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 #24
Tokyo, Japan, January 29-31, 2018

Project Objectives

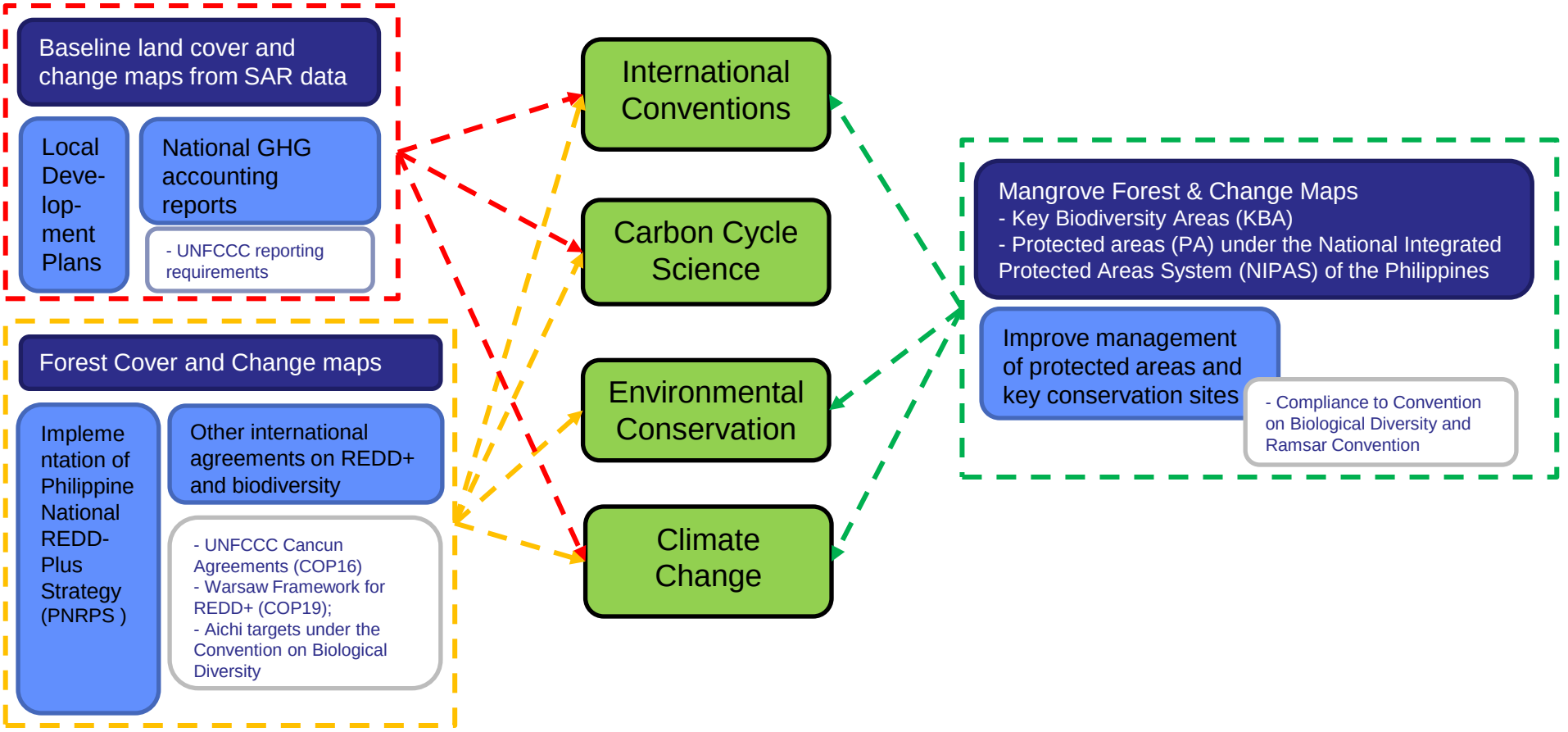
- **TA1 - Land cover mapping and change detection**: assess ability of spaceborne L-band SAR systems to support the generation of national baseline land cover and forest cover and change maps

- **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.

Contribution to K&C thematic drivers

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



Why is it significant for the Philippines?

