

Monitoring Mangrove Forests in the Philippines using Remote Sensing

Dr. Ariel Blanco
Director
Space Information Infrastructure Bureau (SIIB)
Philippine Space Agency

Serafin Meneses
Chief SRS
SIIB – Space Data Mobilization and Applications Division
Philippine Space Agency

Alvin Baloloy
Researcher
Department of Geodetic Engineering
University of the Philippines Diliman

59th Session of the UN COPUOS STSC
14 Feb 2022



PhilSA

Outline

About PhilSA

Recent works mapping and monitoring of mangroves from various initiatives

Directions in Research, Development, and Operationalization

The Philippine Space Agency

Key Development Areas



08 August 2019

Republic Act 11363
“The Philippine Space Act” is signed by the President

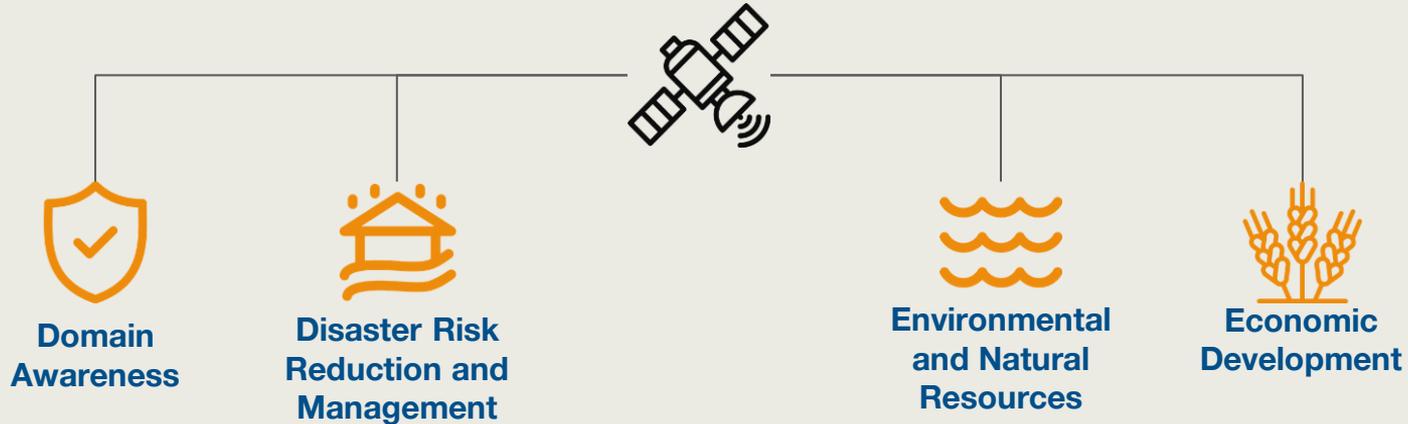
PhilSA Mandate

The **primary policy, planning, coordinating, implementing, and administrative entity of the Executive Branch** of the govt that will **plan, develop, and promote the national space program** in line with the Philippine Space Policy.

Mobilizing Space Data

For Economic Development, Disaster Risk Reduction, & Maritime Domain Awareness

The PhilSA aims to further the **development and application of remote sensing (RS), artificial intelligence (AI), machine learning (ML), data science and other methodologies** in producing space-enabled information to support the operations of various government agencies and other end users.



Mangroves

Mangroves are trees or large shrubs which grow within the intertidal zone in tropical and subtropical regions and have special adaptations to survive in this environment.

Ecosystem services:

- support commercial fisheries and biodiversity
- water filter
- essential resource for coastal human communities
- storm protection
- ability to sequester and store huge amounts of carbon



Green Carbon vs. Blue Carbon

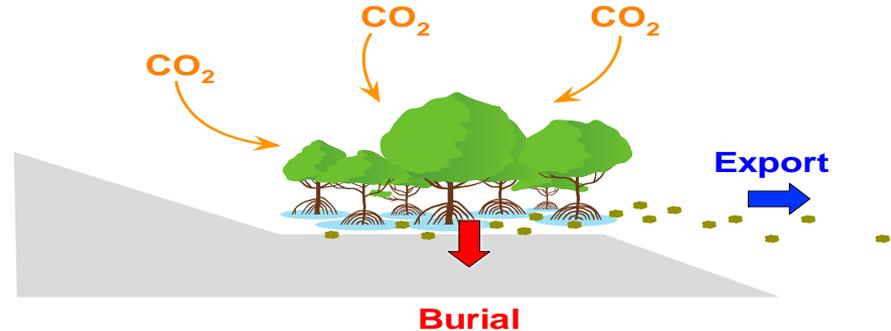
Green carbon – tropical and temperate forest



Green carbon ecosystems

- store organic carbon predominantly in the form of **above- and belowground biomass**.

