K&C Phase 3 – Brief project essentials

## Climate-Relevant Modernization of the National Forest Policy and Piloting of REDD+ Measures in the Philippines

Mari Trix L. Estomata [1], Jose Don T. De Alban [2],
Angelica Kristina V. Monzon [2], Enrico C. Paringit [3]
and Francisco B. Tavora, Jr. [1]

[1] *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ PH)*
[2] *Fauna & Flora International (FFI)*
[3] *Department of Geodetic Engineering, University of the Philippines (UP-DGE)*
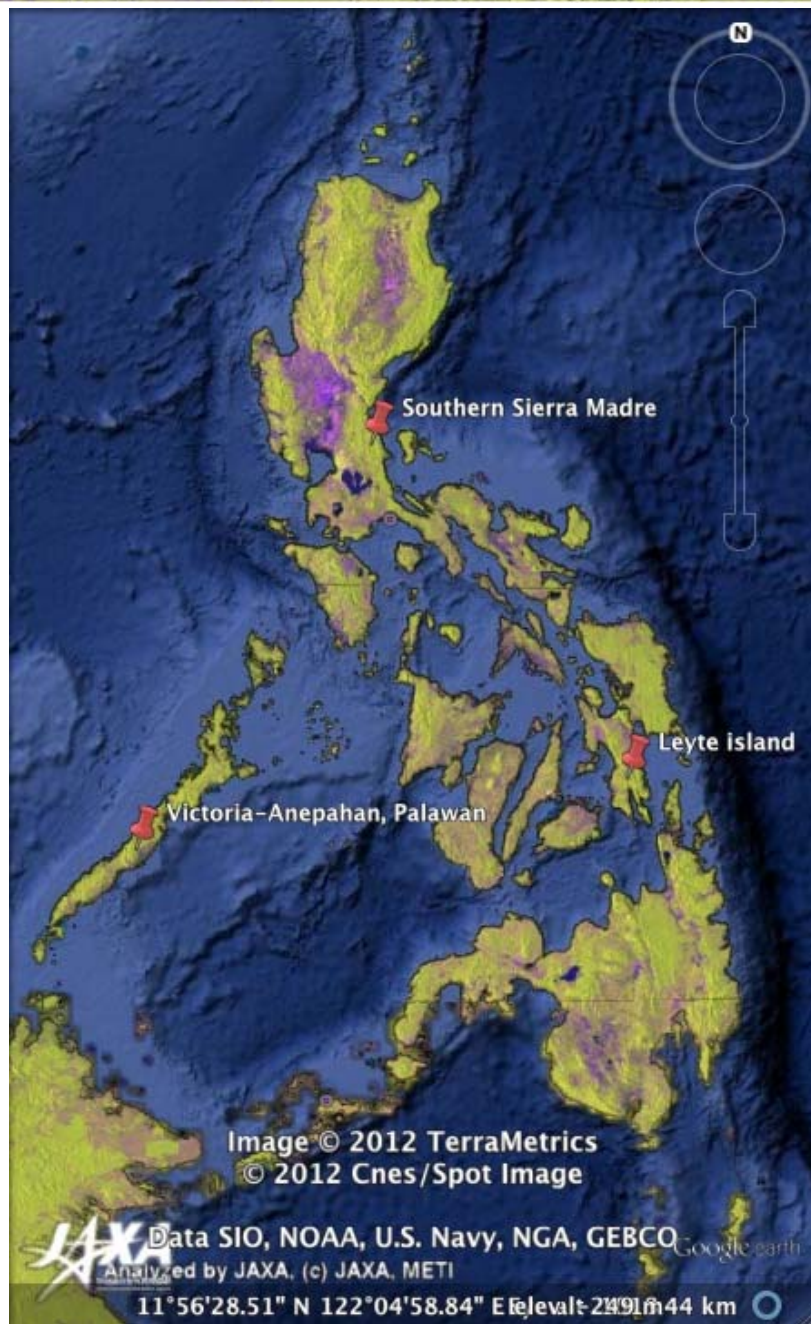
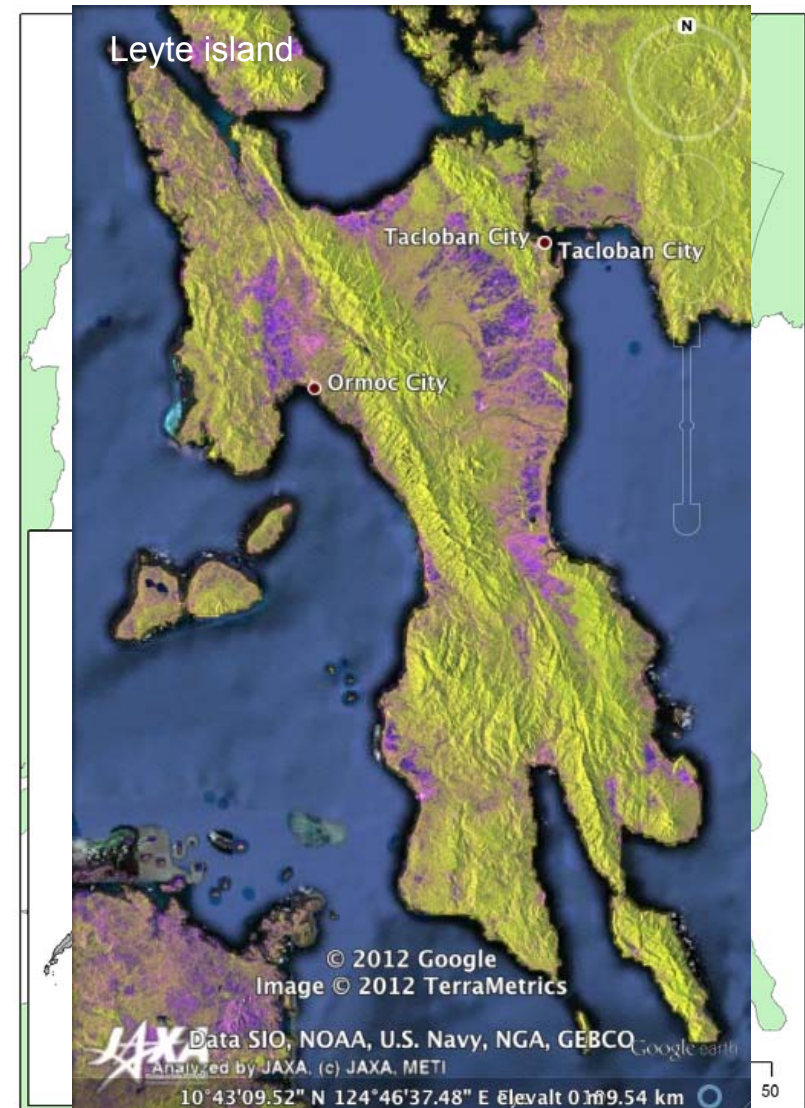# Project areas: Philippines

