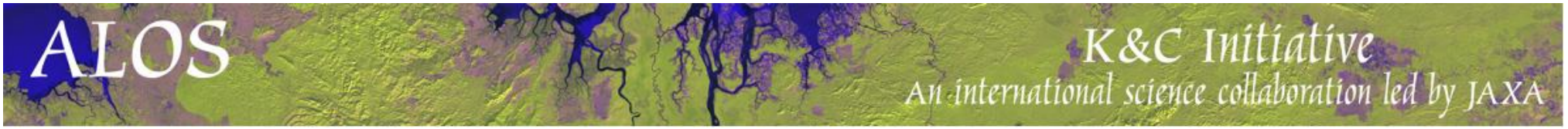

K&C Phase 4 – Final Report

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

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°ALOS Kyoto & Carbon Science Team member

Science Team meeting #25
Tokyo, Japan, February 5-8, 2019

Original 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

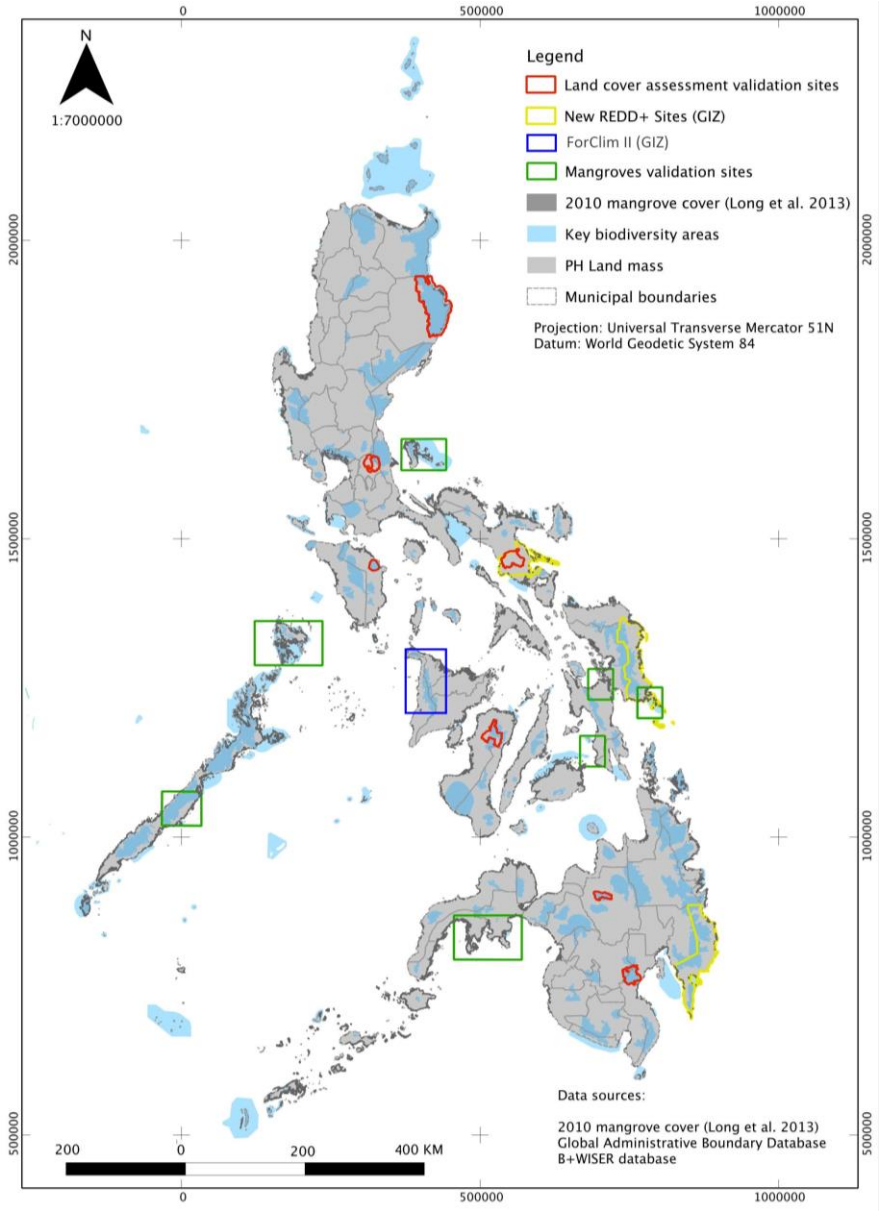
Project areas: Philippines

TA 1: protected areas (7 sites)