Local

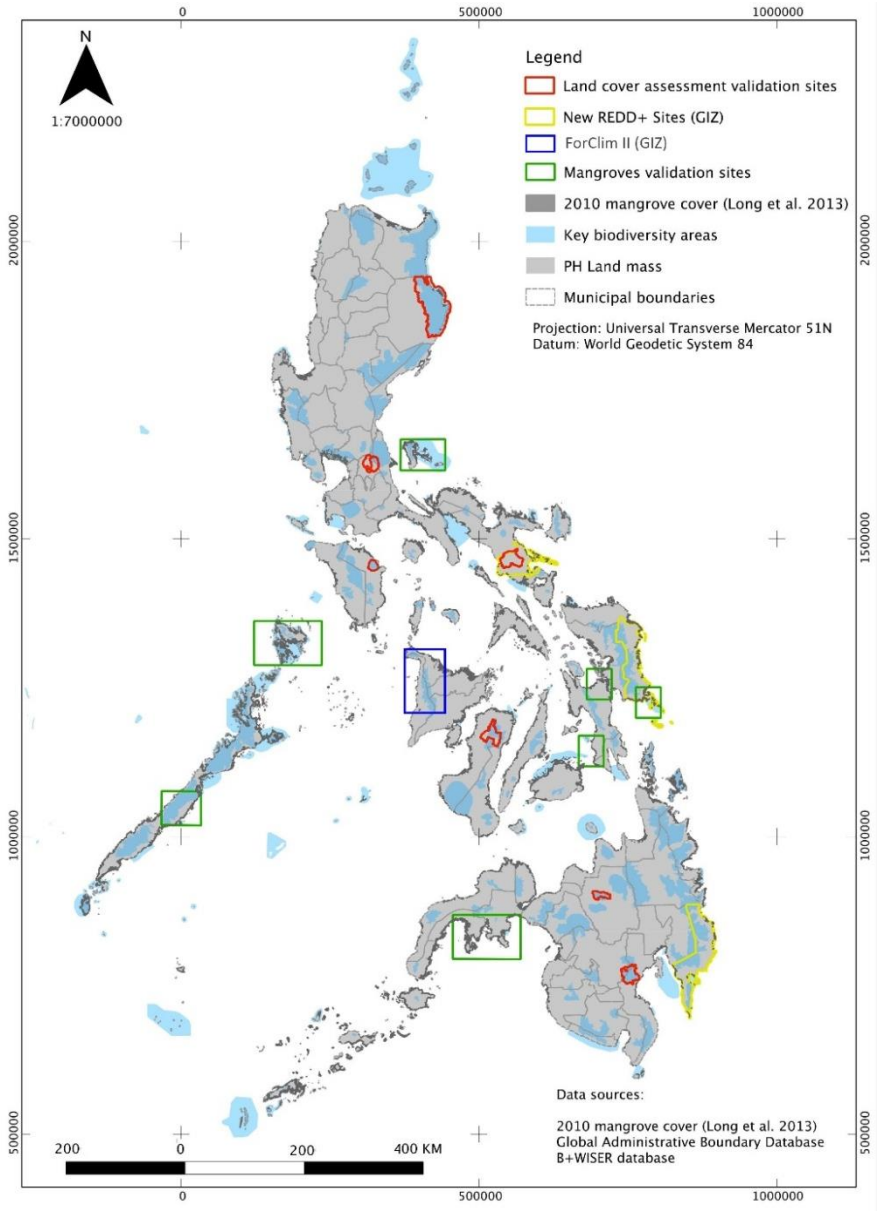
- Forest land use plans, water shed management plans, protected area plans

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)



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

Progress and results (GIZ)

TA 2: REDD+ and Forest Management
→ can be provided this KC 24

- Field data in 3 sites are available

- Forest resource assessment (FRA) database application was developed with all available GIZ FRA data (including 1 site in KC3).

- Reports on the FRA methodology and results have been finalized and are available.

Methods -- What's new?

1. Automated pre-processing (using RSGISLib)

2. Multi-temporal speckle filtering of all available mosaic data (using SNAP)

3. Decision tree classifier thresholds were automatically identified (using R)

4. Direct classification done for forest cover change mapping (use of difference change index [DCI] image).

5. Unbiased area estimation of the all maps with accuracy assessment samples.

1. Automated pre-processing

Python codes from the 2013 RSGISLib trainings were utilized and revised to automatically:

- Stack the raw HH and HV bands
- Recalculate the mask band into a binary mask (0 or 1)
- Convert the HH and HV bands into decibel values
- Calculate additional ratios and apply the binary radar mask
- Stack all available bands (HH_dB, HV_dB, ratios, binary radar mask, incidence and acquisition date bands)

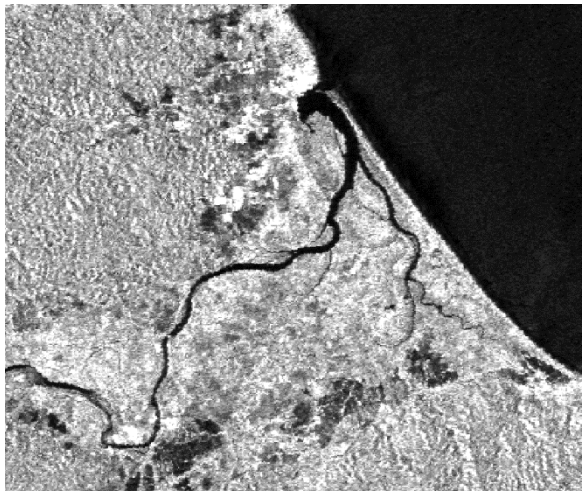
✓Just provide file name of the input file and the output file name