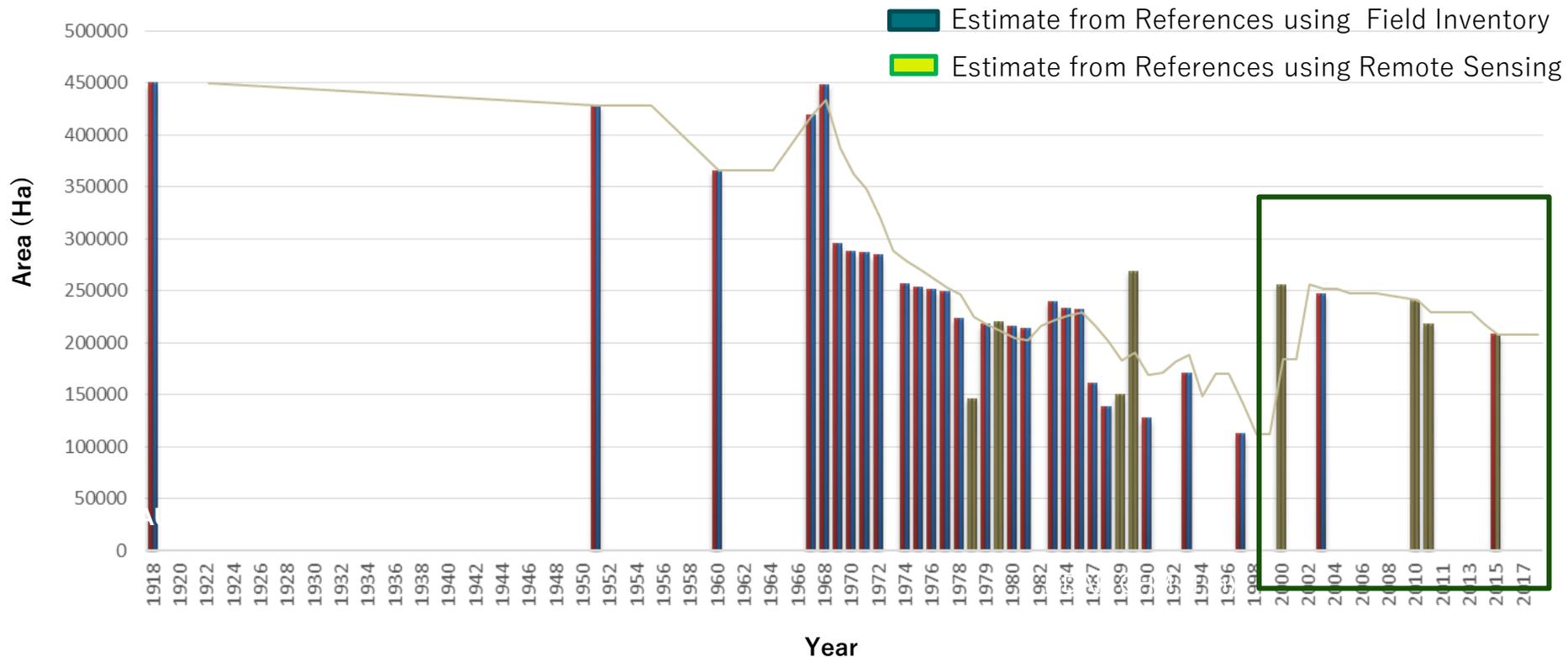
Blue carbon – mangroves and seagrass



Blue carbon ecosystems

- store most of fixed carbon within the **soil (sediment)** and even export a significant fraction of fixed carbon to the **outer ocean**.

