The map on Figure 6 shows the normalized difference vegetation index (NDV) after the damages caused by typhoon Odette revealing massive damage and forest loss for 2022. The map shown on Figure 7 emphasizes the area where changes in the vegetation index occurred from pre-Odette to post-Odette through the normalization process. The red color scheme on the map indicates possible vegetation loss/ damage while the blue color scheme signifies possible vegetation growth. Evidently, there is massive possible vegetation loss/damage than possible vegetation growth. Using the identified areas where there are possible changes in vegetation, it can be inferred where the damaged ecosystem exists. Thus, experts and planners can already undertake broader plans and urgent directions for actions to abate further collapse of the damaged ecosystems. while preparing for specific measures to deal with disaster mitigation of damaged ecosystems in stages three and four.

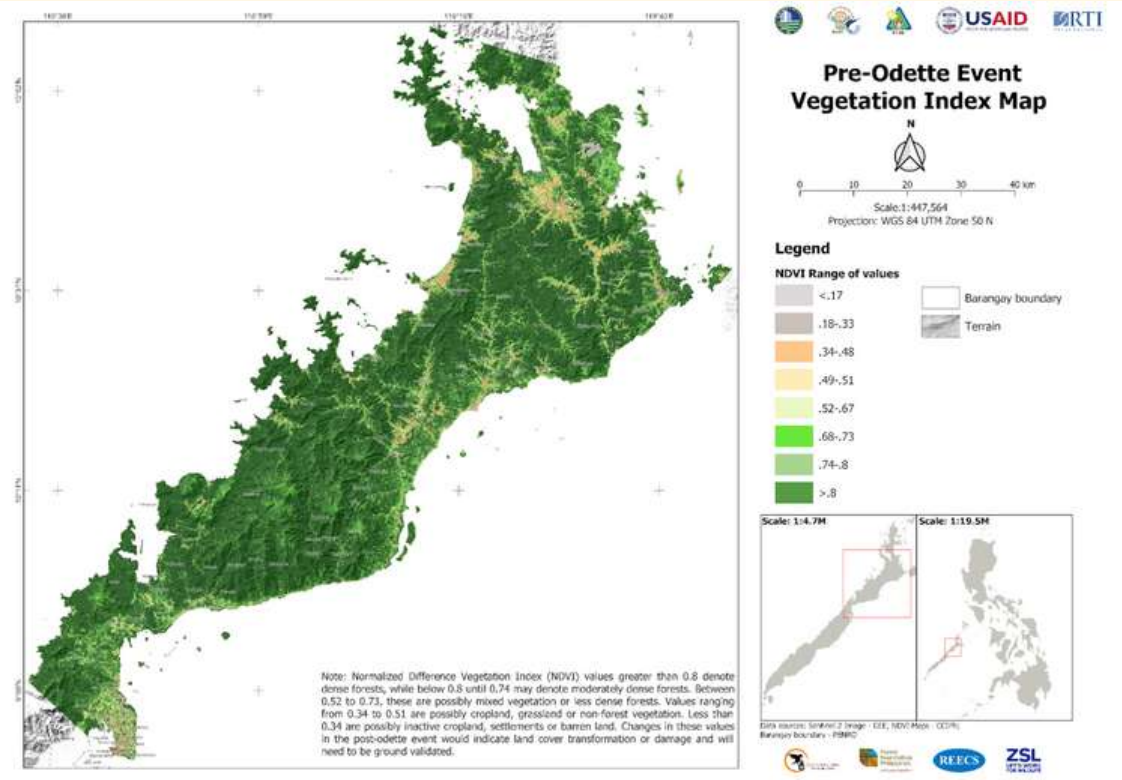

Figure 5. Pre-Odette Event Vegetation Map

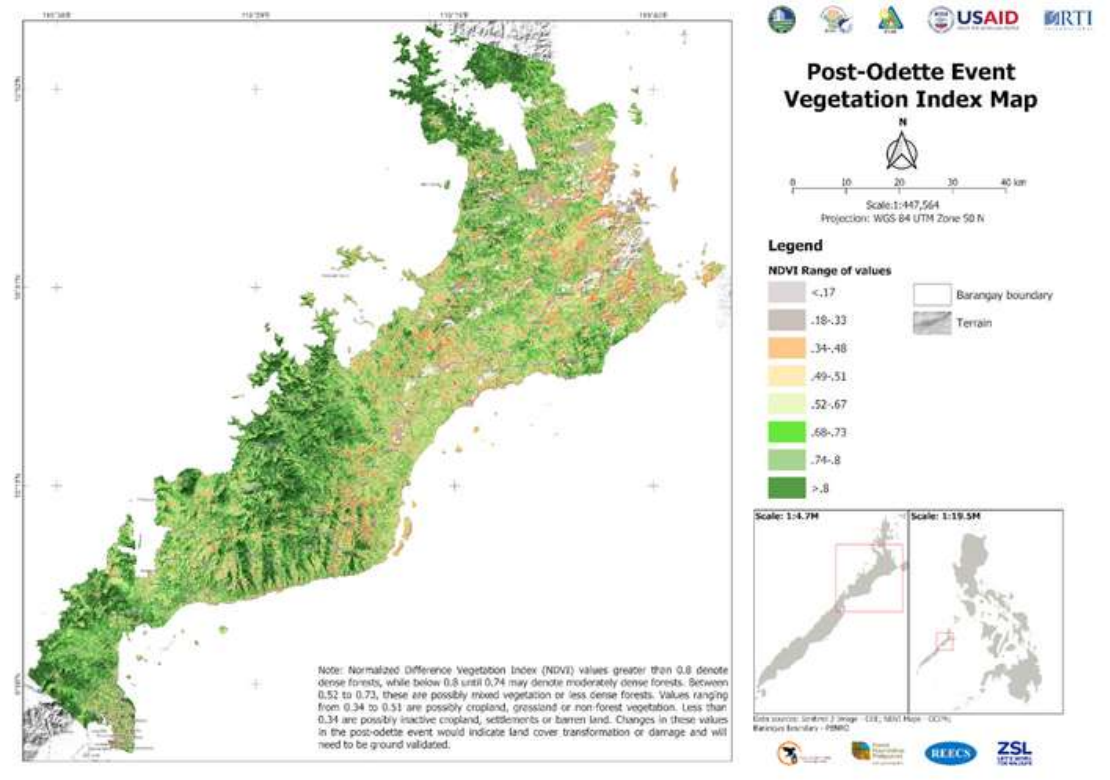

Figure 6. Post-Odette Event Vegetation Map