✓Process one tile at a time

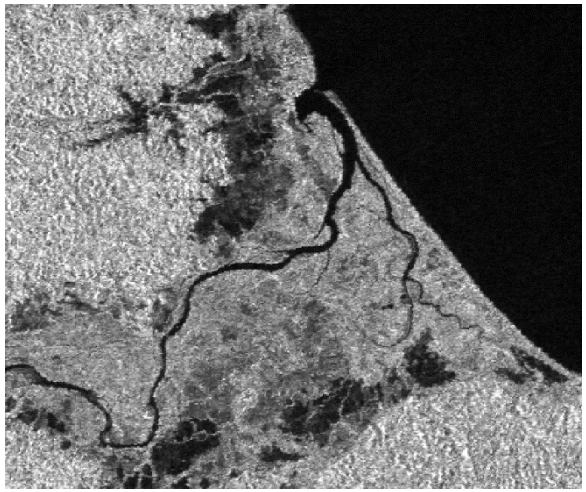
✓Process time = ~5mins (VirtualBox in core i7, 16GB RAM Desktop Computer)

2. Multi-temporal Speckle Filtering (MTSF)

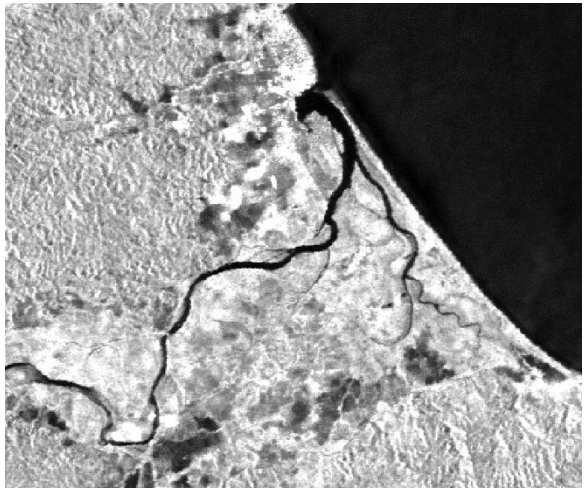
HH band before MTSF



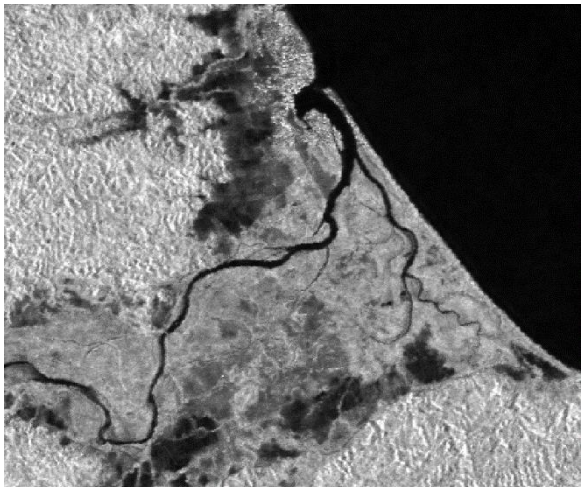
HV band before MTSF



HH band after MTSF

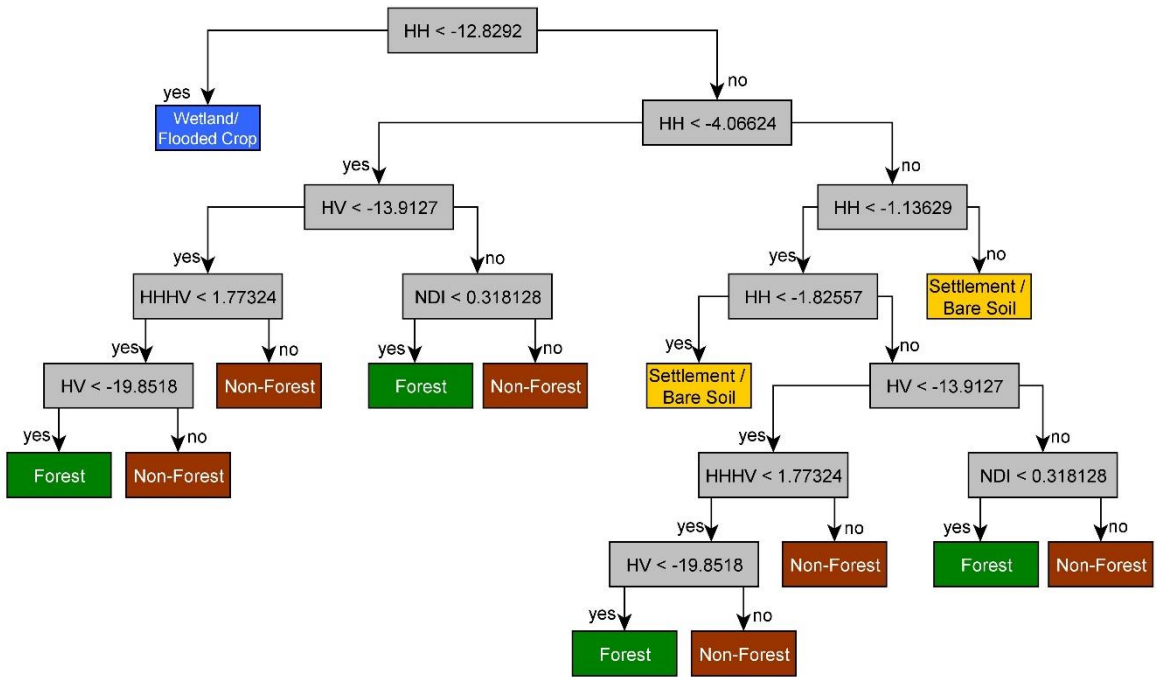


HV band after MTSF

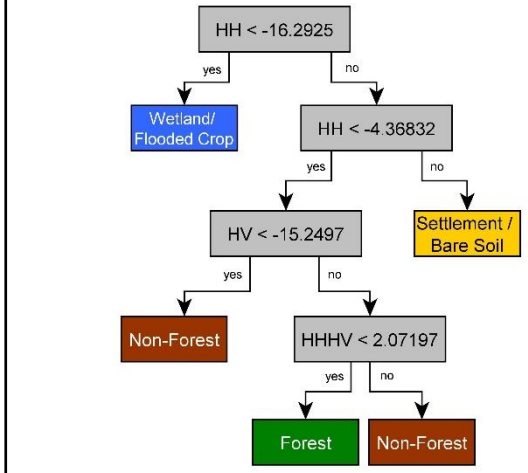


3. Decision Tree Classifiers

Forest cover (PALSAR-1)



Forest cover (PALSAR-2)



Forest Cover Results