Mangrove Extent in the Philippines



BlueCARES/IAMBlueCECAM developed a rapid yet accurate **mangrove vegetation index (MVI)** using Sentinel-2 imagery bands.

$$\text{MVI} = \frac{(\text{NIR} - \text{Green})}{(\text{SWIR} - \text{Green})}$$

Expresses the vegetation greenness level of mangroves

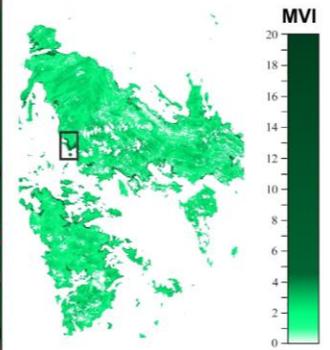
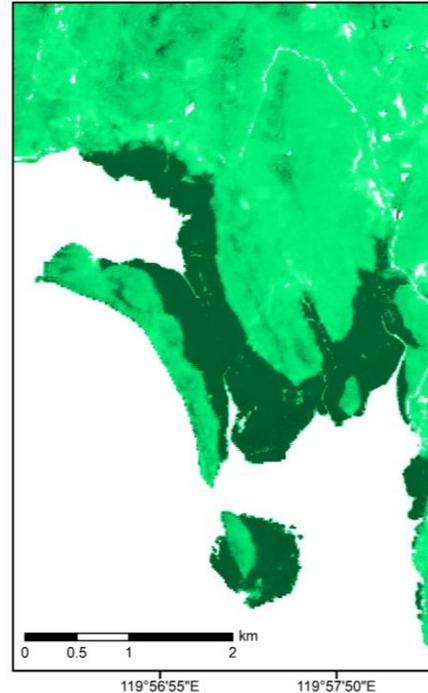
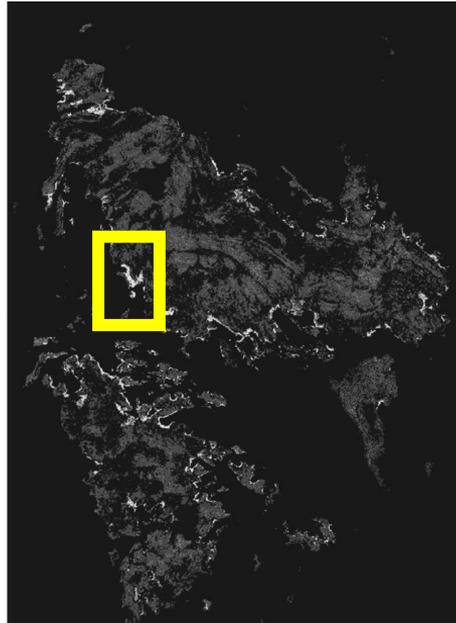
Expresses the vegetation moisture level unique to mangroves

Mangrove Vegetation Index, or MVI, measures the probability of a pixel to be a 'mangrove' by extracting the greenness and moisture information from the Sentinel-2 green, NIR and SWIR1 bands.

Advantages in using MVI-based for Nationwide Mapping



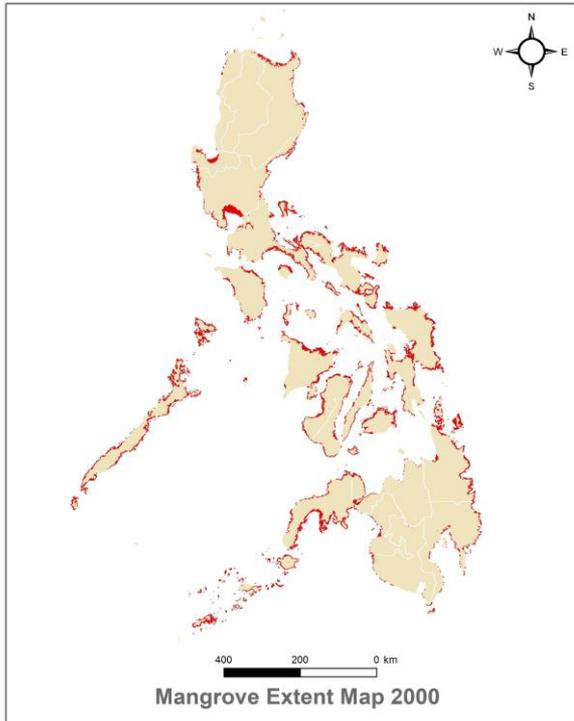
MVI can generate mangrove maps in minutes thus applicable for regular and rapid mangrove mapping.