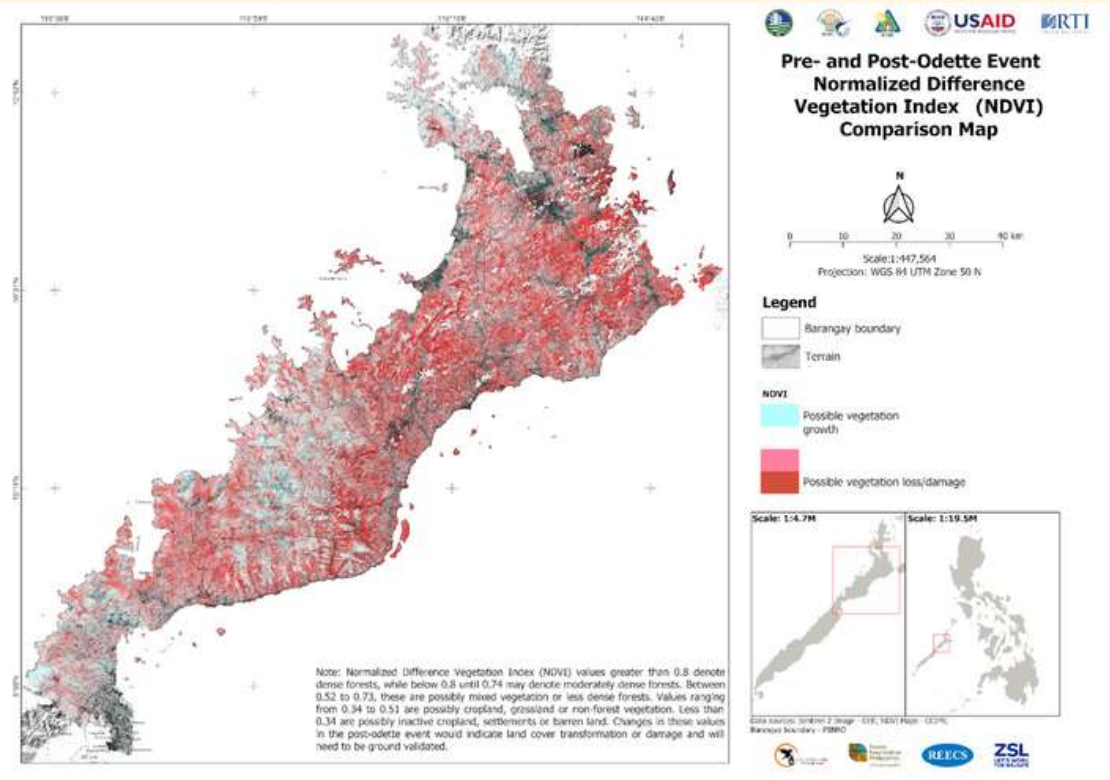

Figure 7. Pre and Post-Odette Event Normalized Vegetation Index (NDVI) Comparison Map

Stage 2: Ground Validation Surveys

This stage is about understanding the identified damage from Stage 1 through ground-truthing activities. This is divided into two streams: technical data (Stage 1) and citizen science data (Stage 2). The stream one (technical data) covers High Conservation Value Area Assessment from biodiversity assessments, comprehensive appraisal, ecosystem valuation and resource utilization. Stream two (citizen science data) uses technological solutions while working with the IPs and communities to assess the extent of damage caused by disaster in their area. Both of these streams generate information necessary for ground validation surveys such as biodiversity information, disaggregated land cover classification based on 6 IPCC classes and impacts of land cover change in resource utilization of local communities.

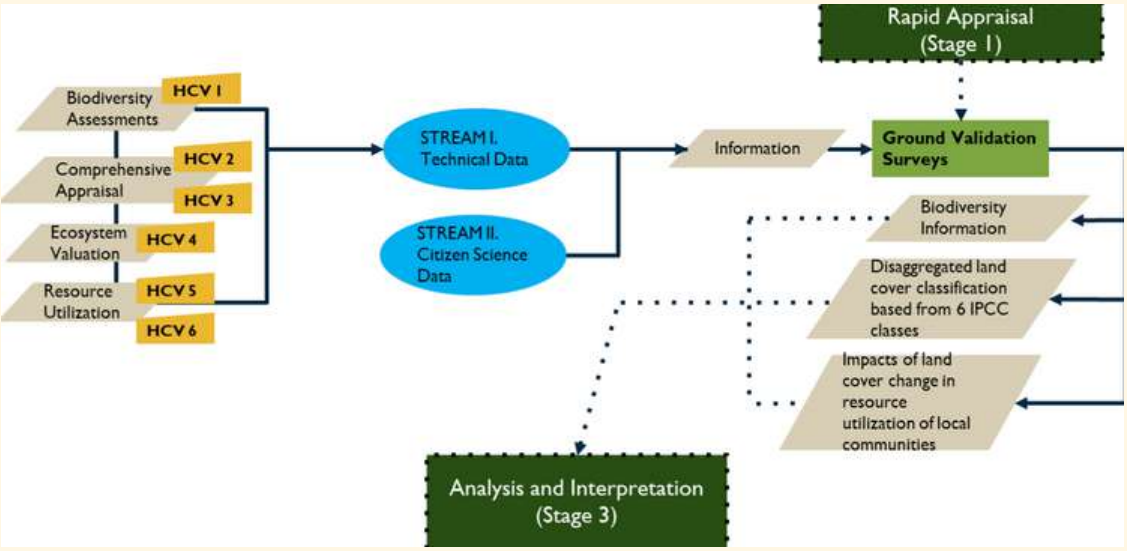

Figure 8. Green Assessment Stage 2 Ground Validation Surveys to Assess Impacts to HCVs