Sub-national REDD+ Pilot Sites

1. Southern Sierra Madre mountain range (General Nakar)
2. Leyte island
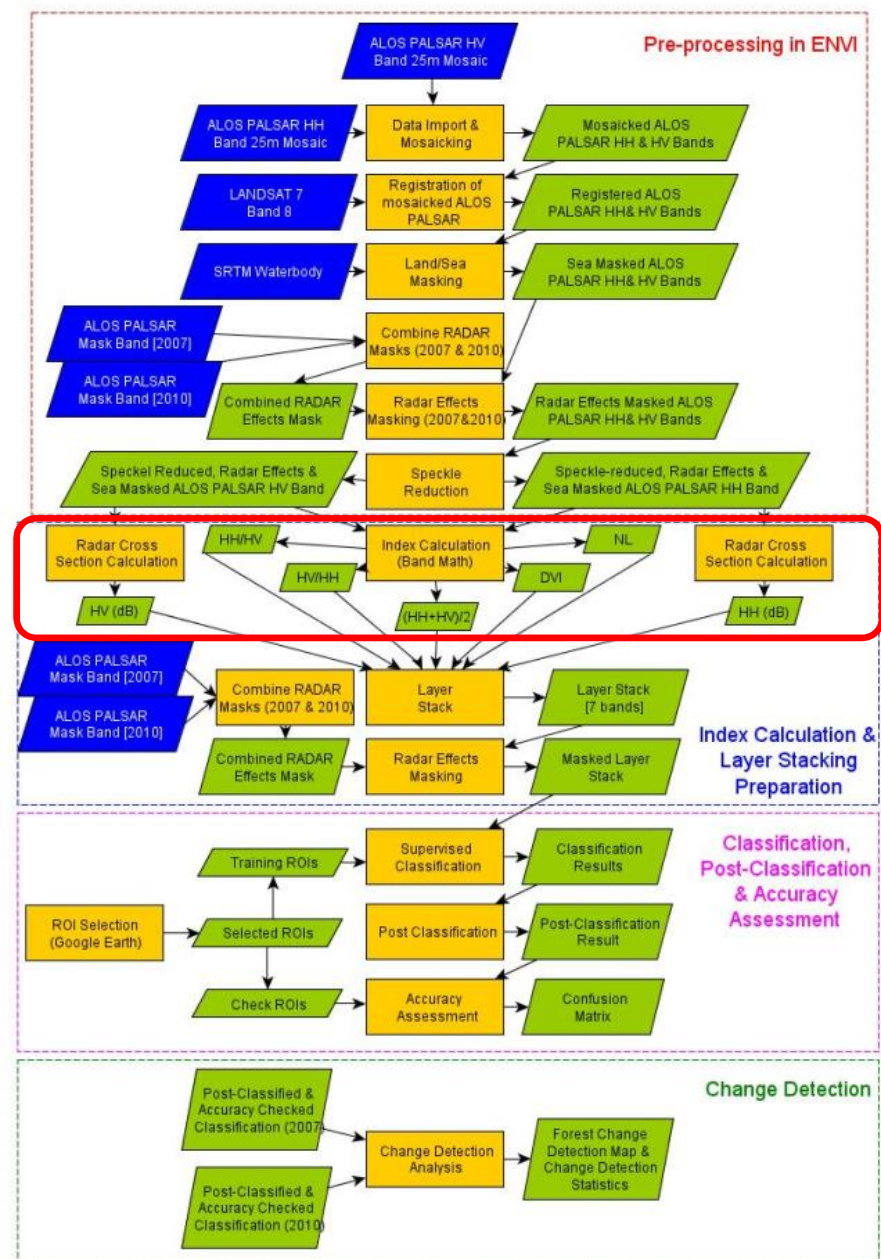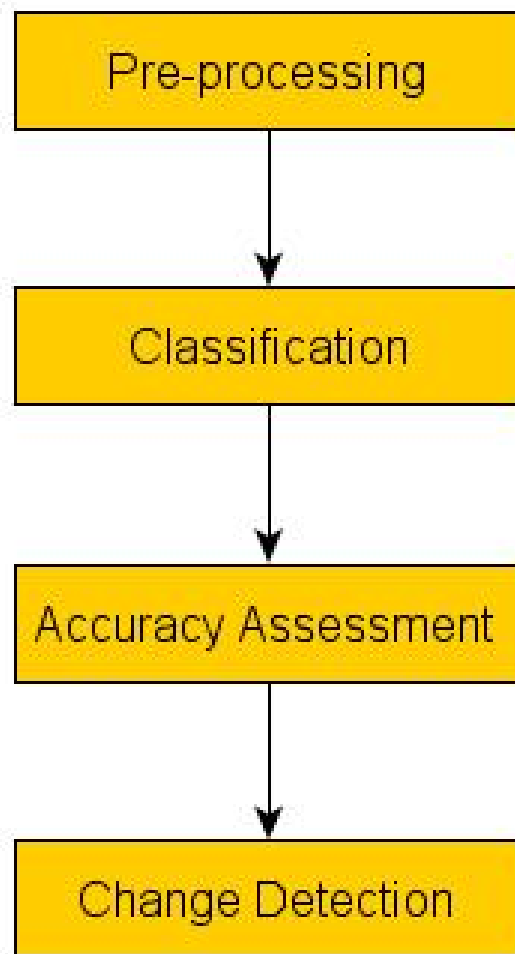3. Victoria-Anepahan mountain range, Palawan island

Leyte island

Updates

LEYTE ISLAND

Methodology: Bands & ROIs

- ❖ 7-Layer Stack:
  - ❖ Radar Cross-section Values of:
    - ❖ HH Band → HH_dB
    - ❖ HV Band → HV_dB
  - ❖ Indices:
    - ➢ $\dfrac{HH}{HV}$
    - ➢ $\dfrac{HV}{HH}$
    - ➢ $HH \cdot HV_{ave} = \dfrac{HH+HV}{2}$
   - ➢ $NL = \dfrac{HH*HV}{HH+HV}$
    - ➢ $NDI = \dfrac{[HH-HV]}{[HH+HV]}$, Normalized Difference Index

No sampling scheme was undertaken because the high-resolution images taken on year 2010 were available only on selected portions of Leyte Island.

Still, the ROIs selected were evenly spread throughout the Island, as much as the available high-resolution data could possibly allow.

- ❖ 40 samples/polygons per ROI
- ❖ At least 4 hectares for each polygon
- ❖ 20 polygons used to train the classifiers; 20 polygons used for accuracy assessment – selected using Random Generator Code (Excel)

ROI Separability
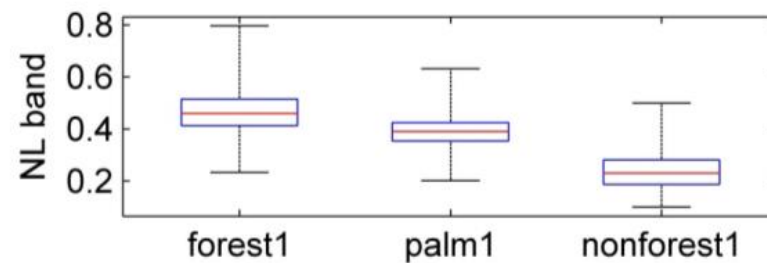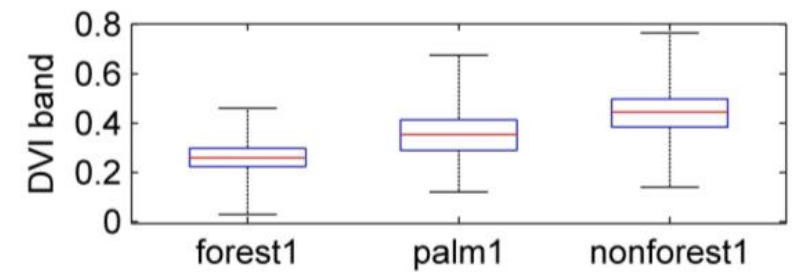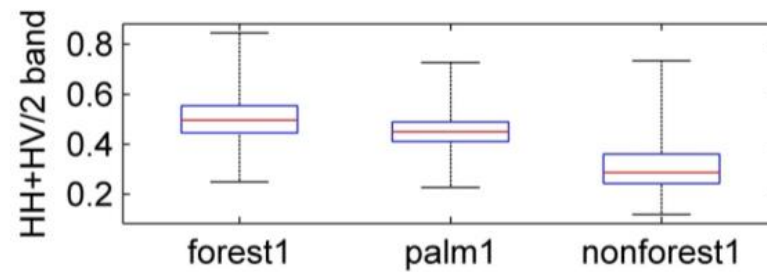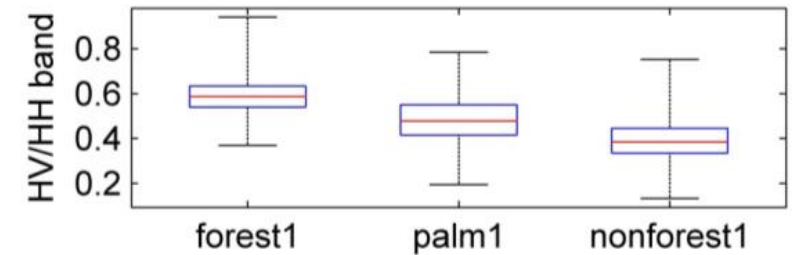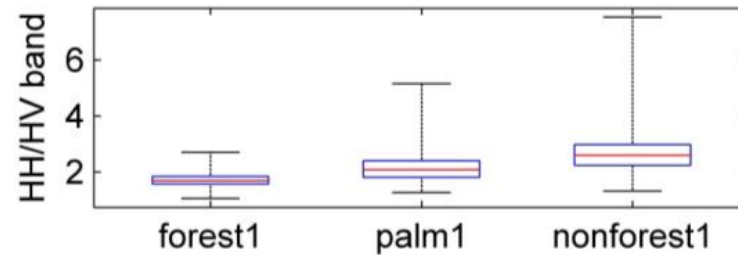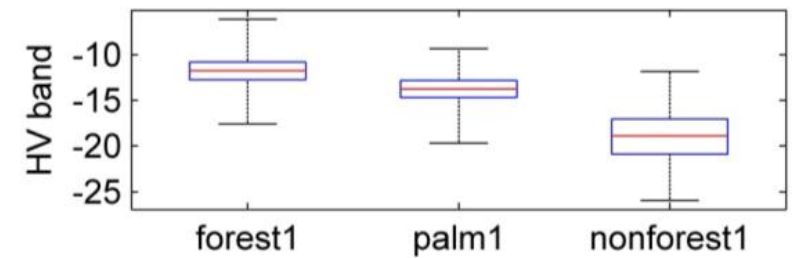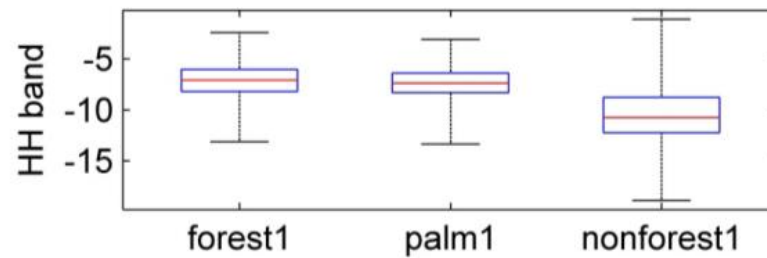
Methodology: Classification & Post-Classification