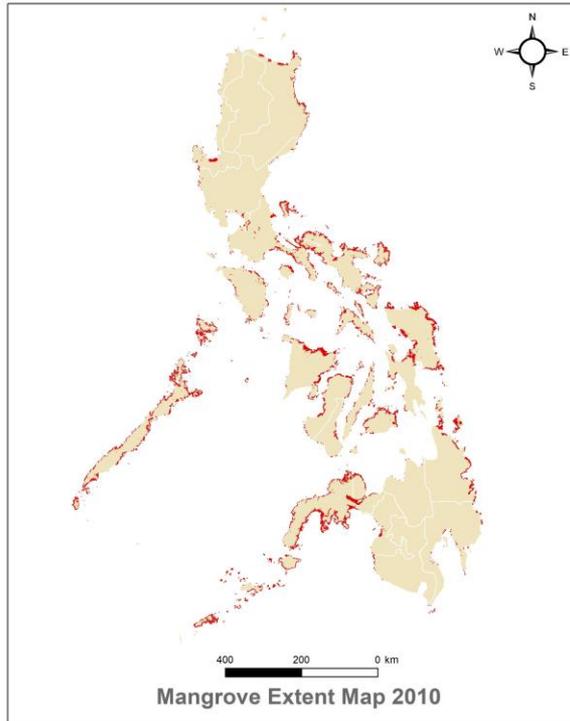
Decadal Mangrove Extent

Baloloy, et al.

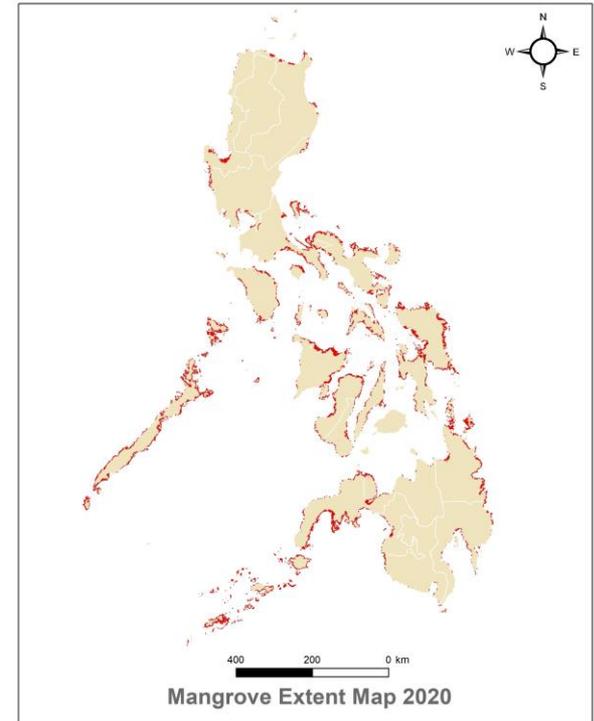
Total mangrove extent difference from 2000 to 2020 (hectares) were correlated to the environmental (SST, SSH, rainfall, typhoon count, climate exposure) and anthropogenic (land cover change) variables.