TA 2: REDD+ sites (3 sites)

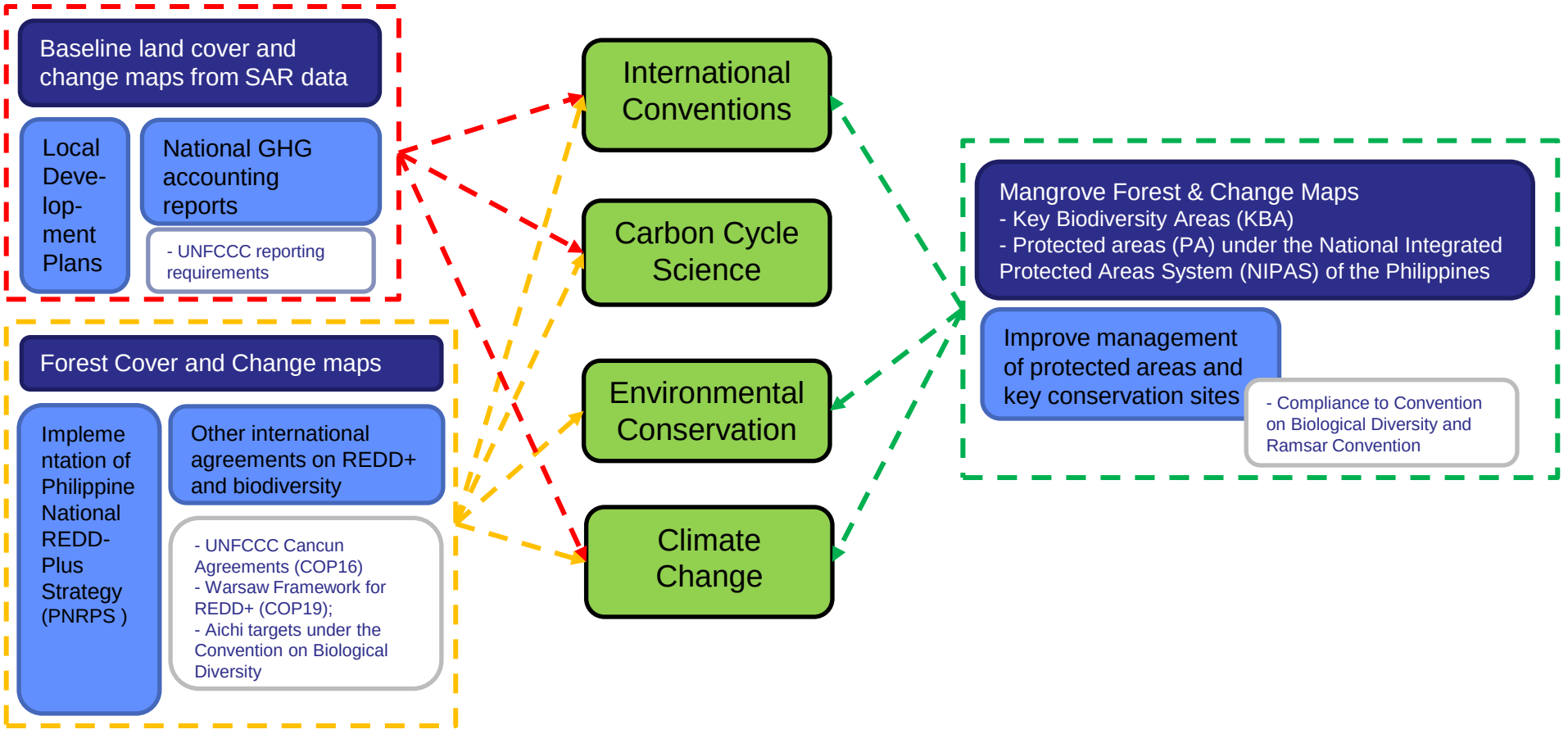
ForClim II (1 site)

