eastern Samar and Davao Oriental were tested on the Albay PALSAR images.
  - Thresholds for Davao Oriental classified plenty of coconut palm areas as forest.
  - Thresholds of Eastern Samar seemed to give reasonable results.



Albay 2015 Classified Map (PALSAR)



*2007 image have regular lines that look like sensor error

Challenges (Forest Cover Maps)

- Thresholds differed in all three sites.
- The thresholds used to classify the ALOS 1 mosaics were not applicable for ALOS 2 mosaics. Results for ALOS 2 mosaics had severe under estimation of forests in all three sites Also observed this in 2015 FNF maps from JAXA. (Patricia will illustrate later)
- In Albay, thresholds generated from samples did not generate realistic results.

Challenges (Forest Cover Maps)

- Accuracy Assessment results were quite good and were either made better or lowered (~70-90%) using the Unbiased Area Estimation method by Olofsson (2014) but the generated forest area values greatly differed with the 2010 national land cover maps of the Philippines as well as the estimates from Hansen's maps.

- Results were also checked against Google Earth, in some areas:
  - forest areas are classified as non-forest
  - non-forest areas are classified as forest

Challenges (Forest Cover Maps)

in ha	Data	2003	2007	2010	2012	2014	2015
Albay	Hansen	4,850		4,677	4,669	4,665	
	NAMRIA/GE			6,900			6,400
	PALSAR (UAE)		11,946	10,063			11,729
	95% CI		1,644	1,367			1,680
Davao Oriental	Hansen	33,216		32,446	32,294	32,038	
	NAMRIA/GE			38,500			36,400
	PALSAR (UAE)		54,021	49,795			58,928
	95% CI		3,550	3,631			3,082
Eastern Samar	Hansen	54,106		52,256	52,037	51,914	
	NAMRIA/GE			42,000			41,800
	PALSAR (UAE)		38,242	39,980			35,470
	95% CI		2,429	2,362			3,534

Forest Cover Change Maps

Based on Reiche's (2013) technique.

1. Computation of Difference Change Index of HV band of two PALSAR image dates (2007 vs 2010, 2010 vs 2015).
2. Application of Reiche's technique: classify all HV DCI values below 2.2 dB as Stable Forest, otherwise, it is considered deforestation.
3. Masking out of non-forest areas so that only deforestation within forest areas are identified.
4. 50 validation samples for stable forests taken from FRA (~2015) and back tracked to 2007 using Google Earth.
5. 50 validation samples for deforestation taken from Landsat and Google Earth.

Forest Cover Change Maps

- Looked like it gave reasonably realistic results but...

Accuracy assessment results:

- Davao Oriental: only 15 samples out of 50 samples of deforestation were correctly classified
- Eastern Samar: only 7 were classified correctly.

Possible reasons:

- The deforestation sample that were selected were incorrectly located in Google Earth.
- Actual field samples may be needed to get accurate mapping of deforestation.

Forest Cover Change Maps

- Replicate forest cover map method

1. Computation of Difference Change Index of all available band of two PALSAR image dates (2007 vs 2010, 2010 vs 2015).
2. 20 training samples for stable forests taken from FRA (~2015) and back tracked to 2007 using Google Earth.
3. 20 training samples for deforestation taken from Landsat and Google Earth.
    - Samples were used to identify thresholds specific to sites
    - Separability analyses between Stable Forests and Deforestation were usually good (~1.8-1.9)
    - But, boxplots showed plenty of overlap
    - Some results looked reasonable but accuracy assessment results are not good (<50%!!!!)
    - Compared to Hansen maps, too much deforestation.

Progress and intermediate results (FFI)

TA1: *JD De Alban[1], AK Monzon[1], M Parinas[1], SR Reyes[1], RK Veridiano[1], R Tumaneng[1]*

TA2: *AK Monzon[1], RK Veridiano[1], G Mendoza[2], RJ Vinluan[3], O Agoncillo[3], JD De Alban[1]*

TA3: *AK Monzon[1], SR Reyes[1], JD De Alban[1], M Parinas[1], RK Veridiano[1], R Tumaneng[1], P Sanchez[4], NM Rocas[4], DM Dela Torre[1]*

[1] Fauna & Flora International (FFI)
[2] Biodiversity & Watersheds Improved for Stronger Economy and Ecosystem Resilience Programme (B+WISER)
[3] United States Agency for International Development (USAID)
[4] Forest Management Bureau, Department of Environment and Natural Resources (FMB-DENR)

Science Team meeting #22
Tokyo, Japan, February 16-18, 2016

Progress and intermediate results (Summary)

- Field data collection in all sites completed
- Used eCognition rulesets for mangrove classification using SAR and Landsat data
- Final forest/non-forest change and mangrove cover change maps and statistics produced for all sites
- Documentation of methods and results have been drafted

Project Milestones (same as reported in Feb 2016)

Main Activities	2014		2015		2016		2017	
	S1	S2	S1	S2	S1	S2	S1	S2
1. Image processing								
2. Field data collection and assessments								
3. Image post-processing, modeling, and analysis								
4. Report writing								

Legend: Land cover mapping; REDD+ and forest management; Forest and climate protection; Mangrove mapping and change detection

Data sharing

Thematic Area	Description	Status
TA 1	• FFI: land cover and habitat ground-truth data collected from 2014-2015 in seven sites; GPS coordinates, photos	Collection completed

TA 2	• GIZ: FRA in 2015
	  • Eastern Samar (120)
	  • Panay Island (104)
	  • Davao Oriental (150)
		Collection completed

	• FFI/B+WISER: forest inventory data collected in 2015 from one site; 62 plots	Collection completed
TA 3	• FFI: mangrove ground-truth data collected from 2014-2015 in six sites; GPS coordinates, photos	Collection completed

Deliverables

Thematic Area	Description	Status
TA 1	• Land cover/FNF cover and change maps, 2007-2010-2015 • Documentation report	On-going completion
TA 2	• Forest and non-forest cover and change maps (4 sites) • Forest Biomass Maps (except Albay) • Documentation report • Baseline carbon stock assessment from Forest Resources Assessments (except Albay)	On-going On-going Completed.
TA 3	• Mangrove cover and change maps 1996, 2007-2010, 2015 • Documentation report	Done
Others	• Conference papers published/presented in: 14th World Forestry Congress (4) and 36th Asian Conference on Remote Sensing (3)	Done

PALSAR/PALSAR-2 data access

All requested datasets were delivered and downloaded. ☺

→ 2017 mosaic datasets will be needed by FMB for future forest cover maps

Some datasets may still be needed from JAXA but for the work of Phil-LiDAR FRExLS (forest component) project. They plan to use PALSAR with LiDAR data for forest mapping.

May not have sufficient time to generate forest biomass maps because the GIZ REDD+ project is ending in April and the next 2 months will probably be consumed in refining and finalizing all the other deliverables for JAXA…

Acknowledgements

This work commenced within the framework of the JAXA Kyoto & Carbon Initiative. ALOS/PALSAR data have been provided by JAXA EORC.

This K&C project is also undertaken through the joint collaboration between Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Fauna and Flora International, University of the Philippines Department of Geodetic Engineering (UP-DGE) and the DENR-Forest Management Bureau (DENR-FMB). The REDD+ project was funded by BMU under its International Climate Initiative through GIZ.

Thank you!