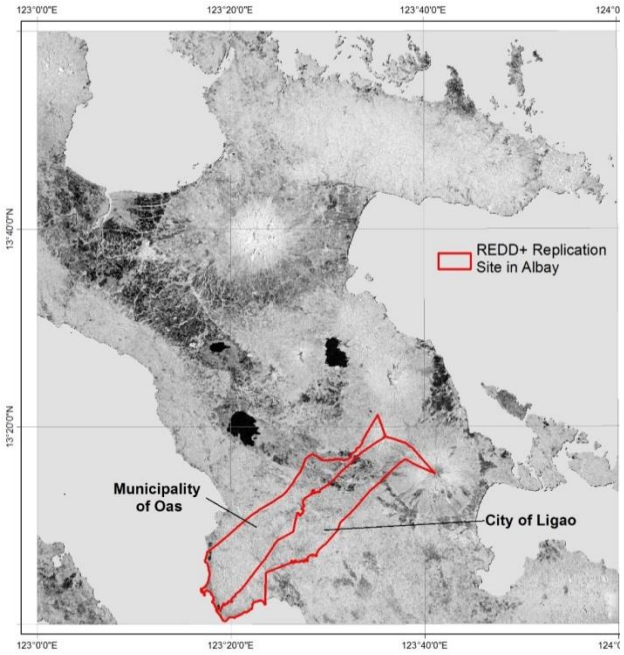
Albay and Eastern Samar:

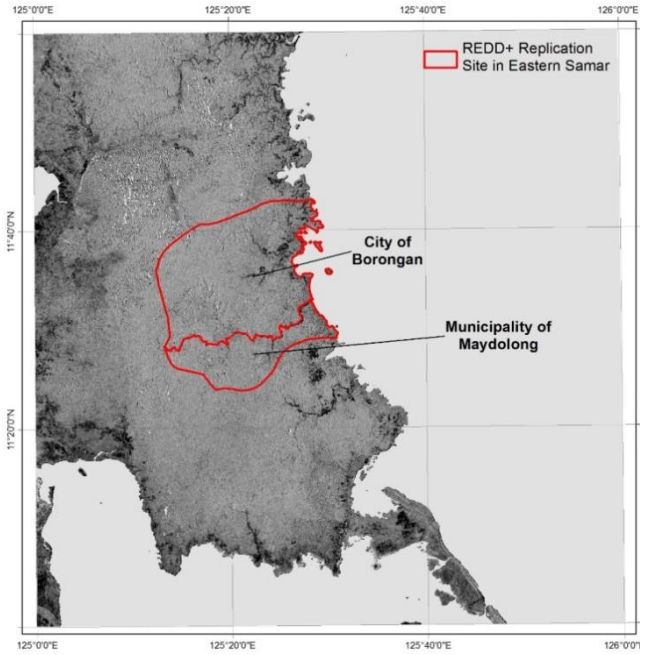
•Mapped forest cover was 10% more than the calculated unbiased area estimation of forest.

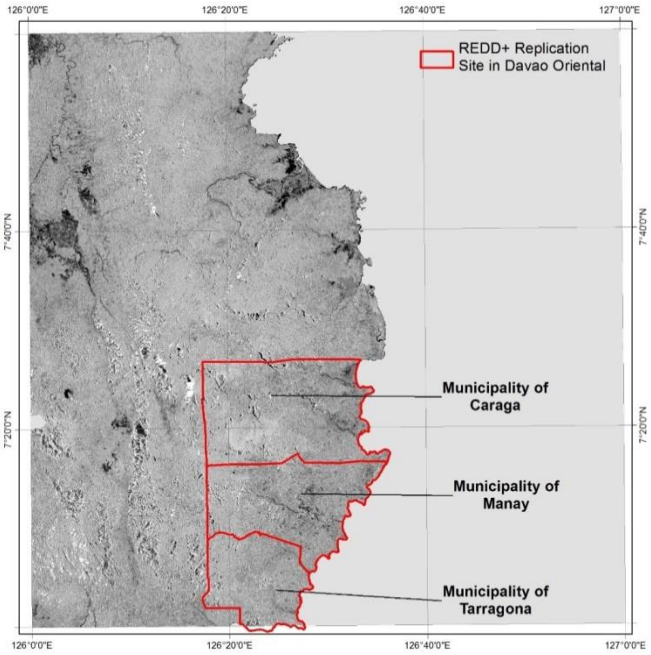
Davao Oriental:

•Mapped forest area is 5% more than unbiased area estimation of forest (still over-estimate forests)

Forest Cover in REDD+ Replication sites







Accuracy Assessment Results

Accuracies for the forest cover maps of Davao Oriental were much better than the forest cover maps of Eastern Samar and Albay.