TA 3: mangrove sites (6 sites)



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 Outcomes

Cover & Change	TA1: Land	TA2: Forest	TA3: Mangrove
Area Coverage	4 protected areas	REDD+ replication sites	National scale
Data used	L-band SAR Optical Images	L-band SAR (mosaic)	L-band SAR Optical Images
Change period	2007-2010 2010-2015	2010-2015	1994-2007 (13 years)
Classification	Multi-level hierarchical – implemented using Random Forests classifier	Decision tree classifiers (ENVI-based)	Multi-level classification using decision tree classifiers (OBIA framework)

Significant findings: Land Cover

- High accuracies @ 2-class level classification (F/NF)
  - 74-90%, comparable to studies using single sensors
- Moderate accuracies @ 6-class level classification → despite synergy of radar and optical data, indices and texture measures
  - 53-66%, low compared to other studies
    - Could be because of low separability of classes (some classes are aggregate of more detailed classes!)
      - Grassland: grassland, shrubs, and wooded grassland;
      - annual crops - rice paddies, maize, sugar cane;
      - perennial crops - banana or coconut plantations
- Low accuracies @ more than 6-classes

Significant findings: Land Cover

- Important predictor variables to improve classification accuracies
  - Both radar and optical data layers
  - HH and HV are equally important as optical Landsat bands
    - HV - slightly more important in detailed classifications
    - 1 texture index (HV sum average texture)
      - Especially @ detailed classification levels
    - 2 optical indices (LSWI* and SATVI**)

*Land Surface Water Index

**Soil-Adjusted Total Vegetatic

$$LSWI = \frac{\rho_{NIR} - \rho_{SWIR1}}{\rho_{NIR} + \rho_{SWIR1}}$$

$$SATVI = \frac{\rho_{SWIR1} - \rho_{RED}}{\rho_{SWIR1} + \rho_{RED} + 0.1} * \left(1.1 - \frac{\rho_{SWIR2}}{2.0}\right)$$

Significant Findings - Forest

- ✓ Tedious pre-processing could be automated (semi) using open source software (RSGISLib)
- ✓ Multi-temporal speckle filtering really improves the data and classification (ESA SNAP)
  - ✓ Would be really convenient if also available in RSGISLib
- ✓ Unbiased Area Estimation implementation improves area estimates

Significant Findings - Forest

- ✓ Direct classification of change is possible but needs really good training samples of change to achieve good thresholds. Considerations:
  - ✓ limited sources of training samples (esp. historical data)
  - ✓ different thresholds between sensors (PALSAR-1 vs 2)
- ✓ Entire processing can be migrated into open source software (RSGISLib, QGIS, Google Earth)
- ✓ More classification algorithms available in RSGISLib (Random Forest, Extra Trees Classifier) found to achieve better land cover mapping results

Significant Findings - Mangroves

- Viability of synergistic use of radar and optical data for operational wall-to-wall mangrove mapping and change analysis at a **nationwide** scale
- Semi-automated batch pre-processing SAR mosaic data (1996, 2007-2010) was developed using the commercial software ENVI/IDL
- Segmentation and rulesets developed using commercial software eCognition