❖ Classification:

➢ Maximum Likelihood Classification (MLC)

➢ Support Vector Machine (SVM)

➢ Neural Network Classification (NNC)

❖ Post-Classification:

➢ Majority analysis (5x5 kernel)

➢ Clumping of classes (default setting)

Black – mask   Green – Forest   Red – Coconut
Yellow – Agriculture/Non-Forest

Results & Discussions: Accuracy

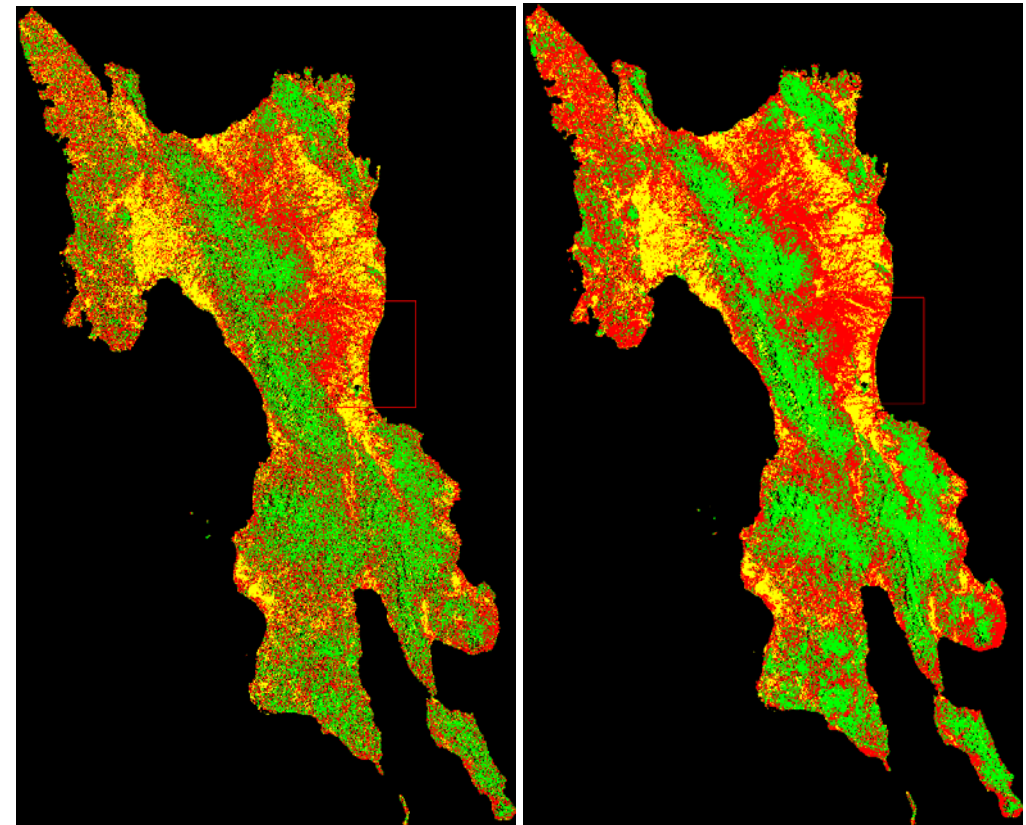| Complete error matrix for the post-classified neural network classification results for the 2010 radar image					
Class	Forest [%]	Non-Forest [%]	Palm [%]	Total [%]	User's Accuracy [%]
Unclassified	0.69	0.84	0.31	0.62	
Forest	90.98	0.00	10.71	33.96	89.60
Non-Forest	3.62	89.32	0.94	31.51	95.17
Palm	4.70	9.83	88.04	33.91	85.63
Error of Omission	9.02	10.68	11.96	Overall Accuracy	89.4533
Error of Commission	10.40	4.83	14.37	Kappa Coefficient	0.8423

All **Producer's Accuracies** and **User's Accuracies** reach at least 85% and the errors of commission and omission are at a maximum of 15%. This is the reason why the NNC was the chosen classifier for the 2007 radar image.

Complete error matrix for the post-classified neural network classification results for the 2007 radar image					
Class	Forest [%]	Non-Forest [%]	Palm [%]	Total [%]	User's Accuracy [%]
Unclassified	0.69	1.15	10.16	3.97	
Forest	91.83	0.54	9.23	33.94	90.50
NF	4.01	87.17	7.90	33.21	88.12
Palm	3.47	11.14	72.71	28.88	83.04
Error of Omission	8.17	12.83	27.29	Overall Accuracy	83.9608
Error of Commission	9.50	11.88	16.96	Kappa Coefficient	0.7640

Lowered accuracies could be due to the fact that the ROIs used to classify the 2007 radar image and ROIs used to check its results were selected during the year 2010 because high resolution images for year 2007 were very limited in Google Earth.
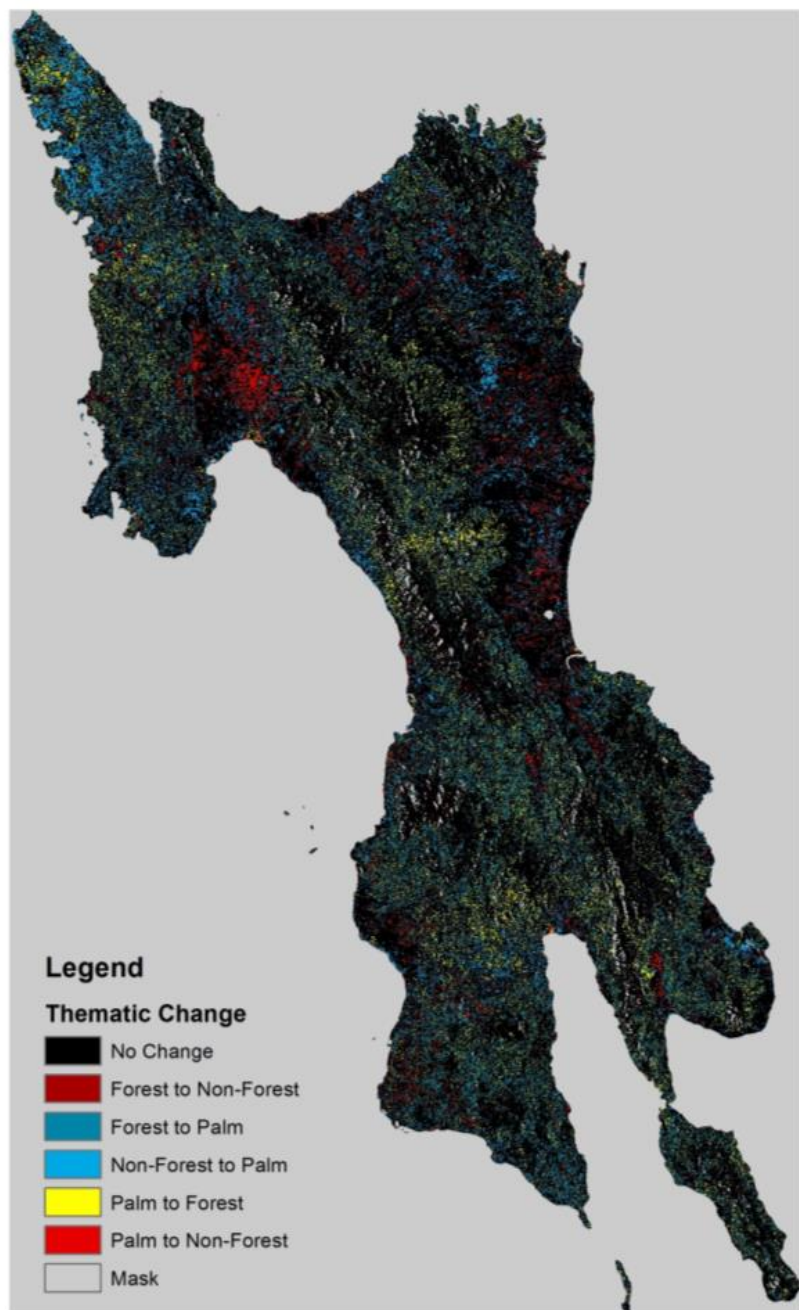
Results & Discussions: Accuracy

Thematic Change Detection Statistics		
Change	Area (ha)	Percentage
Non-Forest to Forest	2,678.19	0.38
Non-Forest to Palm	41,656.50	5.88
Forest to Non-Forest	3,251.25	0.46
Forest to Palm	59,091.38	8.34
Palm to Non-Forest	16,272.56	2.30
Palm to Forest	33,094.88	4.67

Doubtful change: 33,000 ha of palm areas changed back to forest in 3 years' time:

➢ might be due to the misclassification of palm areas in the 2007 forest cover map, as indicated by the low PA (72.71%) and high errors of commission (16.96%) and omission (27.29%).