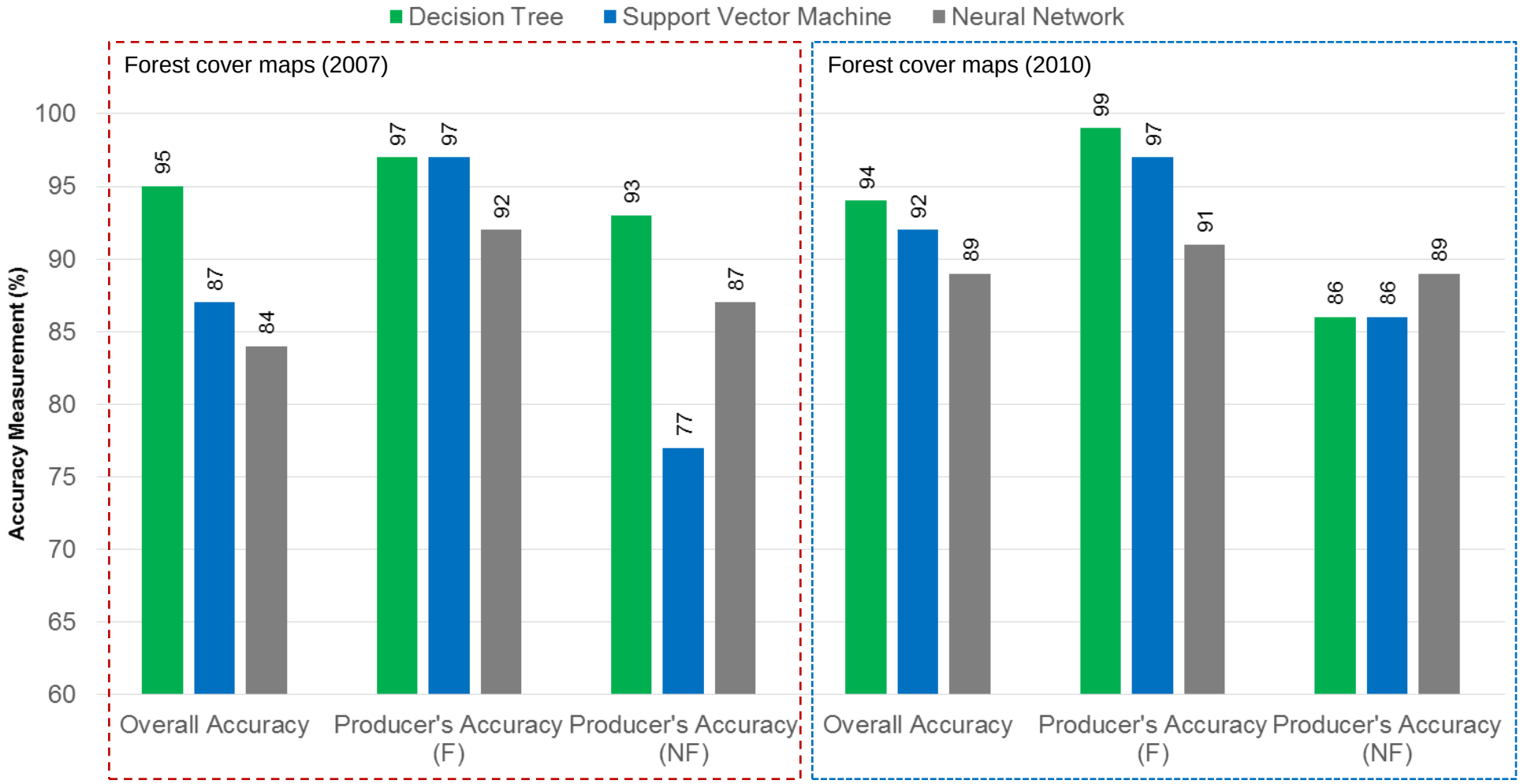
This implies that the thresholds used for the decision tree classification **worked better for the radar imageries of Davao Oriental.**