294,026 ha



230,597 ha



264,818 ha

Nationwide Constant Mangrove Cover

from 2000 to 2020

Constant Mangroves



Nationwide Mangrove Cover Gain

from 2000 to 2020

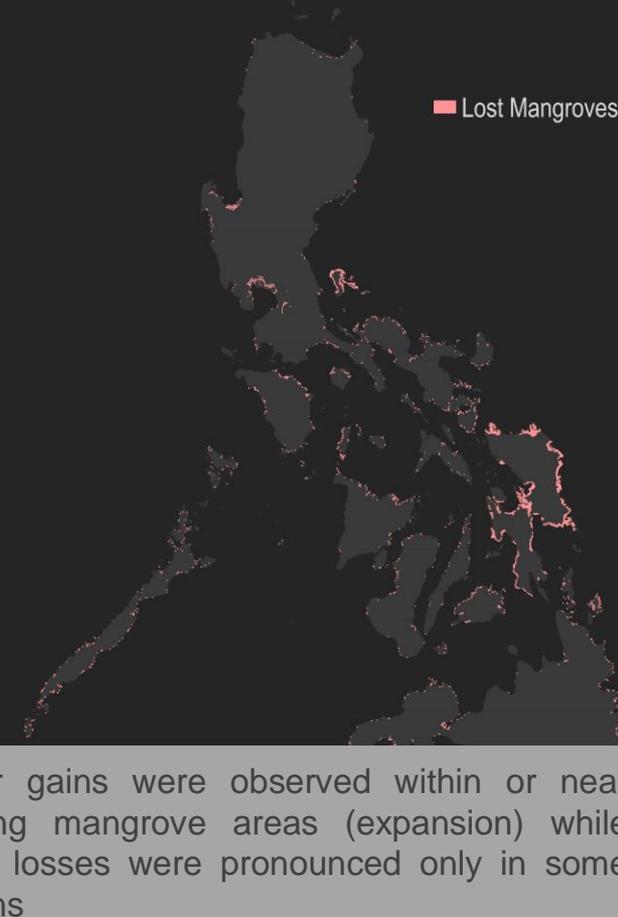
New Mangroves



Nationwide Mangrove Cover Lost

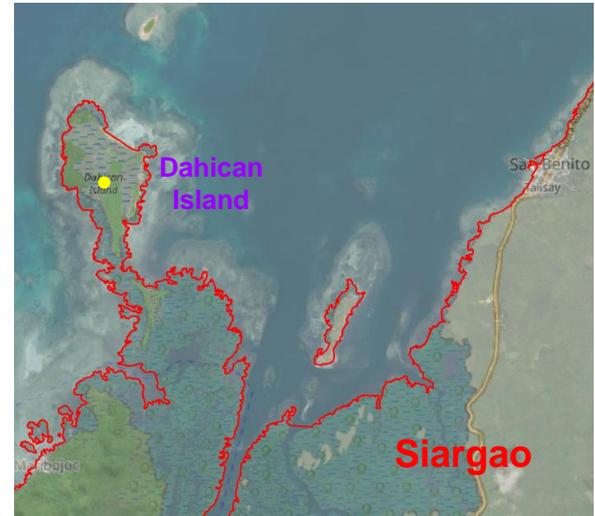
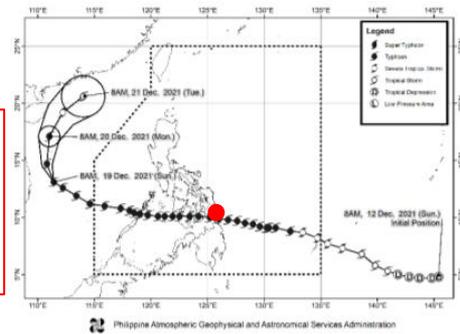
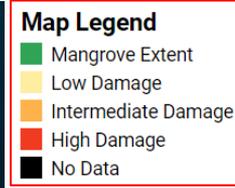
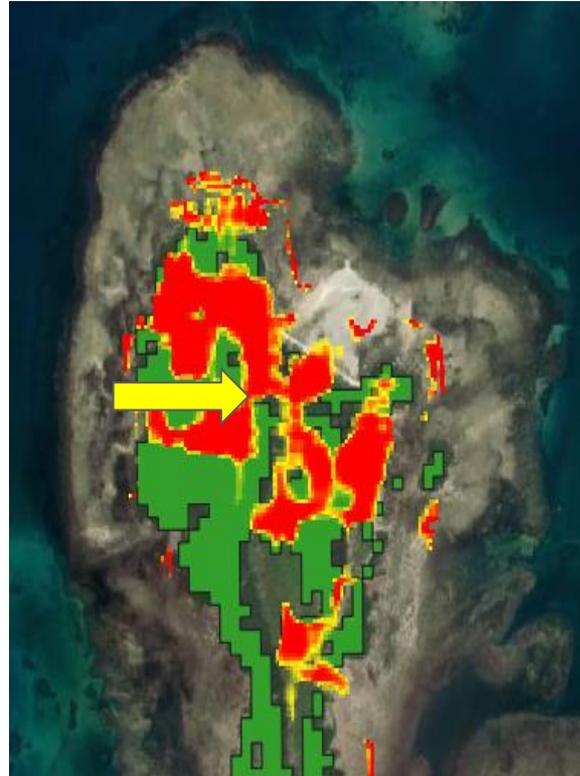
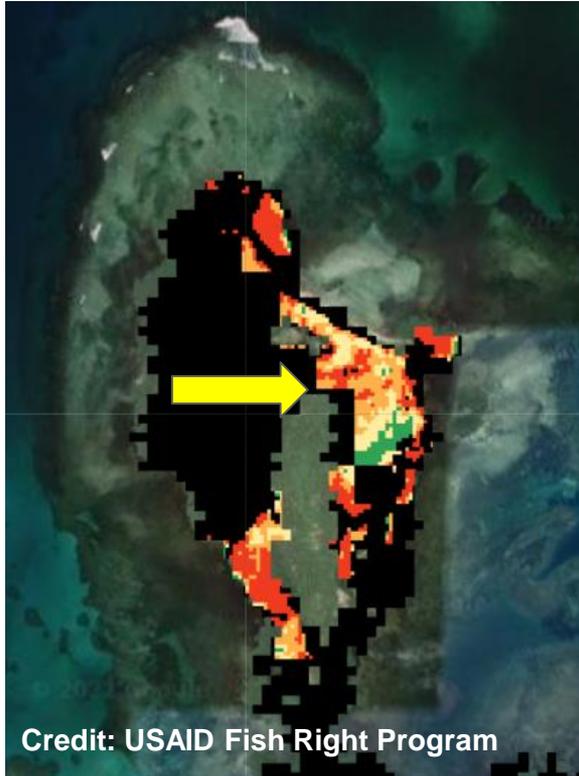
from 2000 to 2020