Case Study: Palawan Ground Validation Survey Activities and Results

SIBOL, together with local partners in Palawan, carried out and pilot tested Stage 2 between March 11 and June 12, 2022. All field activities were anchored on a participatory and capacity-building modality with regular mid-survey calibration and methods feedbacking to ensure replicability and sustainability of our efforts. These activities are started with proper courtesy calls and vetting with key agencies (Figure 9) such as the Puerto Princesa City Environmental and Natural Resources Office (CENRO), Provincial Environmental and Natural Resources Office (PENRO), Puerto Princesa Subterranean River and Natural Parks Protected Area Management Office (PAMO) and Palawan Council for Sustainable Development (PCSD). The capacity-building activities conducted in Palawan prior to ground-validation surveys are rapid biodiversity mid-surcey calibration, remote sensing training equipment calibration, rapid biodiversity planning, ground truthing training and methods feedbacking as shown on Figure 10 below.

Figures 9-10

Figure 9. Courtesy calls and vetting with key agencies of the Green Assessment Framework Stage 2: Vetting and Courtesy Calls

Figure 10. Capacity building activities conducted prior to ground validation surveys

Stream 1: Technical Data

Aerial Ground Truth Survey (Activity 1)

The 1st ground-validation survey for the 2nd stage of Green Assessment is the aerial ground-truthing survey using Remotely Piloted Aircraft Systems (RPAS) to assess the land cover condition and potential impacts of the typhoon to ecosystem assets (Figure 11).

Figure 11

Figure 11. Aerial Ground Truthing Survey using RPAS

Aerial Ground Truth Survey Output

The image below (Figure 12) is a sample processed drone image from the aerial ground truthing survey showing damaged mangrove forest in San Miguel, Roxas with a flight area of 5.4 hectares. Processing of the aerial images can be done using the *Pix4D Mapper* or *DJI Terra* software depending on the brand and model of the drone that will be used.

Figure 12. Processed drone image from the aerial ground truthing survey of mangrove forest in San Miguel, Roxas

Municipality	Barangay	Number of Flights per Barangay	Total Number of Flights per Municipality
Puerto Princesa	Cabayugan	2	70
	San Rafael	5	
	Tanabag	6	
	Concepcion	3	
	Binduyan	1	
	Langogan	9	
	Buenavista	7	
	Tagabinet	8	
	Bahile	5	
	Marufinas	11	
	New Panggangan	12	
Roxas	Tinitian	10	78
	Jolo	8	
	Nicanor Zabala	7	
	Caramay	6	
	Magara	13	
	San Jose	4	

Municipality	Barangay	Number of Flights per Barangay	Total Number of Flights per Municipality
Roxas	San Miguel	14	78
	Minara	5	
	Dumarao	8	
	Rizal	3	
San Vicente	Kemdeng	4	55
	Port Barton	11	
	Binga	4	
	Alimanguan	3	
	San Isidro	2	
	Caruray	6	

Rapid Biodiversity Assessment (Activity 2)

During the rapid biodiversity assessment, the team usually travels miles on foot to assess the effect on biodiversity. They coordinate with the communities regarding the location of birds, mammals, reptiles and amphibians to determine the displacement of animals upon the onset of disaster.

The following are the study sites for rapid biodiversity assessment in Palawan and their inclusive dates:

- PPSRNP (12 days)
  Sitio Calaga, and Panablan, Marufinas - March 11 to 22, 2022
- CNCH (Cleopatra's Needle KBA) (13 days)
  Sitio Kalakwasan, Tanabag - March 29 to April 5, 2022
  Sitio Mangapin, Langogan - April 7 to 11, 2022
- Roxas (Cleopatra's Needle KBA) (7 days)
  Sitio Kayasan, Nicanor Zabala, Roxas - April 23 to 29, 2022

Figure 13. Rapid Biodiversity Assessment

This is the sampling effort for the rapid biodiversity assessment conducted in the study sites covering a total of 320 hectares:

Overall effort:

- 21 2-km biodiversity transect lines

Effort per taxonomic group:

- Herpetofauna - 550 person-hours
- Mammals - 1,470 trap nights
- Birds - Length: 40 km, Width: 80 m
  - Area = 320 ha
- Flora - Length: 40km, Width: 40 m
  - Area = 160 ha

Rapid Biodiversity Key Observations on Fauna

Here are the fauna key observations during the rapid biodiversity assessment in Palawan study sites:

- Higher occurrence of herpetofauna near water bodies (Figure 14);
- Observed Carcasses (sample found Palawan Hornbill and Palawan Flying Squirrel) (Figure 15);
- Dominance of insect bats in PPSRNP (Figure 16);

Continue

- In PPSRNP, bird detection, especially frugivores, reduces with increased canopy openings caused by damaged trees and high defoliation (Figure 17);
- In CNCH, fewer trees are damaged and defoliated. Fruit-bearing and flowering trees are able to provide food sources to frugivorous birds

Figure 14. Herpetofauna near water bodies

Figure 15. Observed Carcasses

Figures 16-17

Figure 16. Dominance of insect bats in Puerto Princesa Subterranean River and Natural Park

Figure 17. Bird Detection in Puerto Princesa Subterranean River and Natural Park and Cleopatra's Needle Critical Habitat

Rapid Biodiversity Key Observations on Flaura

On the other hand, the following are the flora key observations during the rapid biodiversity assessment in the Palawan study sites:

- Higher percentage of crown defoliation and broken stems with higher elevation in barangay Marufinas (Figure 18);
- Understorey and ground cover vegetation underneath the fallen logs (Figure 19);
- Increase in leaf litter due to defoliation and dried epiphytes (Figure 20);
- Emergent trees were uprooted or broken from the buttress. Small to medium sized trees were broken in the middle (Figure 21);
- The increase in water volume during the typhoon uprooted most of the trees and exposed large rocks near the rivers and creeks of Kalakawasan, Tanabag. The upland areas consist primarily of patches of old-growth and advanced secondary growth forests, but some portions were severely damaged due to landslides. Some landslides were proximal to kaingin areas (Figure 22);
- There are some canopy openings for some opportunistic species (e.g Palawan Santan and Palm) (Figure 23) .