Forest Cover in REDD+ Replication sites

Site	Year	Mapped Forest Area (ha)	Unbiased Forest Area (ha) at 95% CI	Unbiased Accuracies (%)				
					Forest		Non-Forest	
				Overall	Producer's	User's	Producer's	User's
Albay	2007*	8,608	11,149 ± 12%	*87*	*71*	*79*	*92*	*89*
	2010	16,076	12,188 ± 8%	91	98	74	87	99
	2015	14,326	11,565 ± 8%	92	96	77	89	99
Eastern Samar	2007	63,696	55,271 ± 2%	88	97	86	83	96
	2010	64,898	55,149 ± 2%	87	98	84	81	98
	2015	65,869	52,522 ± 2%	83	99	79	73	99
					High	Low	Low	High
					Over mapping		Under classification	
Davao Oriental	2007	64,243	64,808 ± 1%	95	97	94	93	97
	2010	69,020	66,516 ± 1%	94	99	90	86	99
	2015	62,587	64,840 ± 2%	95	96	95	94	96

* Diagonal lines in mosaic data

Different studies in the Philippines using ALOS PALSAR data



From the works of Estomata 2014, Tumaneng et al. 2015, De Alban et al. 2015, Monzon et al. 2015

Forest Cover Change Maps

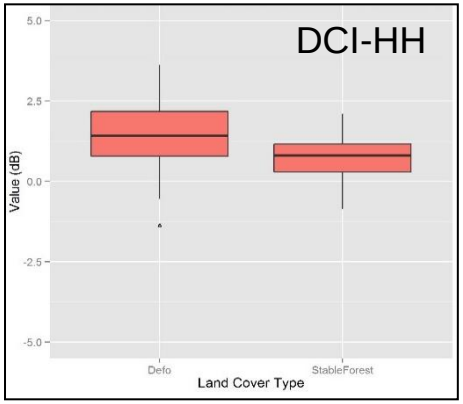
1. The Difference Change Index (DCI) between the 2010 and 2015 ALOS-1/2 PALSAR-1/2 images were calculated for the three sites.

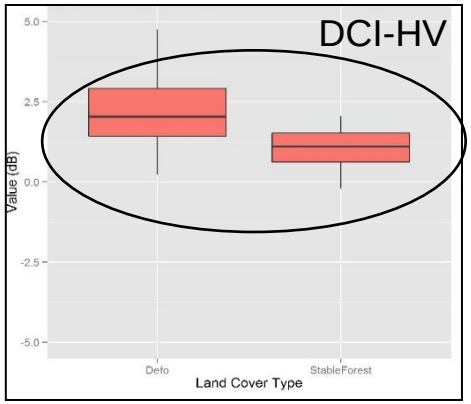
2. 2007-2010 was not analyzed due to limited Google Earth images.

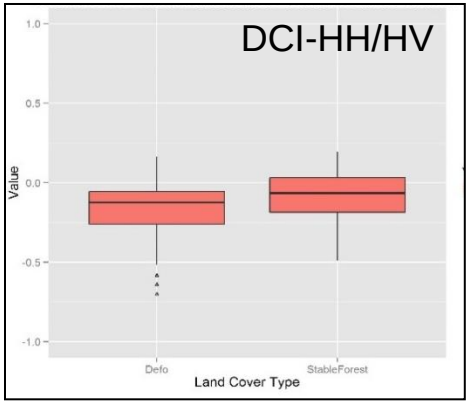
3. A direct classification using the decision tree classification was applied on the DCI of the HV band.

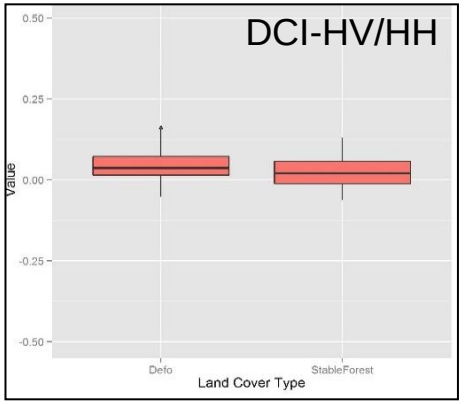
Spectral separabilities of Deforestation and Stable Forest classes

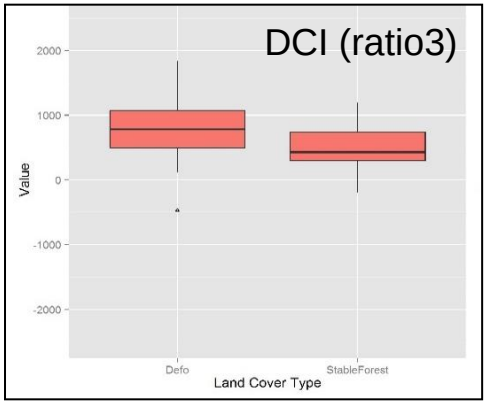
Training Samples: 61 stable forests & 50 deforestation