Significant Findings - Mangroves

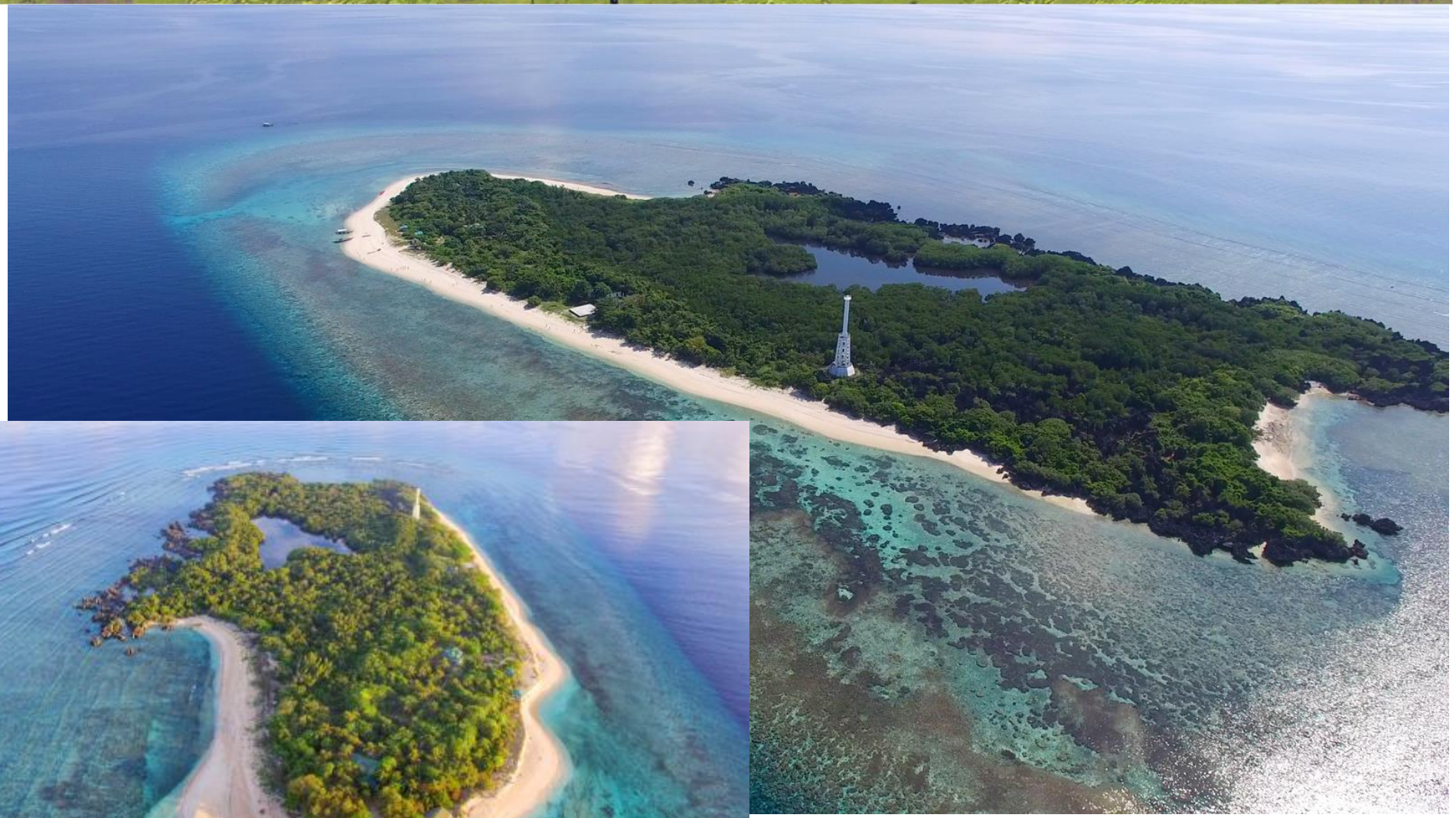
- Low similarity between classification results and reference maps
  - Mangroves not mapped in reference mangrove maps.

- Total area of mangroves mapped is higher from the classification results compared to the reference maps.
  - Detect narrow fringing mangroves along coastlines
  - Apo Reef Natural Park in Occidental Mindoro province (~20 ha) was not detected in reference maps

ALOS

K&C Initiative

An international science collaboration led by JAXA



Sources of Photos: https://www.rappler.com/life-and-style/travel/ph-travel/136955-apo-reef-occidental-mindoro-snorkeling-Philippines
https://www.tripadvisor.ie/LocationPhotoDirectLink-g2094771-d2080788-i193160127-Apo_Reef_Natural_Park-Sablayan_Occidental_Mindoro_Province_Mindoro.html

Significant Findings - Mangroves

- Mangrove change showed a net positive increase in mangrove forests (13 year period)
  - Possible reason: mangrove mapping of Long and Giri (2011) do not map mangroves with area of < 0.08 hectares.
- Suggests that narrow fringing mangroves may contribute **significantly** to the total mangrove cover in the country.
  - Mangrove areas in the country could be **more extensive** than previously thought
  - Baselines must be revisited to reflect better estimates of the remaining mangrove areas in the country

Project extension (2018-2019)

Land Cover of Siargao Islands

Siargao contains one of the largest contiguous mangrove forests in the Philippines (4,000+ hectares).