➢ Misclassifications could be due to the fact that the ROIs used to generate the said map were of year 2010.

Thus, in order to get a better change detection analysis/result, better classification would be required for year 2007.

Legend

Thematic Change

- ■ No Change
- ■ Forest to Non-Forest
- ■ Forest to Palm
- ■ Non-Forest to Palm
- ■ Palm to Forest
- ■ Palm to Non-Forest
- □ Mask

Accuracy of Change Detection Map

To further strengthen the study, quantifying the accuracy of the change detection maps would be recommended. It would require the ff.:

➢ Valid reference data for year 2007 (Congalton & Green, 2006) such as high resolution optical images , which can easily depict palms from forest.

➢ Problem: High resolution images for 2007 are rarely available on Google Earth.

The method used in this study, is backed by the conclusion in the paper of J.-F. Mas (1999), that post-classification comparison is the most accurate way of detecting change. Also, Stow (1980) stated that the change map will generally be as accurate as the accuracies of the individual classification results.

Conclusion

❖ With an overall accuracy of 89.45% for the 2010 forest cover map (κ =0.84) and 83.96% (κ=0.76) for the 2007, it can be concluded that the classification was able to achieve a result that is fairly consistent with reality.

❖ Unfortunately, no change detection accuracy assessment was conducted but based on Stow (1980), since the accuracies of the individual classification results are quite good, it may also be concluded that the change detection map achieved from these individual classification results may also have good accuracy.

Recommendations

❖ To achieve better classification results and accuracies for the 2007 radar image, ROIs used to classify it should be of the same year and not of year 2010.

❖ It is challenging to acquire high resolution images, which are rarely available in Google Earth. However, if they are available, these can be used to further improve the classification maps and verify and quantify the accuracy of the change detection maps.
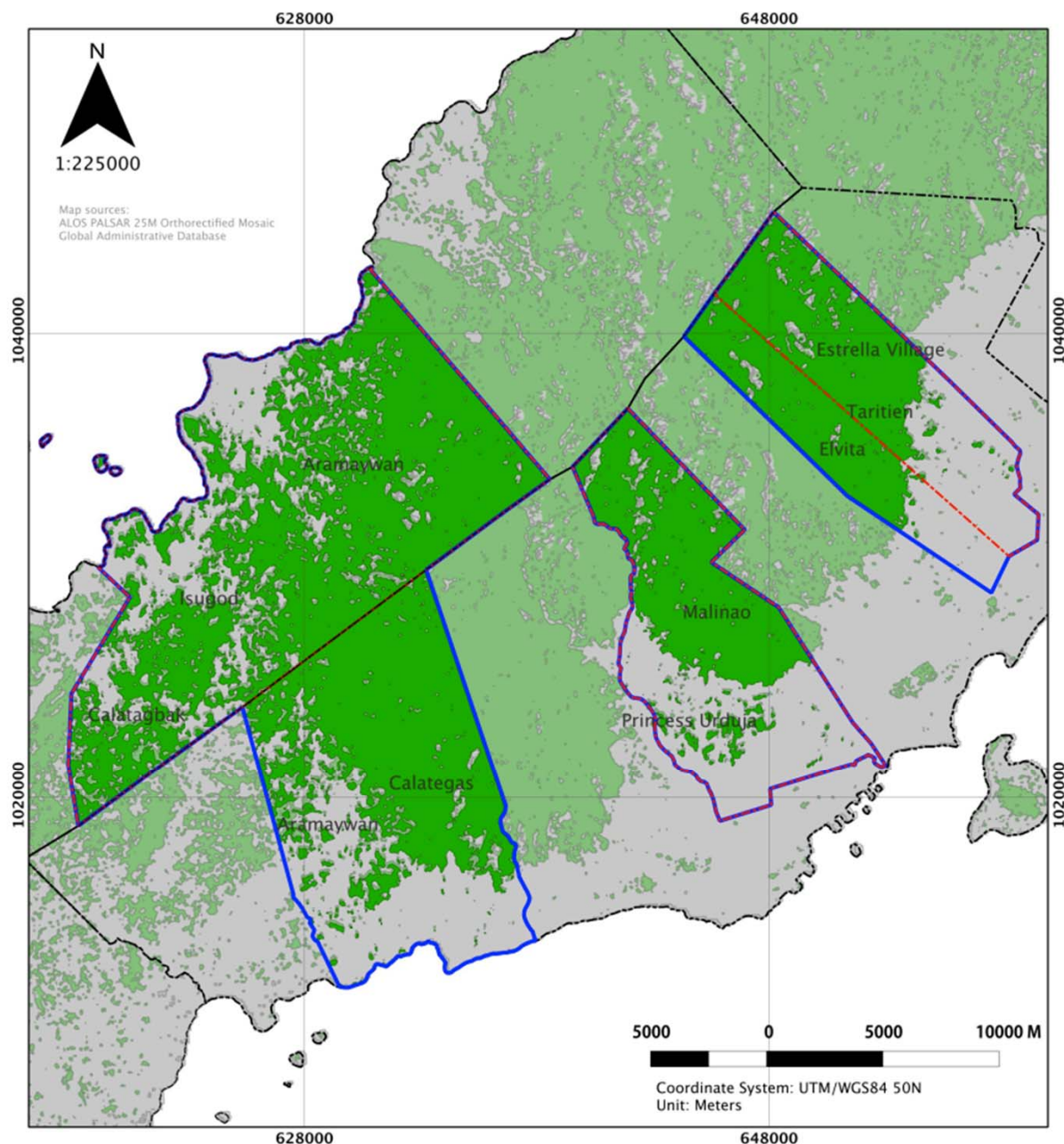
UPDATES

Victoria-Anepahan
mountains, Palawan

Palawan

- **Victoria Anepahan Mountain Range**
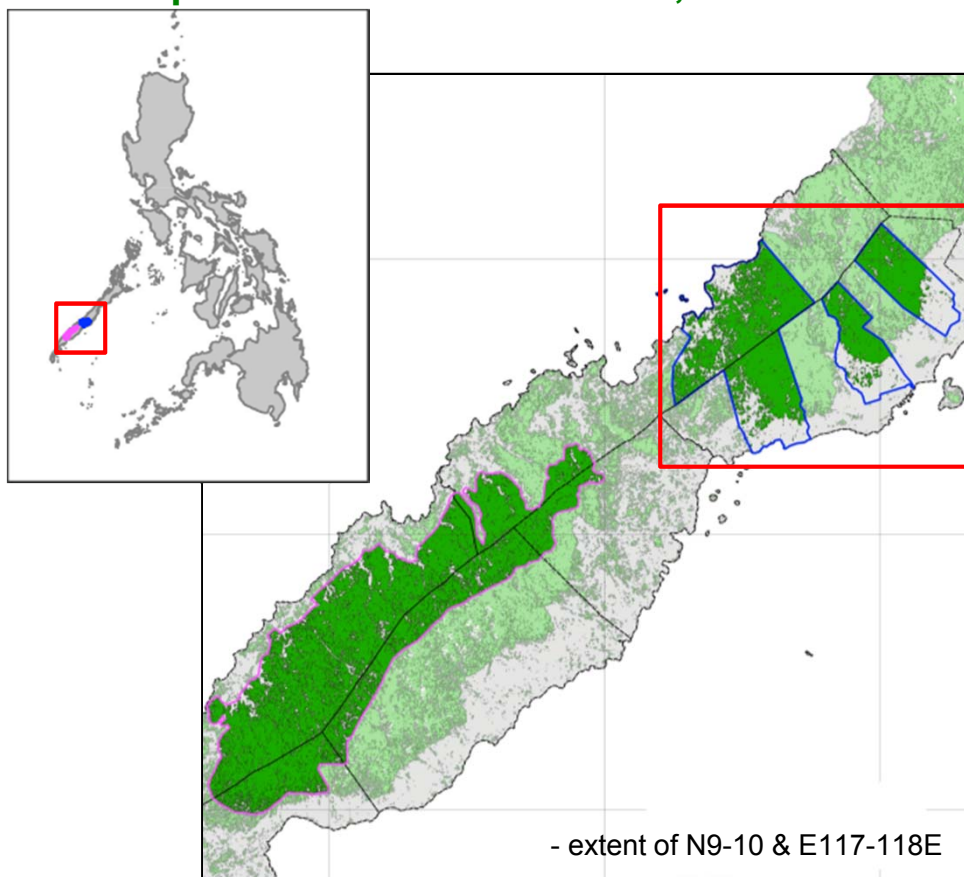
Methodology
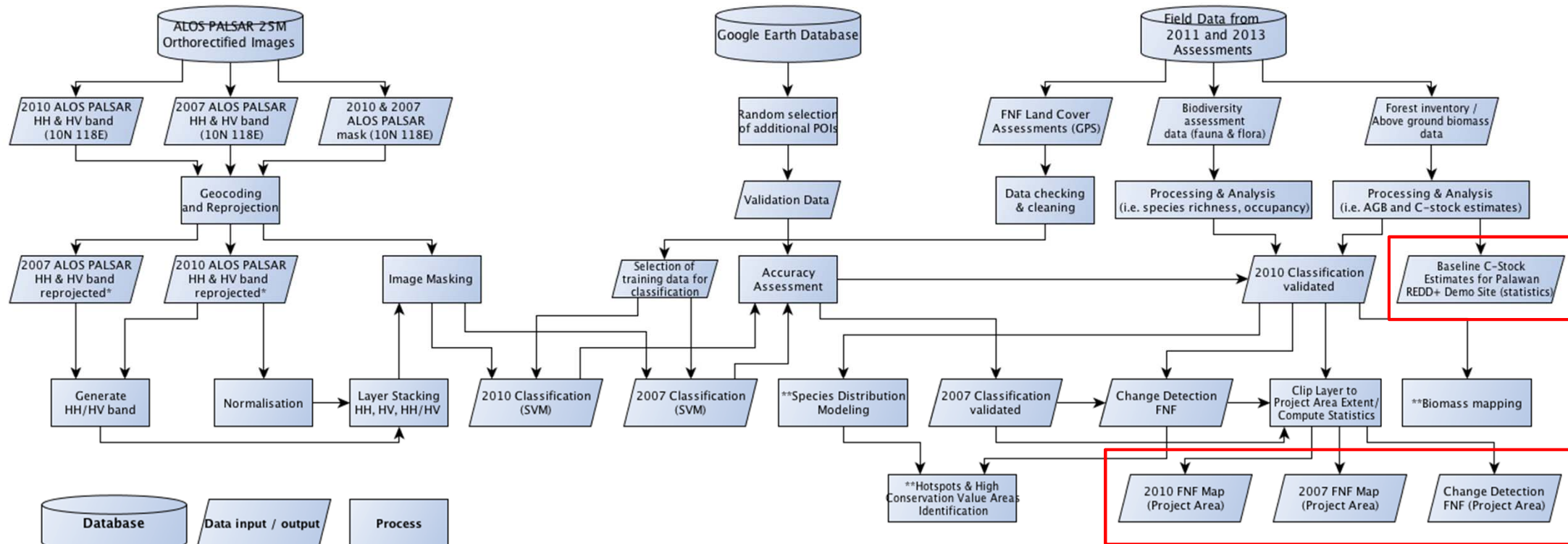
100 random points generated on the extent of the project area was assessed using Google Earth imageries relied on the familiarity on the area's land cover from field visits and recon activities