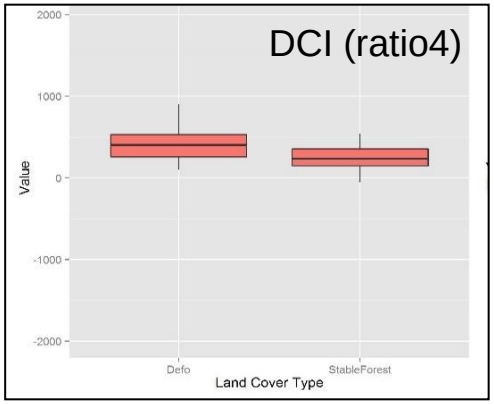


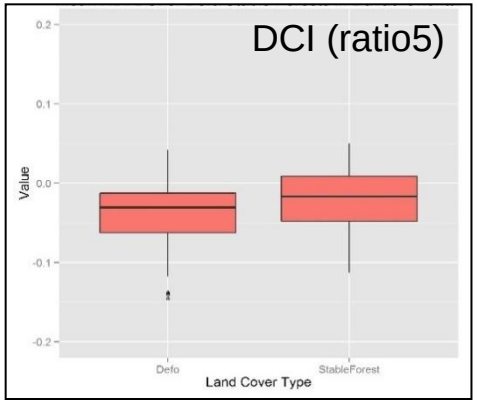






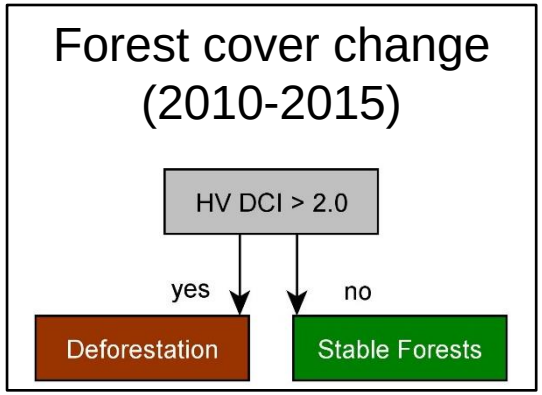






R code automatically identified threshold values to separate the two classes

Decision Tree Classifier for Forest Cover Change Mapping



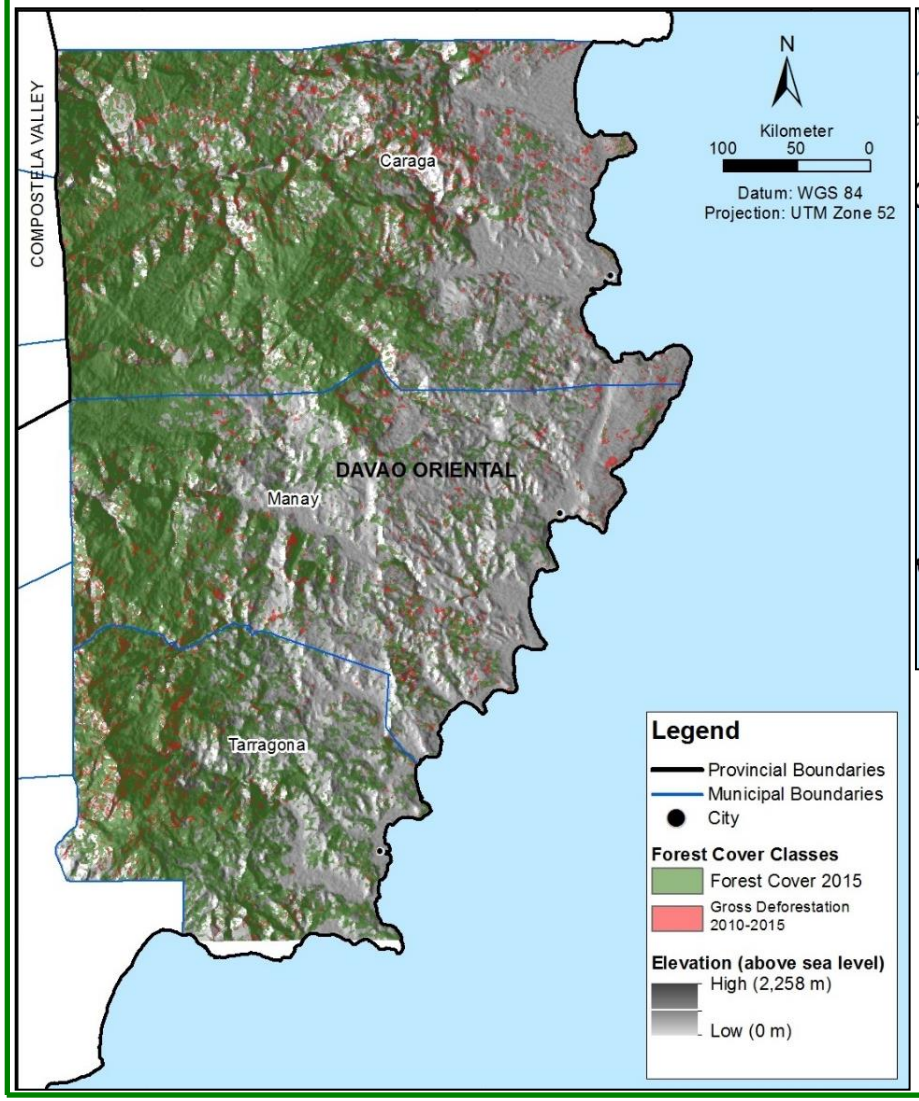
The threshold identified in the study of Reiche et al. (2015) was 2.2 dB.