Lost Mangroves



Cover gains were observed within or near existing mangrove areas (expansion) while cover losses were pronounced only in some regions

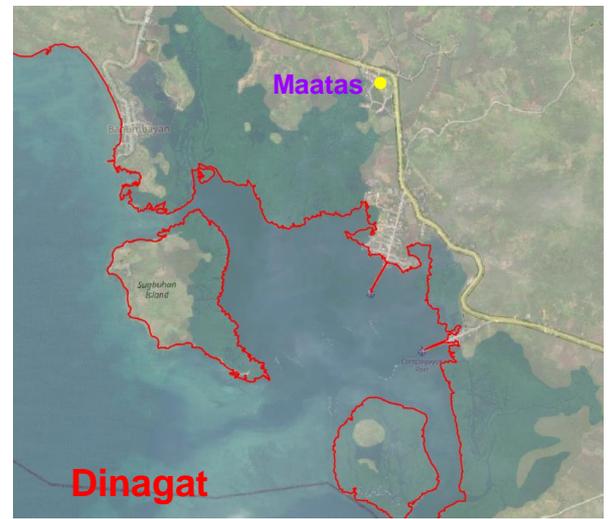
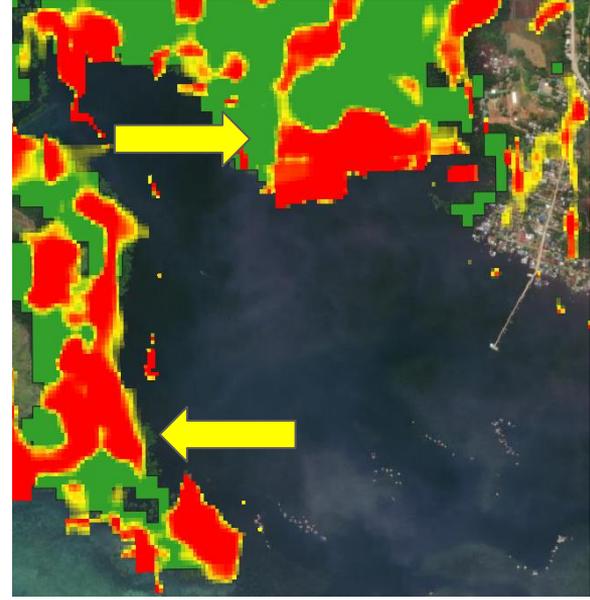
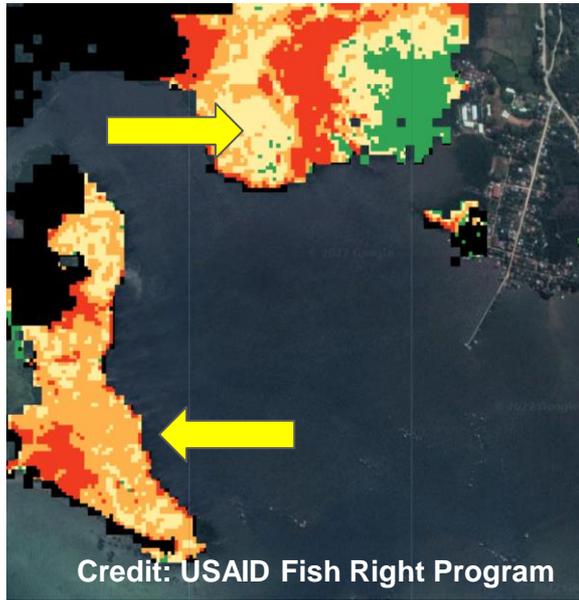
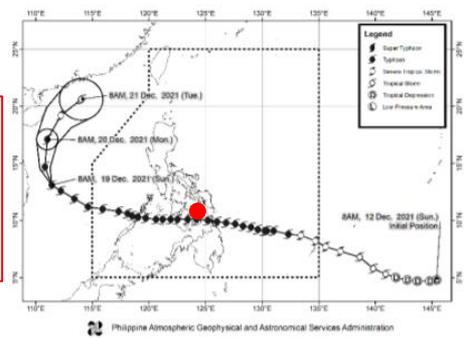
Rapid damage assessment maps of mangrove areas - Dahican Island, Siargao