**Other applications in which FFI wants to use the ALOS PALSAR mosaic data. (the approach is also applied in other projects)

Transect/Plot Design

- Time to survey - average of 1 day/plot with at least 7 team members
- Half day to establish the plot, 1 day to complete the inventory

250 M x 8 segments = 2KM Transect
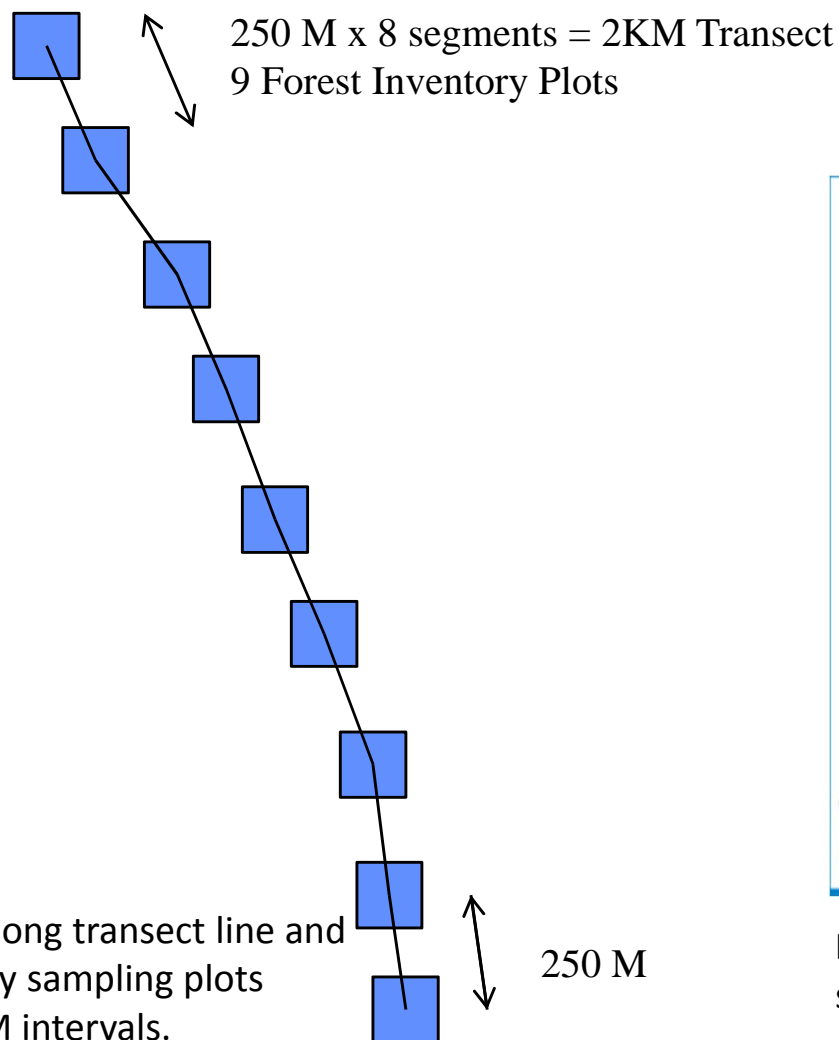9 Forest Inventory Plots

250 M

Figure 1. 2KM long transect line and forest inventory sampling plots placed at 250M intervals.

1 km
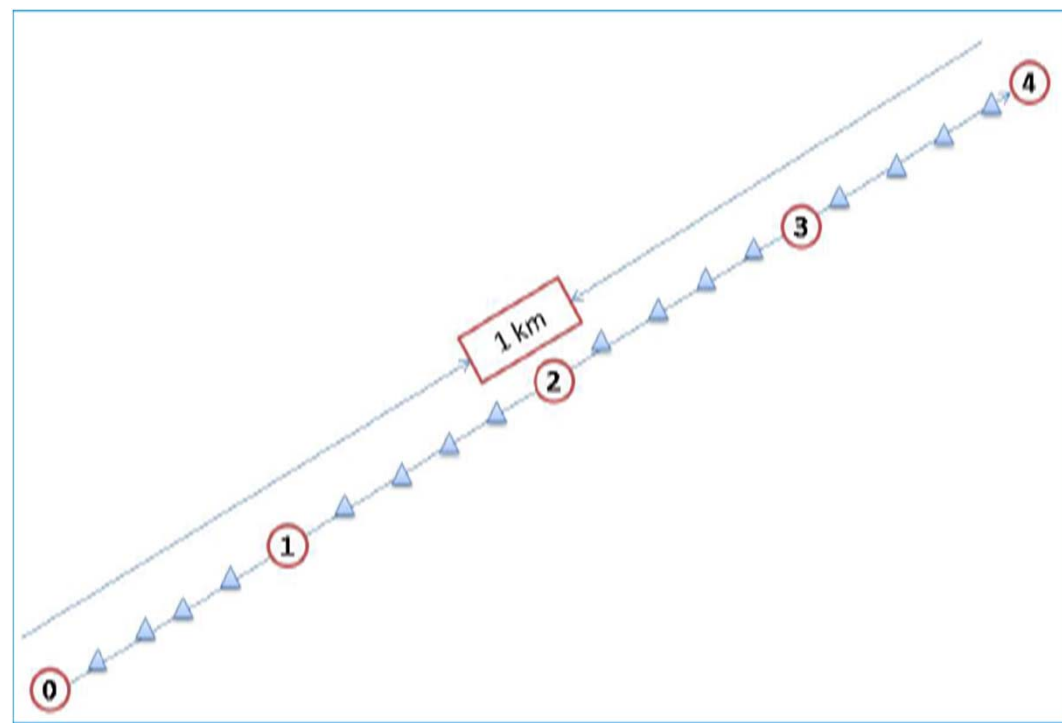
Figure 2. Biodiversity transect line (same with Figure 1) and point sampling plot.

⓪ Stations = every 250M distance

△ Sub-stations= every 50M distance

Transect/Plot Design

250 M x 8 segments = 2KM Transect
9 Forest Inventory Plots

We did this because literature suggests that to compute/model biomass maps, we need to have at least 1Ha-4Ha plot sizes. We will use this to explore this.

Figure 1. 2KM long transect line and forest inventory sampling plots placed at 250M intervals.

250 M

250 M x 8 segments = 2KM Transect
9 Forest Inventory Plots

Time to survey this is average of 2-2.5 days per 1-hectare plot with at least 7 team members.