- Mapped but no field data and accuracy assessment
- Processing: fully open source; still semi-automated
- Processing: also available in QGIS to simplify and make it digestible to non-RS and GIS savvy participants in Del Carmen Surigao Island.

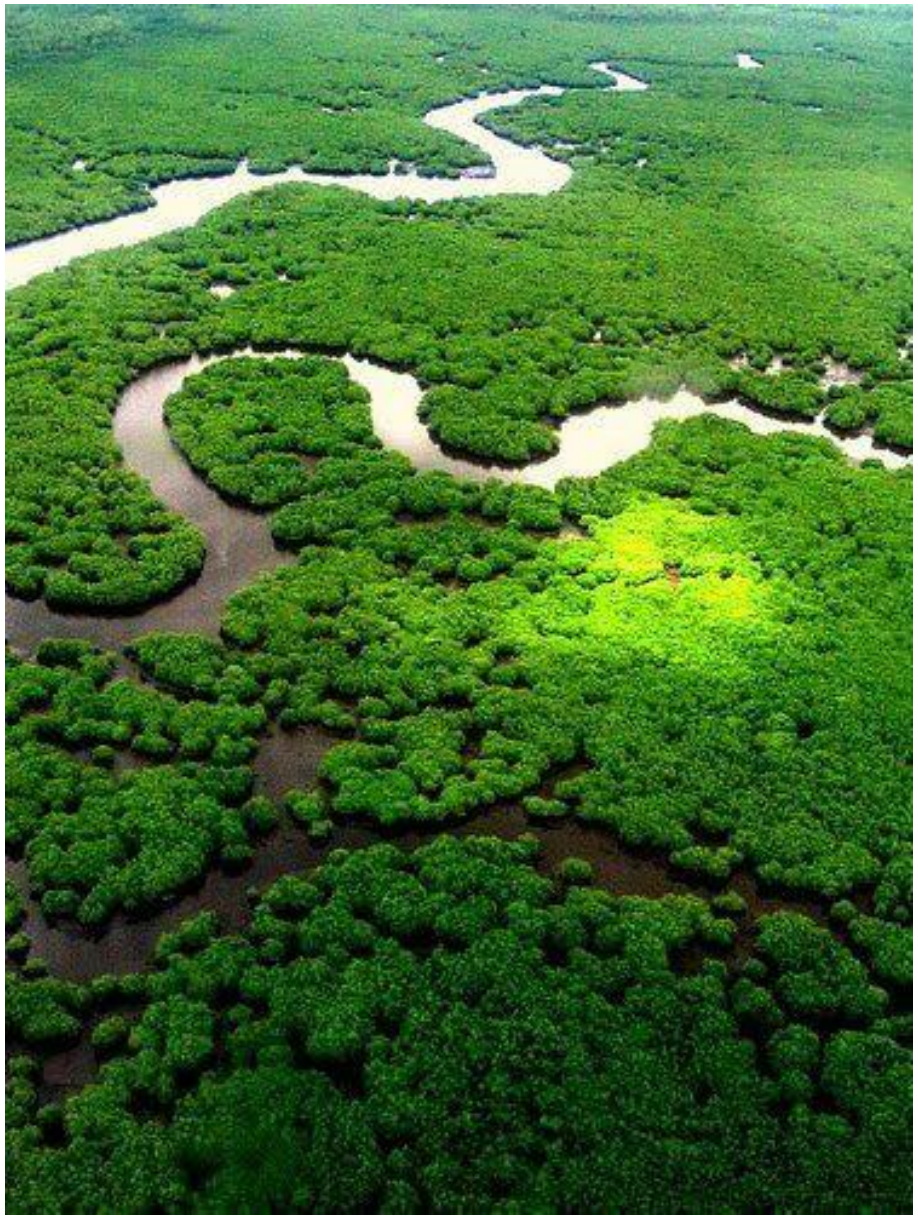
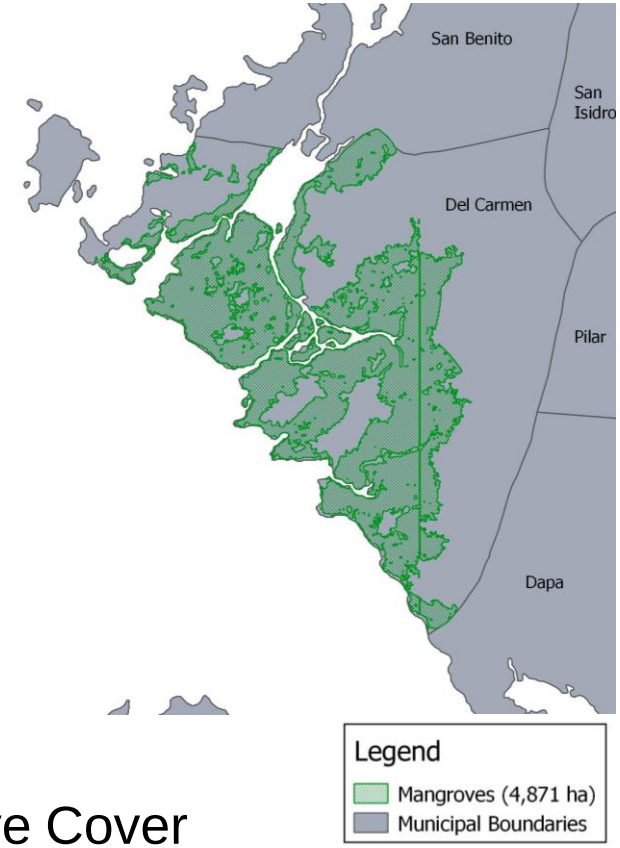
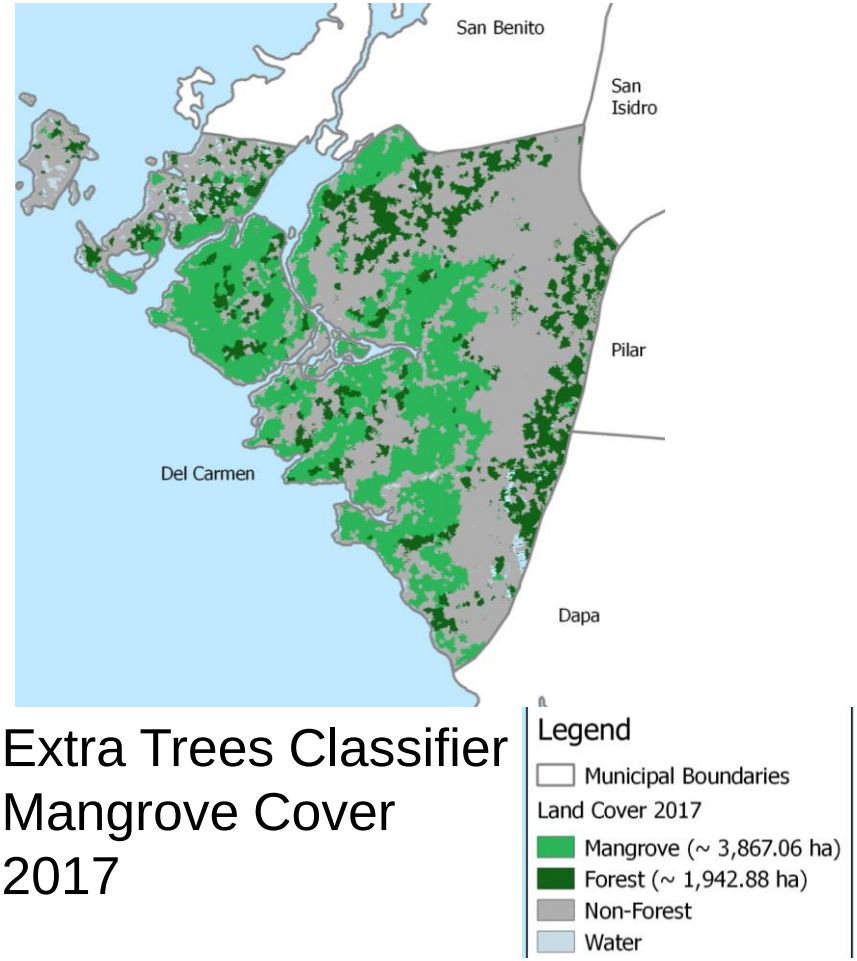