Figure 18. High percentage of crown defoliation and broken stems in barangay Marufinas

Figure 19. Understorey and ground cover vegetation underneath the fallen logs

Figure 20. Increase in Leaf litter due to defoliation and dried epiphytes

Figure 21. Emergent trees were uprooted or broken from the buttress. Small to medium sized trees were broken in the middle.

Figure 22. Uprooted trees and exposed large rocks near the rivers and creeks of Kalakawasan, Tanabag.

Figure 23. Palawan Santan (right) and Palm (left) as opportunistic species.

Study of Land Use Change (Activity 3)

The Study of Land Use Change activities determine areas that are important to wildlife and communities that may have been degraded as a result of natural or anthropogenic activities and would need further assistance in restoration. The agent and drivers of land use change are also determined together with the identification of potential threats to the High Conservation Values. The usual workflow of the study of land use change comprises of the following activities:

1. Preliminary work
2. Calibration Training
3. Assessment Proper
4. Stakeholder Input
5. Analysis
6. Results

Study of Land Use Change: Ground Assessment Key Observations

The following are the ground assessment key observations in Puerto Princesa and Roxas:

1. Forests

The forests in Puerto Princesa have observed siltation, drying up, quarry,landslide and unregulated logging brought about by clearing of debris, insecure water supply, loss of Non Timber Forest Products (NTFP areas, displacement of wildlife and humans, neglected traditional ecological knowledge and loss of customs, rituals, taboos and myths of IP communities.

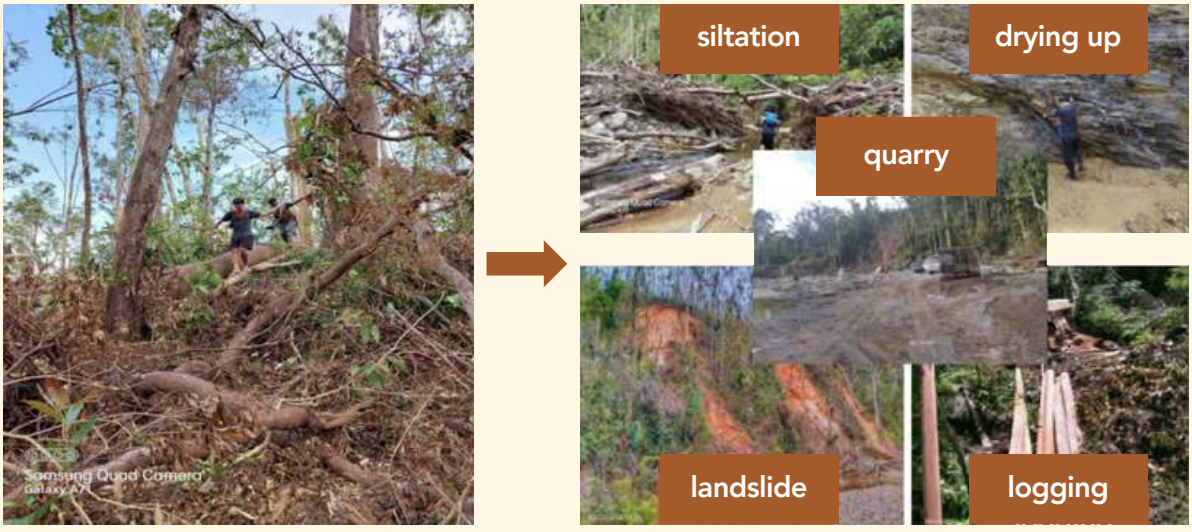

Figure 24. Ground Assessment Results of Forests in Palawan

2. NTFP Areas

The NTFP areas suffered damage to the honey Almaciga areas which resulted in the loss of the main source of income to the communities, redistributing areas for NTFP collection amongst households and traditional ecological knowledge and practices set aside.

Figure 25. Ground Assessment Results of NTFP Areas in Palawan

3. Hunting Grounds

The hunting grounds in Palawan are damaged which lead to the creation of new hunting grounds. Species are harder to locate with traditional practices being set aside.

Figure 26. Ground Assessment Results of Hunting Grounds in Palawan

4. Residential

Among the observed damages caused by typhoon Odette are the damages to residential areas leading to competing for land and natural resources, weak legal claims over new land and unregulated use of materials to rebuild homes.

Figure 27. Ground Assessment Results of Residential Area in Palawan

5. Cropland

Some of the damaged croplands in Palawan include copra, cashew nut harvests, palay and sweet potato.

Figure 28. Ground Assessment Results of Cropland in Palawan

Stream 2: Citizen Science

Training Youth in using Earthranger

One of the citizen science activities that can be done for Green Assessment is to train youth to use Earthranger. It is a platform to record and map the location of damage after the onset of a disaster which can be readily accessed remotely through a dashboard (Figure 30) to share the result faster. The images below (Figure 29) show the training of youth activities in Palawan in using EarthRanger.