Figure 3. Every station/plot #5 in each transect also has forest inventory data with a 100x100m (1Ha) plot size. Comprised of four 50x50m plot, as illustrated.

250 M

Transect/Plot Design
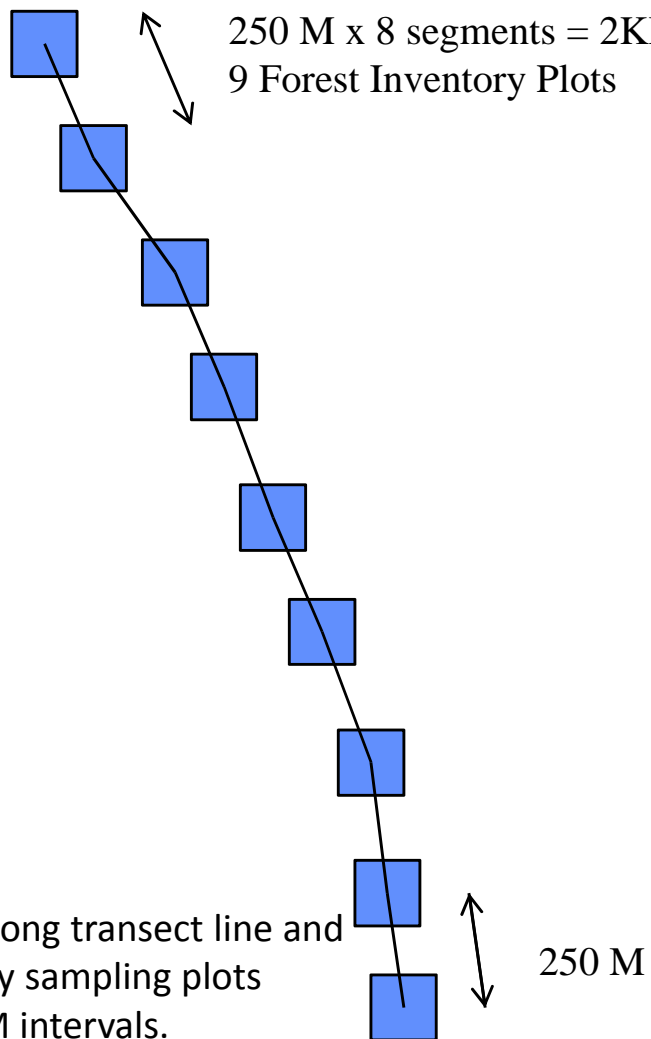
250 M x 8 segments = 2KM Transect
9 Forest Inventory Plots

250 M

Figure 1. 2KM long transect line and forest inventory sampling plots placed at 250M intervals.

AC2 — 50 M — AC3

NORTH

A

50 M

Measure trees
≥ 30cm dbh

AC1

AC4

NORTH

CC2 — 20 M — CC3

C

20 M

Measure trees
10 - 30cm dbh

AC1

CC4

NORTH

CC2 — 50 M — BC3

B

20 M

Measure trees
10 - 30cm dbh

AC1

AC4

Figure 4. Forest inventory plot sampling configuration

Transect/Plot Design
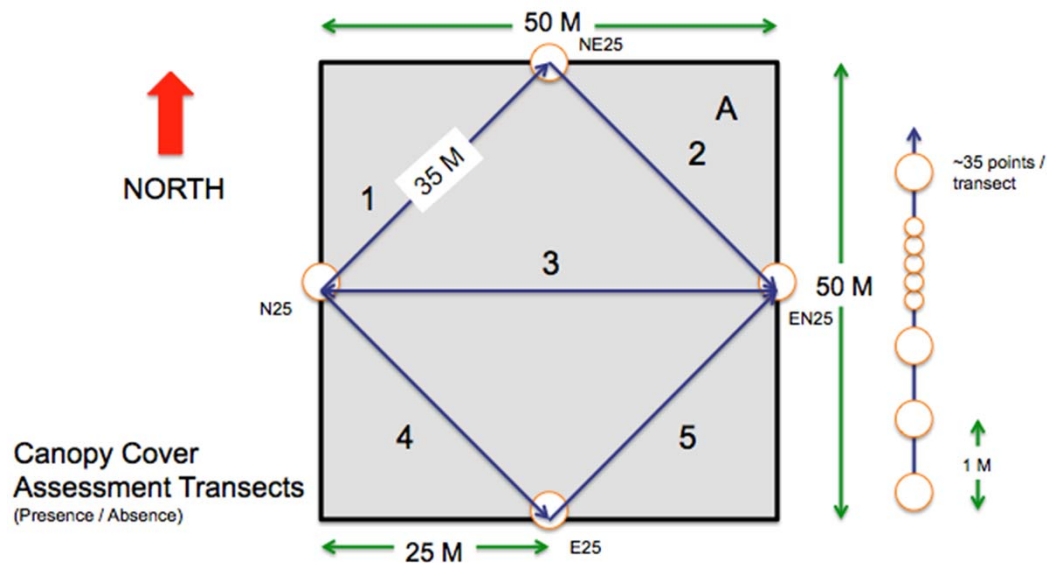
Figure 5. Canopy Cover Assessment using densitometer

- A densitometer has a scope, with a cross hair in the middle. Presence/absence is noted. i.e. if there is canopy upon looking into the scope, it is noted as 1, zero if no canopy or if sky is seen.

- Measured along the diamond transect established inside the plot at 1 meter interval.

Field Data (Transects/Plots)

☐ **5 transects established for forest inventory & biodiversity assessments in our project accounting areas (PAA)**

⬇ **Covered Municipalities (PAA): Narra & Quezon,**

  ▪ **Barangays:**

    ☐ **Estrella, Narra (1 transect)**
    ☐ **Malinao, Narra (2 transects)**
    ☐ **Aramaywan, Quezon (2 transects)**

⬇ **Forest Inventory Plots**
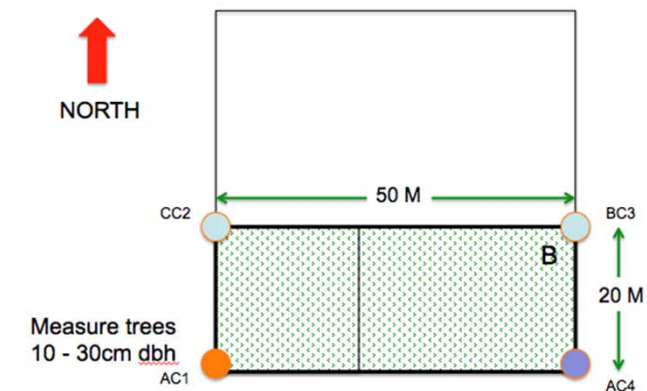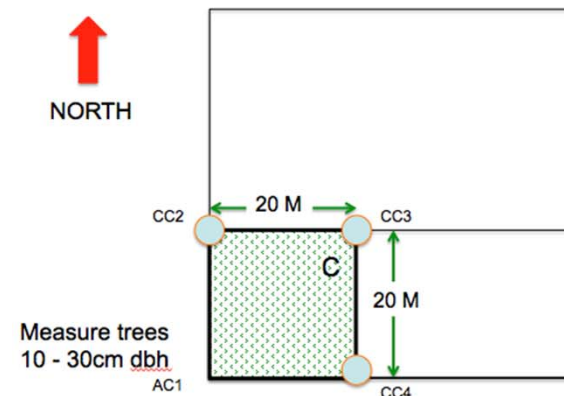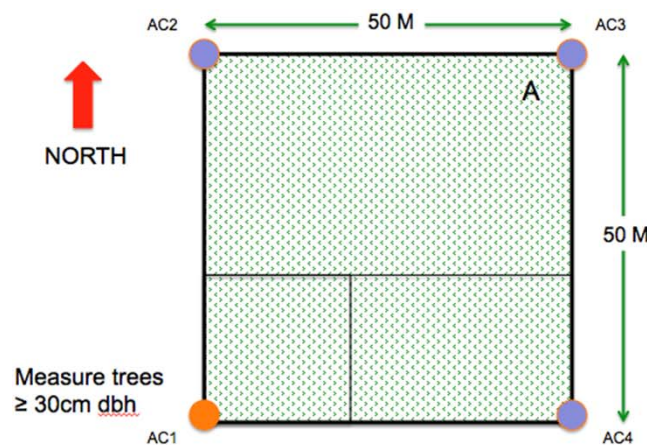
  ▪ **9 (50mX50m) forest inventory plots for each transect. Total of 45 plots for the 5 transects.**

  ▪ **1 (100mX100m) forest inventory plot per transect. Total of 5 one-hectare plots for the 5 transects.**

2011 & 2013 Field Data

- Project Area
- Municipal Boundary
- Field validated non-forest areas
- Forest inventory plot locations
- Other forest areas
- GE validation non-forest
- GE validation forest
- Forest cover
- Non-forest cover