Photo Source: https://www.pinterest.ph/pin/157414949448753246/?lp=true

Project extension (2018-2019)

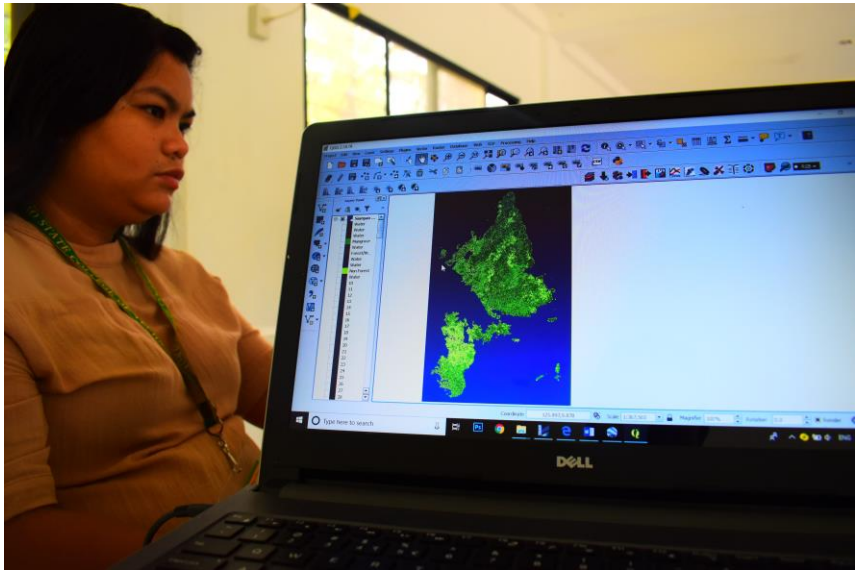


GMW
Mangrove Cover
2010



Extra Trees Classifier
Mangrove Cover
2017

Project extension (2018-2019)



Impact to Philippine Government Agencies

National Mapping and Resource Information Authority (NAMRIA)

- Poor separability between land cover classes despite combined L-band SAR and Landsat data
- recommend to rethink currently adopted classification system
  - i.e. redefine land cover categories based on physical features detected by the satellite sensor

Forest and Biodiversity Management Bureau (FMB/BMB)