Figure 29. Youth training using Earthranger

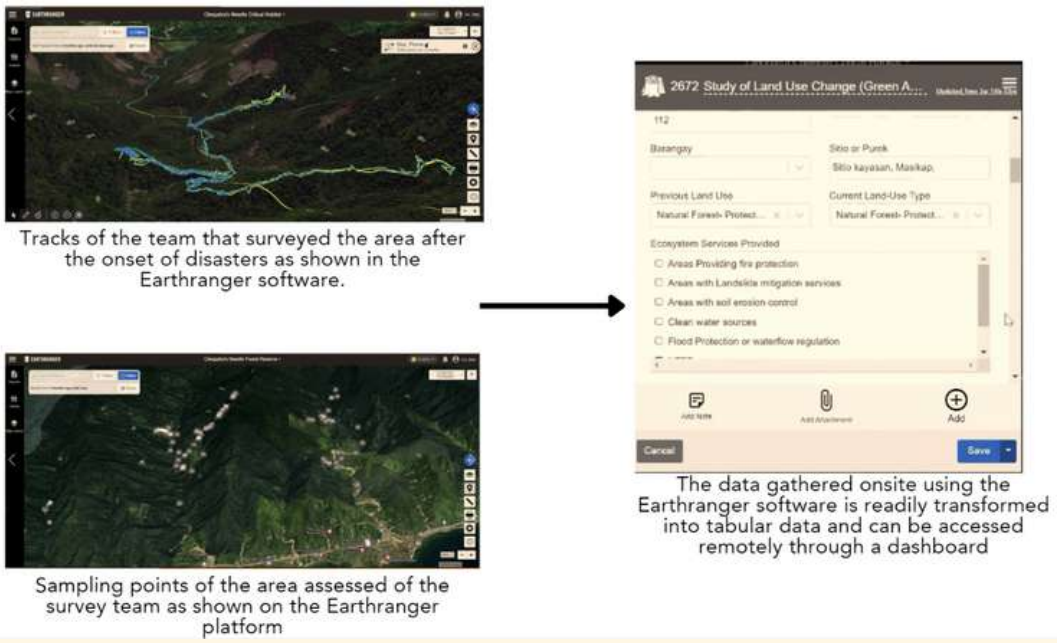

Figure 30. Tracks and Sampling Points shown in the Earthranger platform and dashboard

Stage 3: Data Analysis and Interpretation

In this stage, the damage maps generated from stage 1 will be analyzed and interpreted together whether they are consistent with the ground truthing activities results. Data that may be interpreted and analyzed are hazard maps, management zones (reconstruction, rehabilitation/restoration, & relocation zones), vulnerability and susceptibility maps, pre-Odette and post-Odette species distribution model output, ecosystem service valuation and recovery pathway on damages to agriculture, forestry and fisheries in preparation for the green reconstruction and resilience planning in stage 4.

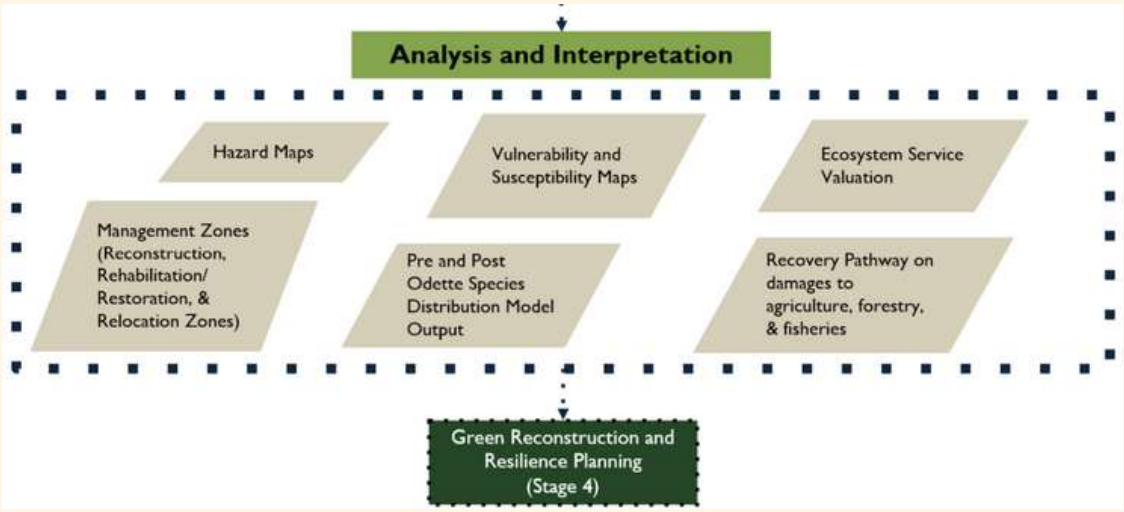

Figure 31. Green Assessment Stage 3 Data Analysis and Interpretation

Case Study: Palawan Green Assessment Preliminary Results

Figure 32 shows the conformance of the Stage 1 rapid map (left) with the result of ground validation survey from Stage 2 (right) where there are evident fallen trees on the aerial survey image.

Figure 32

Figure 32. Post- Odette Event Vegetation Map (Fallen Trees)

The figure below also shows the consistency of the results of Stage 1 rapid mapping (left) and ground validation survey (right) where damaged mangroves and damaged coconut trees are located.

Figure 33. Post- Odette Event Vegetation Map (Damaged Coconut Trees and Damaged Mangroves)

The preliminary analysis revealed different scenarios of the modeled species. The maps below show the habitat suitability model of Palawan Hornbill before the typhoon and after the typhoon. Based on the model, the distribution pattern of the Palawan Hornbill tends to follow where the available forests are in the Puerto Princesa Subterranean River and Natural Park and Cleopatra's Needle as represented by dark shading. This indicates the remaining forest in these areas are suitable to support the survival of this species.