Coordinate System: UTM/WGS84 50N
Unit: Meters
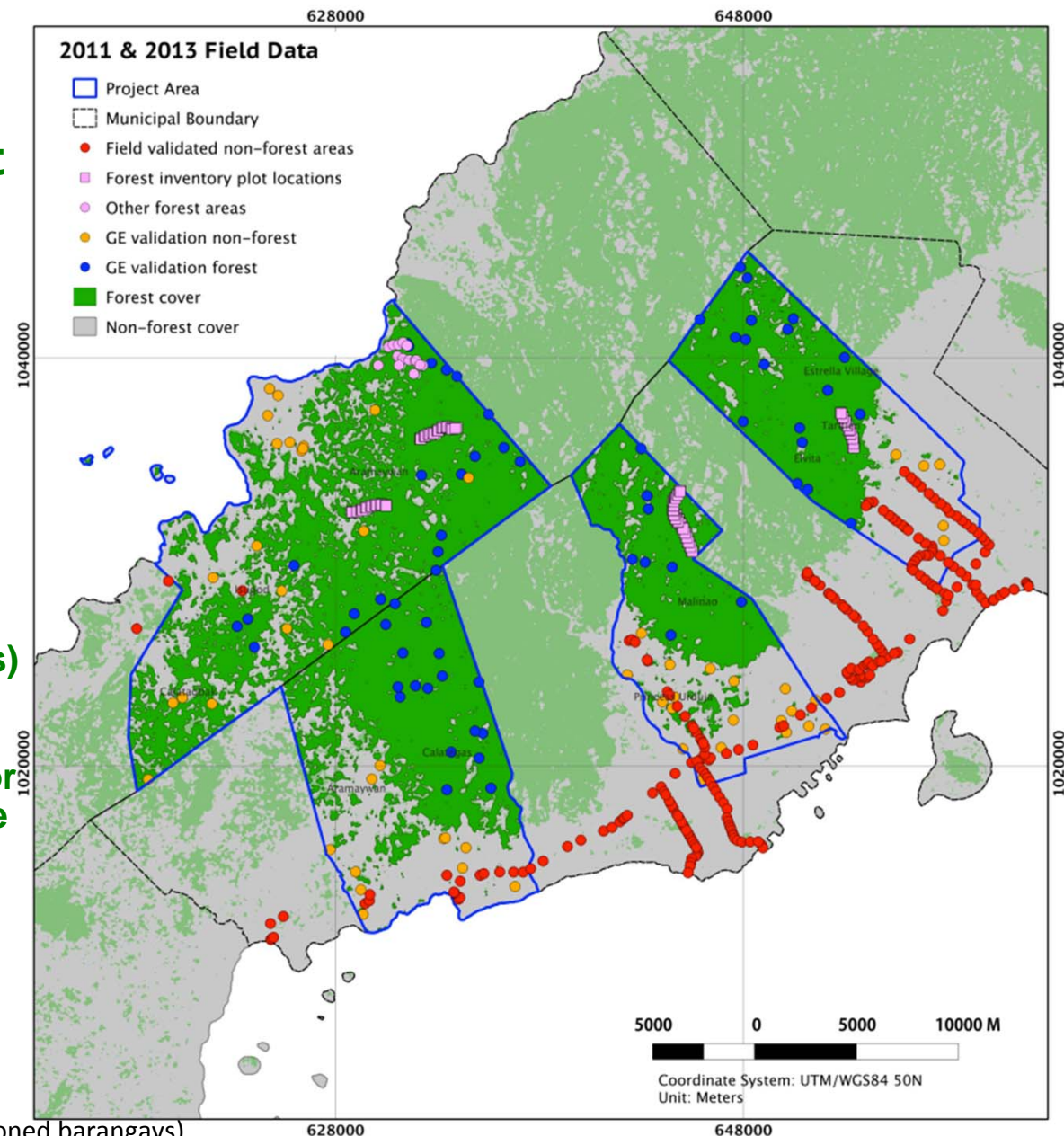
- Transects are located within the project accounting areas. (in the mentioned barangays)
- Due to limitations of permits for the area, we cannot collect data from other barangays.

ROI Separability
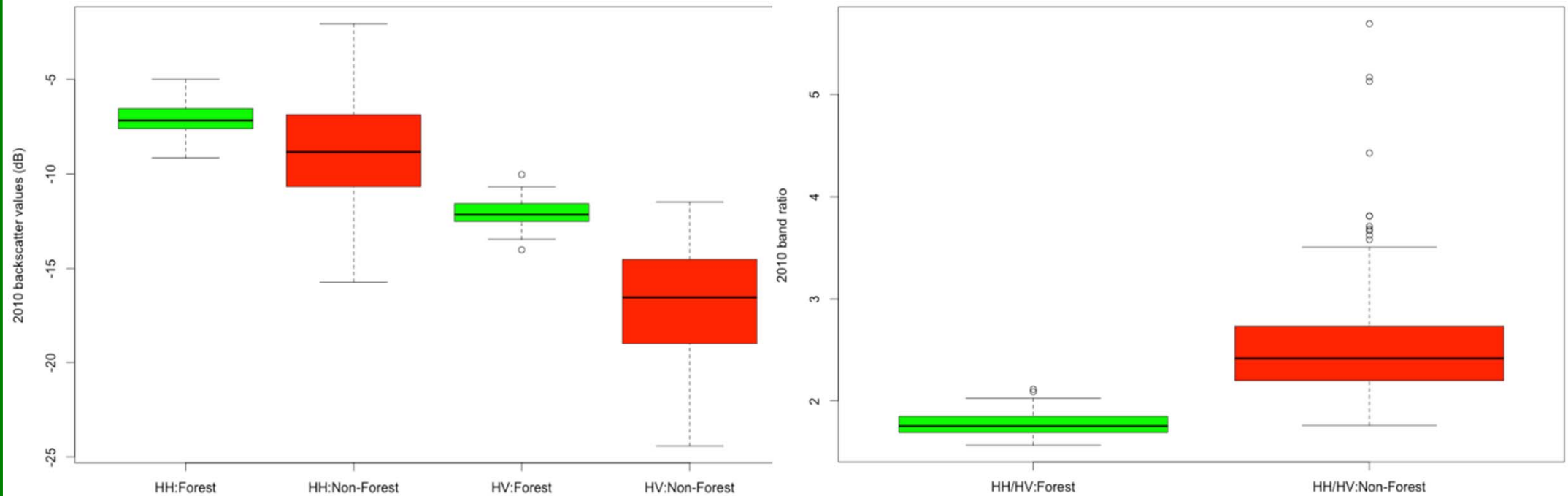
☐ Computed ROI separability between forest and non-forest = 1.928

Forest Cover Maps

Area covered by image tile 10N 118E

Classes	2007	2010	Net Change	
Forest cover	218,026.31	215,216.69	↓	(2,809.63)
Non-forest cover	122,697.75	125,507.38	↑	2,809.63

Project Area

Classes	2007	2010	Net Change	
Forest cover	37,140.55	35,994.98	↓	(1,145.57)
Non-forest cover	17,804.80	18,950.37	↑	1,145.57

Palawan REDD+ Demo Site 2010 FNF Map

Project Area Boundaries & Forest Cover

- Project Area
- Project Accounting Area
- Narra & Quezon Boundary
- Forest cover
- Non−forest cover

*remaining percent cover is attributed to masked pixels of 2007 & 2010

N

1:225000

Map sources:
ALOS PALSAR 25M Orthorectified Mosaic
Global Administrative Database

Estrella Village
Taritien
Elvita
Aramaywan
Isugod
Malinao
Calatagbak
Princess Urduja
Calategas
Aramaywan