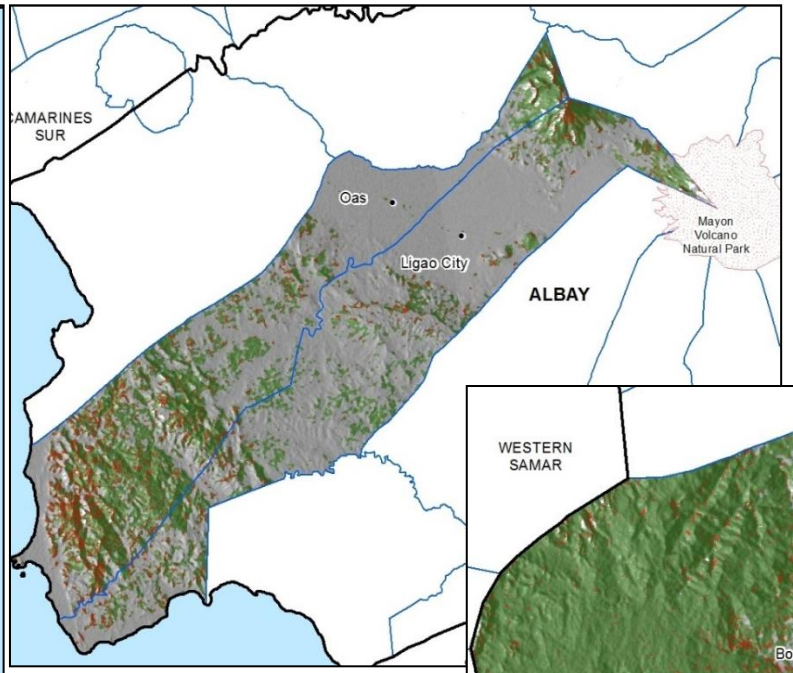
This was also tested on images but seemed to under-classify deforestation.

ALOS

K&C Initiative
An international science collaboration led by JAXA

Forest Cover Change Maps





Forest Cover Change in REDD+ Replication sites

Site	Davao Oriental	Albay	Eastern Samar
Mapped Gross Deforestation Area (ha)	7,994	3,350 [a]	5,650 [a]
Unbiased Estimation of Gross Deforestation (ha) at 95% CI	6,044 ± 12%		
Net Deforestation based on Adjusted Area Estimates ± Uncertainty (%) [b]	1,677 ± 3%	623 ± 16%	2,626 ± 5%
Unbiased Overall Accuracy	92		
Unbiased Producer's Accuracy Non-Forest Stable Forest Deforestation	 93 93 **59**		
Unbiased User's Accuracy Non-Forest Stable Forest Deforestation	 99 91 **44**		

[a] Unbiased area estimate for gross deforestation could not be estimated because accuracy assessment samples were not available.

[b] Post-classification analysis. Net deforestation/ change estimated from unbiased extent of forest cover in 2010 to forest cover in 2015. Estimates and uncertainties may vary if techniques from McRoberts (2014) and MGD version 2 (GFOI 2016) are applied.

Conclusion and Recommendations

Thresholds for Forest Cover DTC	Thresholds for Forest Cover Change DTC	Unbiased Area Estimation
• Most effective on radar images of Davao Oriental • Requires improvement for the other 2 sites	• Needs improvement • More samples of deforestation from higher resolution data with matching acquisition dates of the radar images may help	• Gives error-adjusted estimates of forest and deforestation areas with uncertainties at 95% CI • In this study, below 10% for forest areas and 12% for deforestation)

Conclusion and Recommendations

The methodology can still be streamlined and further automated, but it can already be replicated in other sites for the Philippines.

A country level analysis can also be targeted but more work would be carried out to **obtain better thresholds** for both decision trees of forest cover and forest cover change mapping **(may be done during the extension, if approved).**

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 3 sites (can be provided in KC24)
	  • Eastern Samar (120)
	  • Panay Island (86)
	  • Davao Oriental (97)
		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	Completed.
TA 2	• Forest and non-forest cover and change maps (3 sites) • Documentation report • Baseline carbon stock assessment from Forest Resources Assessments (except Albay) • Forest and non-forest cover and change maps (ForClim site) and all forest biomass maps	Completed. Completed. Completed. Cannot be delivered*
TA 3	• Mangrove cover and change maps 1996, 2007-2010, 2015 • Documentation report	Completed. Completed.
Others	• Conference papers published/presented in: 14th World Forestry Congress (4) and 36th Asian Conference on Remote Sensing (3)	Completed.

* FNF and change maps are not needed by the GIZ ForClim Project. Techniques to generate biomass maps also not priority of FMB.

Deliverables

March 2018 – all available field data for data sharing. All documentation reports. Derivative products from high resolution imageries. Python scripts (RSGISLib). R scripts. Spreadsheets for analysis.

Additional deliverables by March 2019 (if extension is approved)

- Identify **better thresholds** for the forest cover and change mapping (test in new replication sites and see if we can have a universal threshold that would work for more areas in the country)
- Replicate methodologies of TA1 and TA3 in new replication sites.
- Documentation reports on performance of methodologies on replication sites.
- Final report and other supporting documents/reports.

* Other NGO/Academe will tapped for the land cover and mangrove component

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 and can be used for the additional deliverables during extension period.

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!