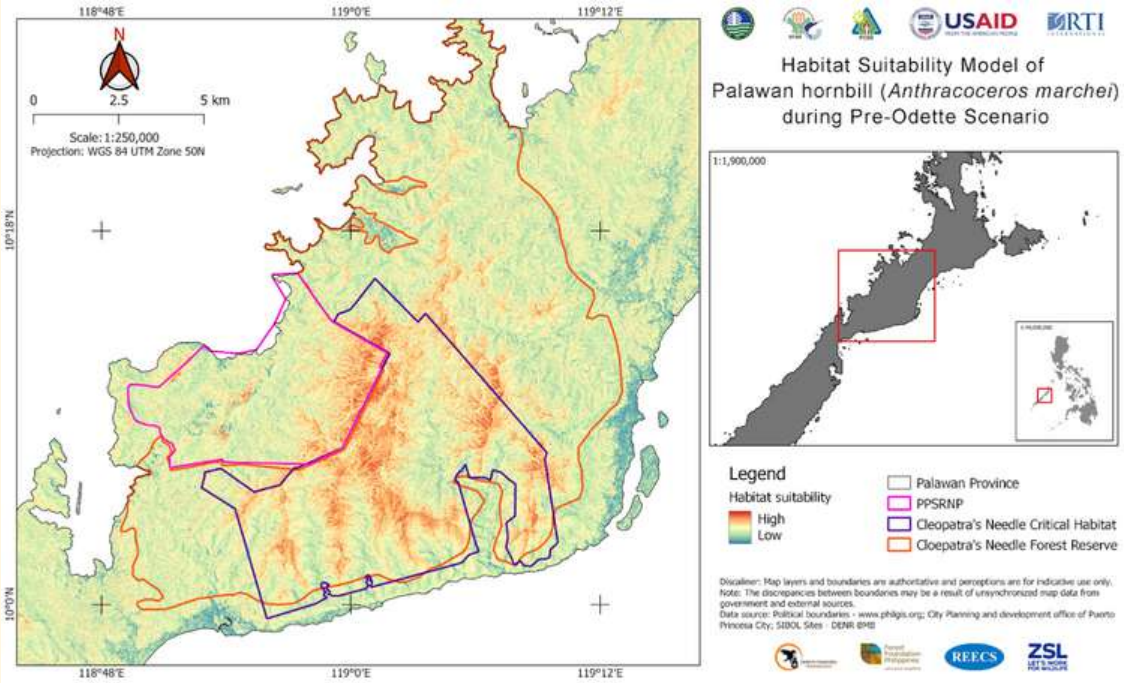

Figure 34. Habitat Suitability Model of Palawan Hornbill during Pre-Odette (2021)

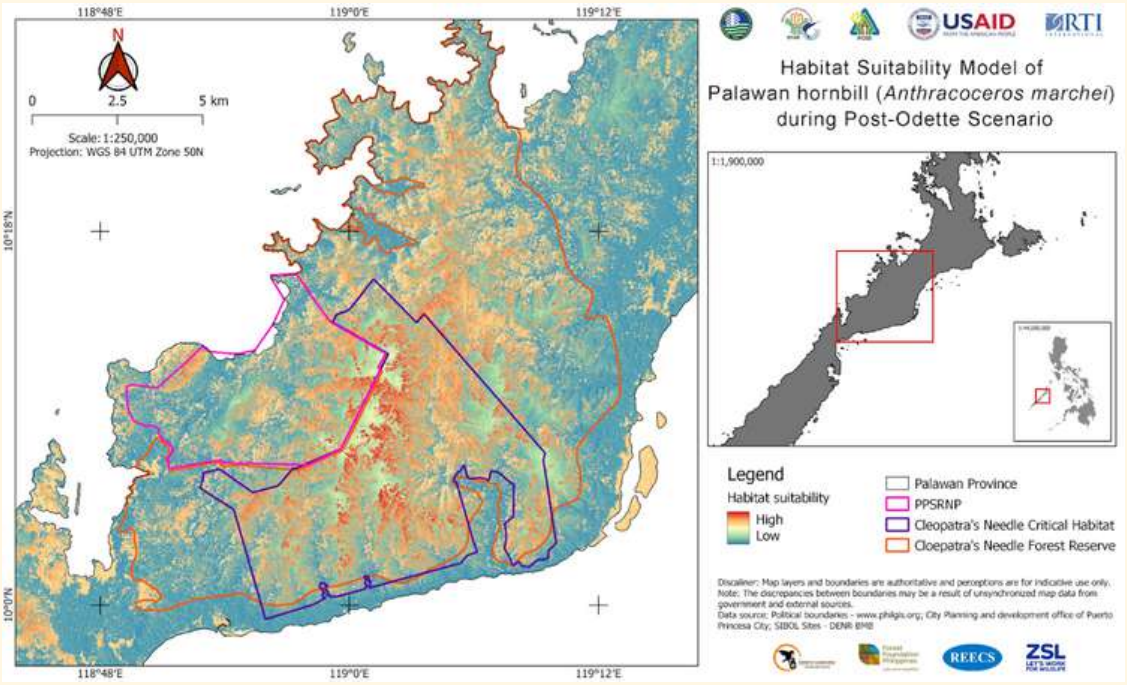

Figure 35. Habitat Suitability Model of Palawan Hornbill during Post-Odette (2021)

Through the data gathered on ground, there are numerous species congruence maps that were generated for the PPSRNP and CNCH Key Biodiversity Area as shown on Figures 36-41.