628000   648000
1040000
1020000

5000   0   5000   10000 M

Coordinate System: UTM/WGS84 50N
Unit: Meters
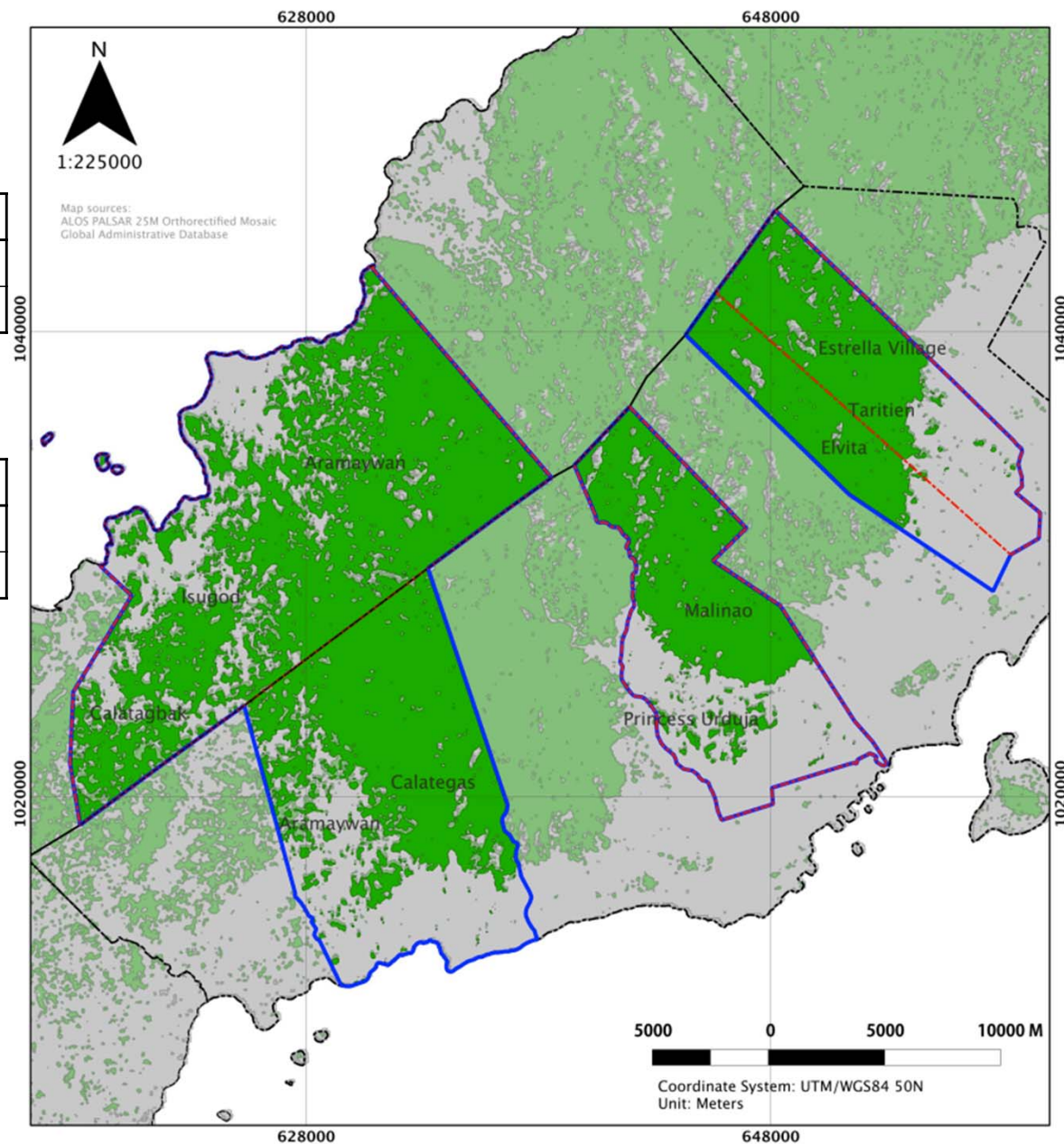
Accuracy Assessments

Confusion Matrix for Forest Cover 2007

	Ground Truth (%)		
Class	Non – Forest	Forest	Total
Non – Forest	76.79	3.23	38.14
Forest	23.21	96.77	61.86
Total	100	100	100

Confusion Matrix for Forest Cover 2010

	Ground Truth (%)		
Class	Non – Forest	Forest	Total
Non – Forest	85.71	3.17	42.02
Forest	14.29	96.83	57.98
Total	100	100	100

2007 Accuracy (%)

Class	NForest	Forest
Producer's	76.79%	96.77%
User's	96.77%	82.19%
Overall	87.28%	
Kappa	0.74	

2010 Accuracy (%)

Class	NForest	Forest
Producer's	85.71%	96.83%
User's	96%	88.41%
Overall	91.60%	
Kappa	0.83	

- We do not have 2007 data, but the forest locations used in training data – we were sure that they have been forest for the past 10 years → We had to check this as requirement of the VCS method
  - Also non-forest because they were mostly agriculture and built-up were used for training data.
- Validation data should be checked again for 2007 to improve accuracy.

Change Detection Results

Area covered by image tile 10N 118E

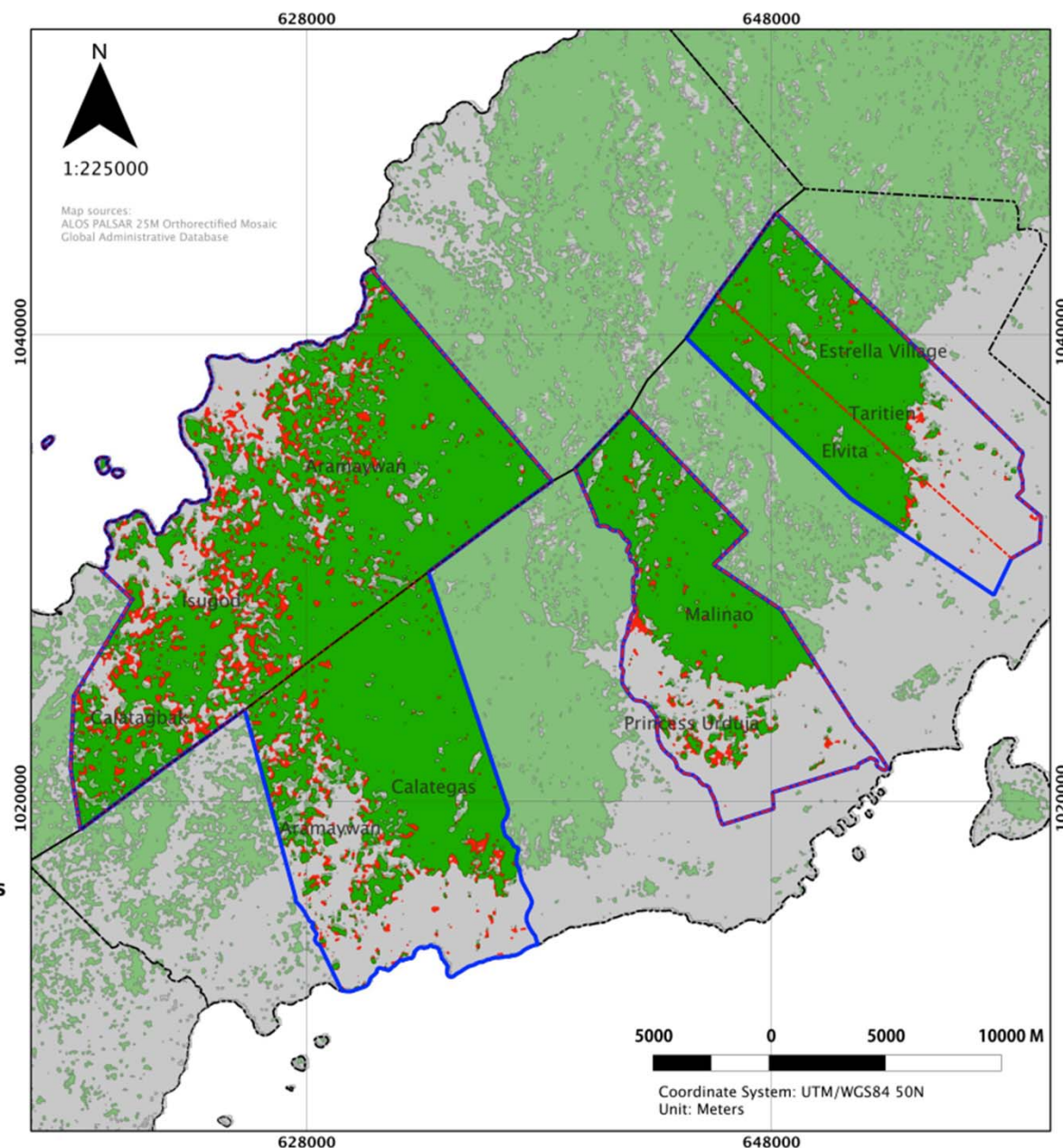| STATE	Hectares	Percentage
Forest remaing as forest	198,868.31	92.13
Non-forest remaining as non-forest	106,349.38	84.24
Forest converted to non-forest	19,158.00	15.18
Non-forest converted to forest	16,348.38	7.57

Project Area

STATE	Hectares	Percentage
Forest remaing as forest	33,594.37	90.22
Non-forest remaining as non-forest	15,404.19	81.06
Forest converted to non-forest	3546.18	18.66
Non-forest converted to forest	2400.61	9.52

*remaining percent cover is attributed to masked pixels of 2007 & 2010

Areas Deforested from Slash and Burn Activities

- Project Area
- Project Accounting Area
- Narra & Quezon Boundary
- Forest Cover
- Deforestation
- Non–forest Cover

1:225000

Map sources:
ALOS PALSAR 25M Orthorectified Mosaic
Global Administrative Database

Coordinate System: UTM/WGS84 50N
Unit: Meters

Deliverables

Deliverables required	LEYTE	*PALAWAN	GENERAL NAKAR
1. Forest cover and change maps produced	Complete	Complete	Field assessments scheduled on January-February 2014
2. Deforestation rates determined	Complete	Complete	TBD
3. Baseline forest carbon stocks established	Complete	Complete	Field methods/approaches are recalibrated (based from experiences in PLW)
4. Image processing methodologies and accuracy assessments documented	Complete	Writing of Manuals/Documentations are on-going	Acquired 2012 RapidEye images for southern part of General Nakar (can be used for validation/accuracy assessments)

*More of the results will be presented in the next Science Meeting