Rapid damage assessment maps of mangrove areas - Maatas, Dinagat Island

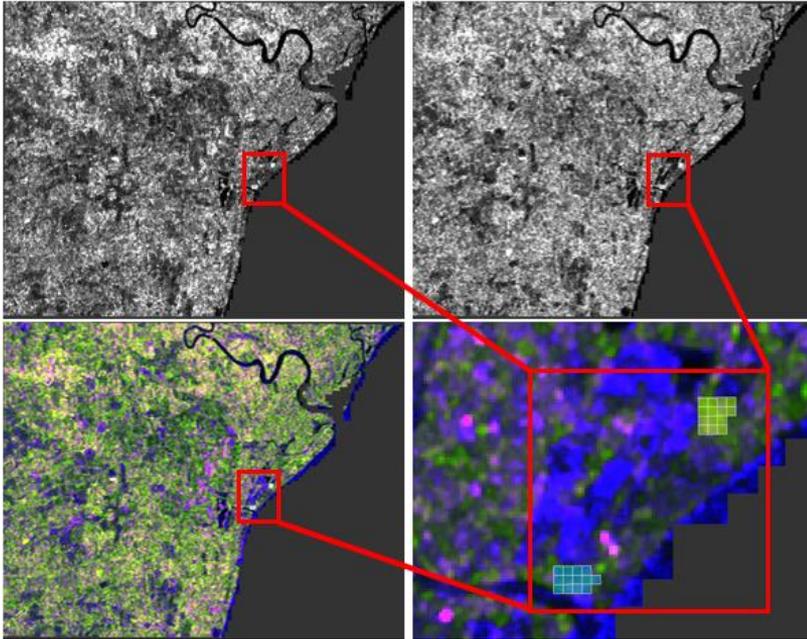
Map Legend

- Mangrove Extent
- Low Damage
- Intermediate Damage
- High Damage
- No Data

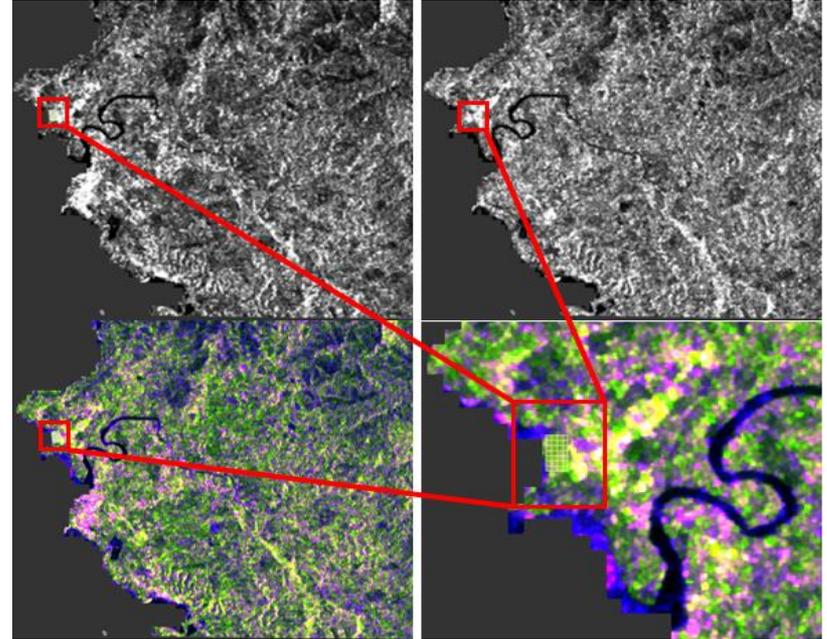


ABOVEGROUND BIOMASS ESTIMATION USING SAR (SENTINEL-1)

Argamosa, et al.