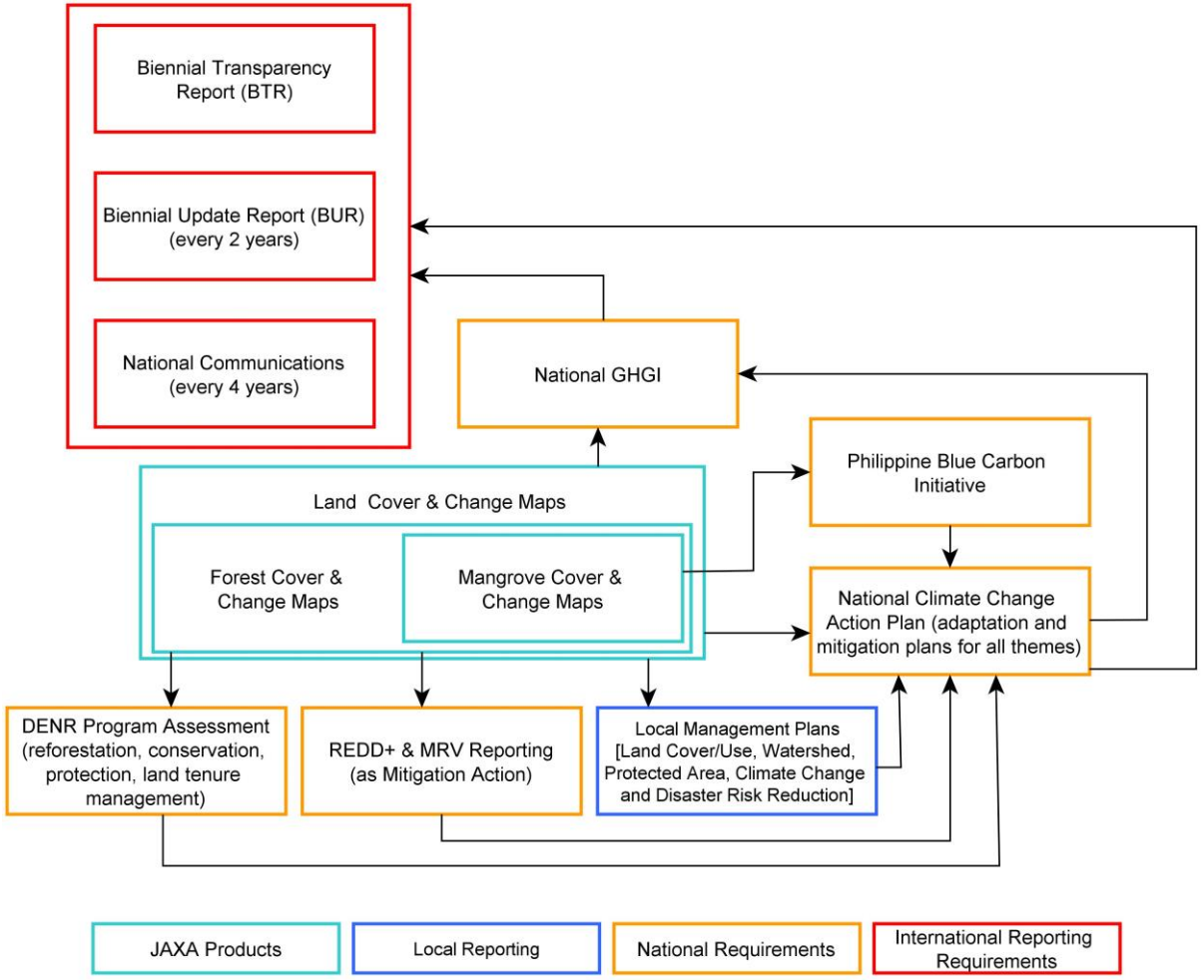
- information enables the bureaus to formulate and design appropriate strategies - priority areas for protection [deforestation hotspots], monitoring areas for survival/mortality [conservation] – leading to more effective enforcement and management.

Impact to Philippine Government Agencies

- Availability of satellite image data sources allows our government to explore new data sets (at no cost!) and methodologies to improve the discrimination of land cover categories and achieve better land cover maps (every 5 years)
  - This is why improvement of the mosaic products in terms of seasonality and other factors is very important, as countries like the Philippines will heavily rely on this Science Team's work! (Thank you!)

- Availability of annual (REDD+ requirement) country wide data and processing using open source software enables our forest ministry (FMB) to achieve their own forest cover estimates for reporting on FREL/FRL (annual/bi-annual) and establishing of NFMS.

Why is it significant for the Philippines?



NCCAP: Ecological and Environmental Stability, Human Security, Food Security, Water Security

Ground Truth Data Shared

	Description	Shared to JAXA?
TA1	Land cover and habitat ground-truth data [2014-2015] in 7 sites (GPS coordinates, photos)	Yes

TA2	• Forest Resources Assessment
	  • Eastern Samar (120)
	  • Panay Island (86)
	  • Davao Oriental (97)
	  • Panay Island
	Forest inventory data [2015] from 1 site; 62 plots
		Yes

TA3	Mangrove ground-truth data collected from 2014-2015 in six sites; GPS coordinates, photos	Yes

Outputs/Deliverables

	Description	Shared to JAXA?
TA1-3	Technical reports including maps	Yes
TA2	• Documentation (step-by-step manual) • 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	Yes(hard & soft copy) Cannot be delivered*
Others	• Conference papers published/presented in: 14th World Forestry Congress (4) and 36th Asian Conference on Remote Sensing (3)	Yes (2016)
Extension	• Land cover maps of Siargao Island • Step-by-step manual (semi-automated and QGIS)	To be shared

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

PALSAR/PALSAR-2 data access

All requested datasets were delivered and downloaded.

2018 and future mosaic datasets will be needed by the Philippines for future mapping efforts (forest, mangrove, land cover).

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!