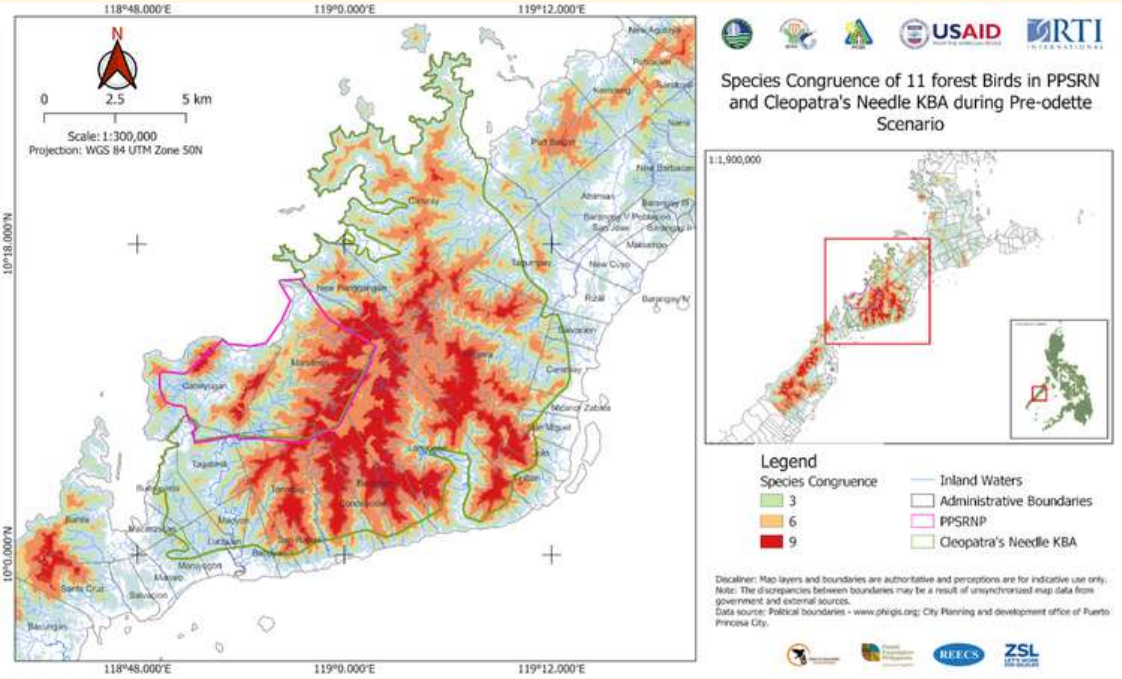

Figure 36. Species Congruence of 11 Forest Birds in PPSRNP and CNCH Key Biodiversity Area during Pre- Odette

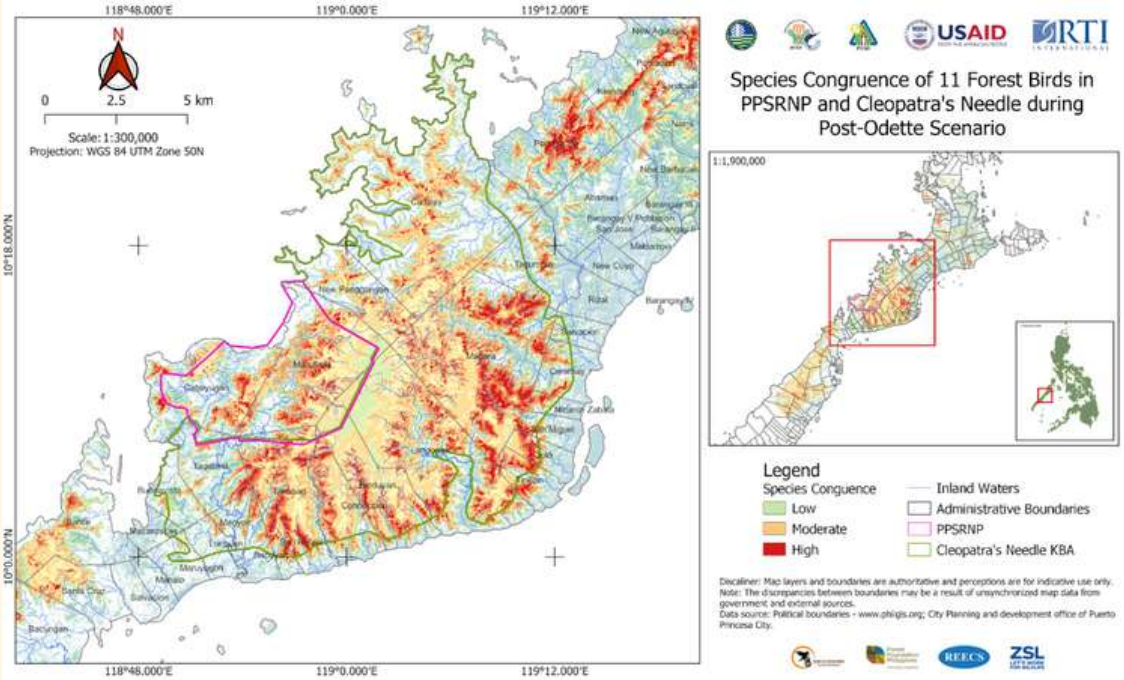

Figure 37. Species Congruence of 11 Forest Birds in PPSRNP and CNCH Key Biodiversity Area during Post- Odette

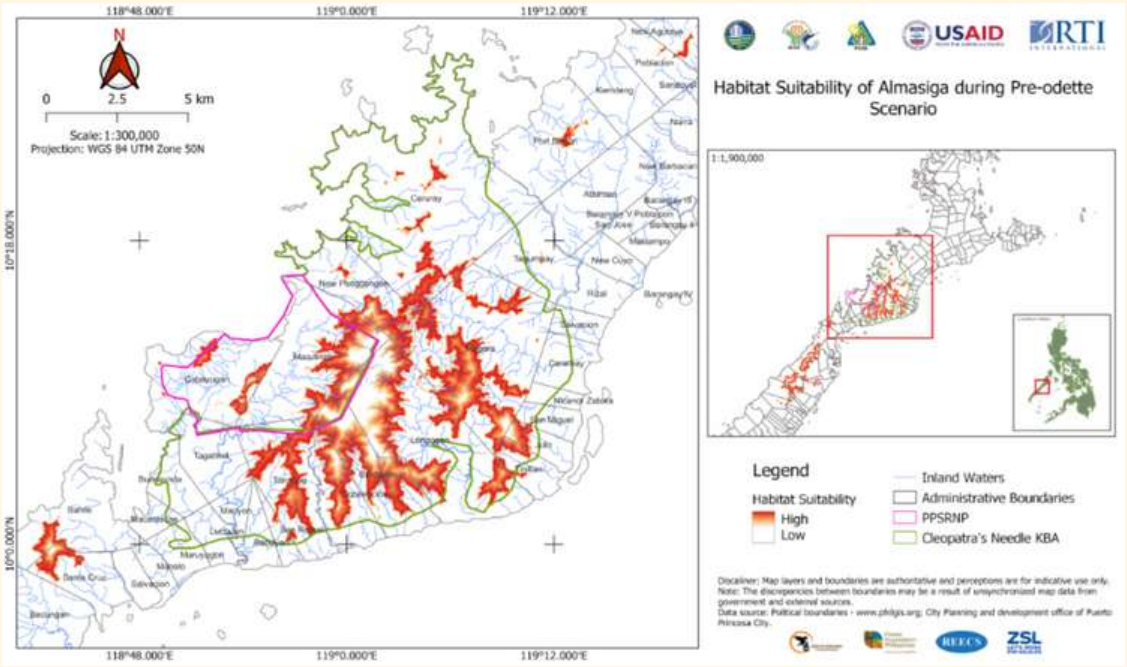

Figure 38. Habitat Suitability of Almaciga during Pre-Odette (2021)