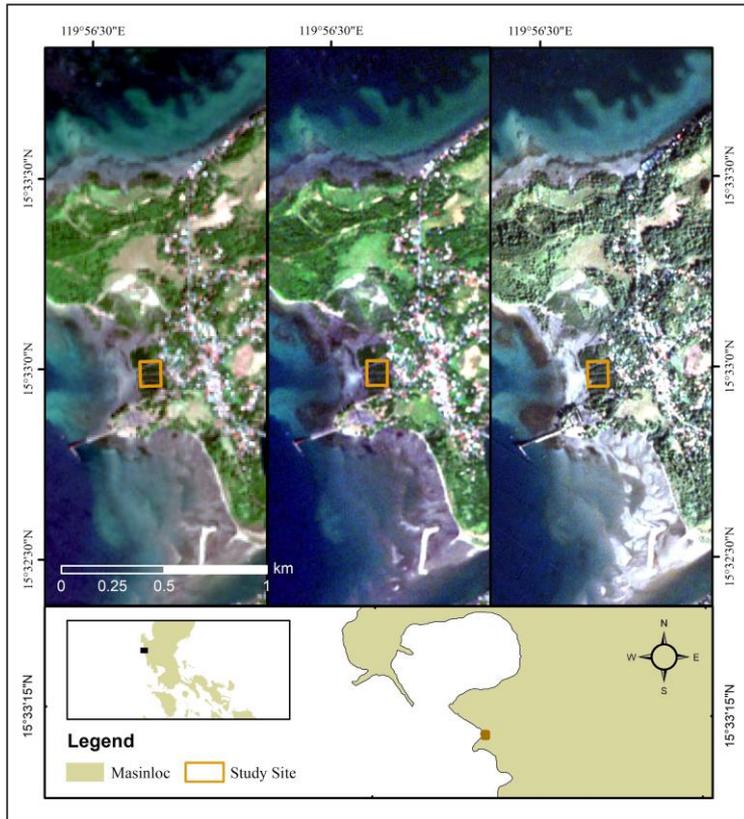


$\sigma^{\circ}_{VV}, \sigma^{\circ}_{VH}$, RGB (σ°_{VV} , σ°_{VH} , $\sigma^{\circ}_{VV}/\sigma^{\circ}_{VH}$), and zoomed to plot images (left to right) of the **dense** mangrove forest area



$\sigma^{\circ}_{VV}, \sigma^{\circ}_{VH}$, RGB (σ°_{VV} , σ°_{VH} , $\sigma^{\circ}_{VV}/\sigma^{\circ}_{VH}$), and zoomed to plot images (left to right) of the **sparse** mangrove forest area

ABOVEGROUND BIOMASS ESTIMATION USING SENTINEL-2, RAPIDEYE AND PLANETSCOPE



| Input Data | Satellite Data | r^2 | RMSE ($Mg\ ha^{-1}$) | Important Variables |
|---|------------------|-------|------------------------|---------------------------------|
| Vegetation Indices (NDVI, SAVI, GNDVI, SR, SRre) | PlanetScope | 0.80* | 7.68 | GNDVI, NDVI, SAVI |
| | Rapideye | 0.82 | 7.24 | GNDVI, SR, NDVI, SR, SRre, NDVI |
| | Sentinel-2 | 0.89* | 5.69 | NIR, Red, Green |
| Bands (B ₂ , G, R, NIR, RE TM) | PlanetScope | 0.80 | 7.78 | NIR, Blue, Red |
| | Rapideye | 0.92* | 4.96 | Blue, Red-edgel |
| | Sentinel-2 Set A | 0.62 | 10.66 | |
| Additional Bands (Set A + RE ₂₋₄ , SWIR 1,2) | Sentinel-2 Set B | 0.84 | 6.94 | Blue, SWIR1, Red-edgel |

Location of the study site in Masinloc, Zambales. A subset area is shown in RGB composite: Sentinel-2 (left), RapidEye (center) and PlanetScope (right)

Baloloy, et al

Directions in Research, Development & Operationalization

- **Continuous monitoring of mangrove forests**

Disturbance/anomaly alerts → immediate actions

- **Citizen Science**

App-empowered (volunteered geographic information)

- **Biomass and SOC models for the entire Philippines**

- **Development of spatial ecological metrics**

- **Geoportal and dashboard**

- **Network of institutions**

PhilSA Integrated Network for Space-enabled Actions towards Sustainability

Our Vision

The PhilSA envisions a Filipino nation **bridged, uplifted, and empowered** through the peaceful uses of outer space.

Our Mission

We will promote and sustain a robust Philippine space ecosystem that **adds and creates value** in space **for and from Filipinos and for the world.**

Thank you. Maraming salamat.



**Philippine
Space
Agency**

c/o UPD-Electrical and Electronics Engineering Institute,
EEEE (ULYS3ES) Building, Velasquez St.
UP Diliman, Quezon City 1101 Philippines

FB: PhilSpaceAgency

E: info@philsa.gov.ph

IG: philspaceagency

TW: PhilSpaceAgency

W: space.gov.ph/spacedata

LI: philspaceagency