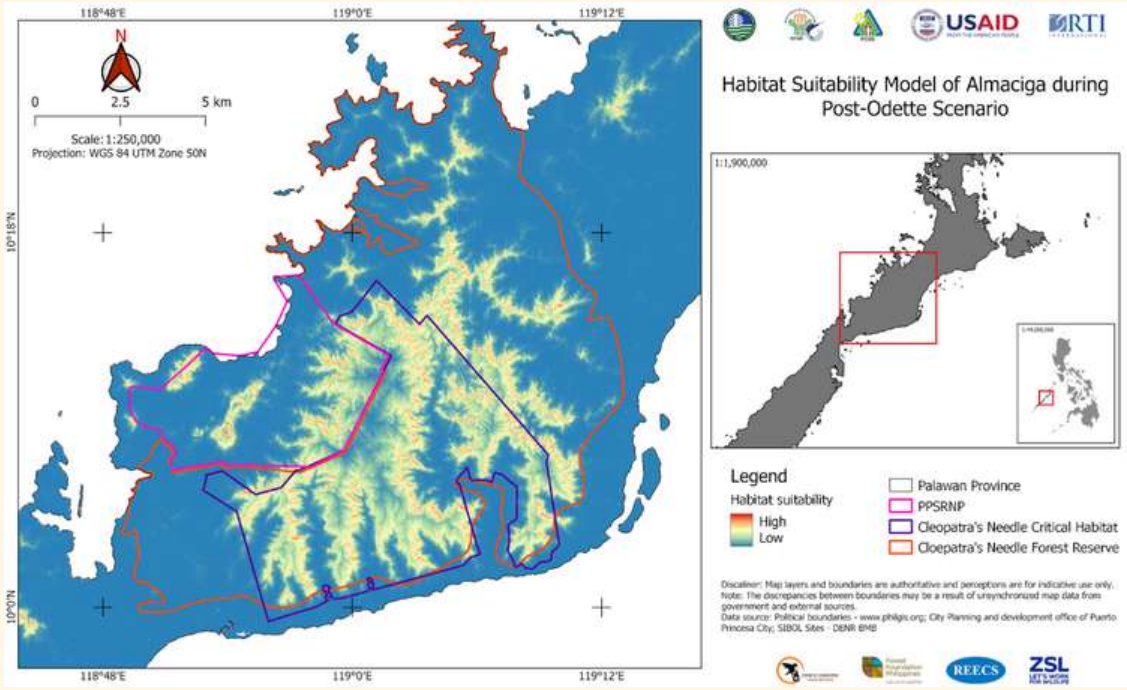

Figure 39. Habitat Suitability of Almaciga during Post-Odette (2022)

Figures 40-41

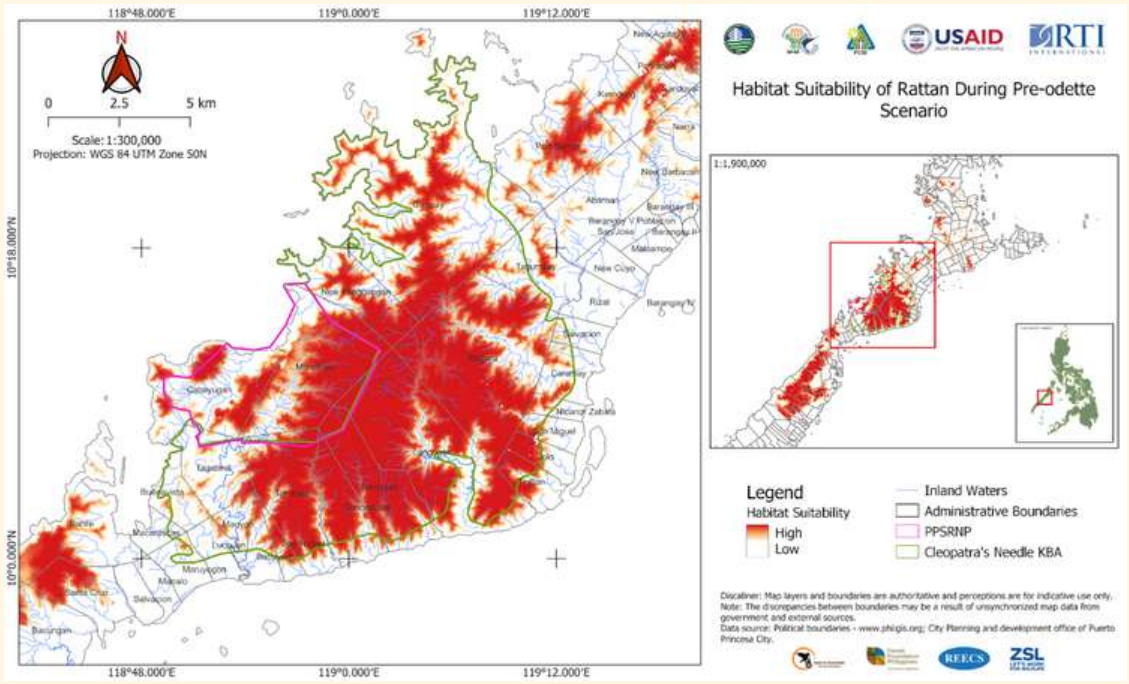

Figure 40. Habitat Suitability of Rattan during Pre-Odette (2021)

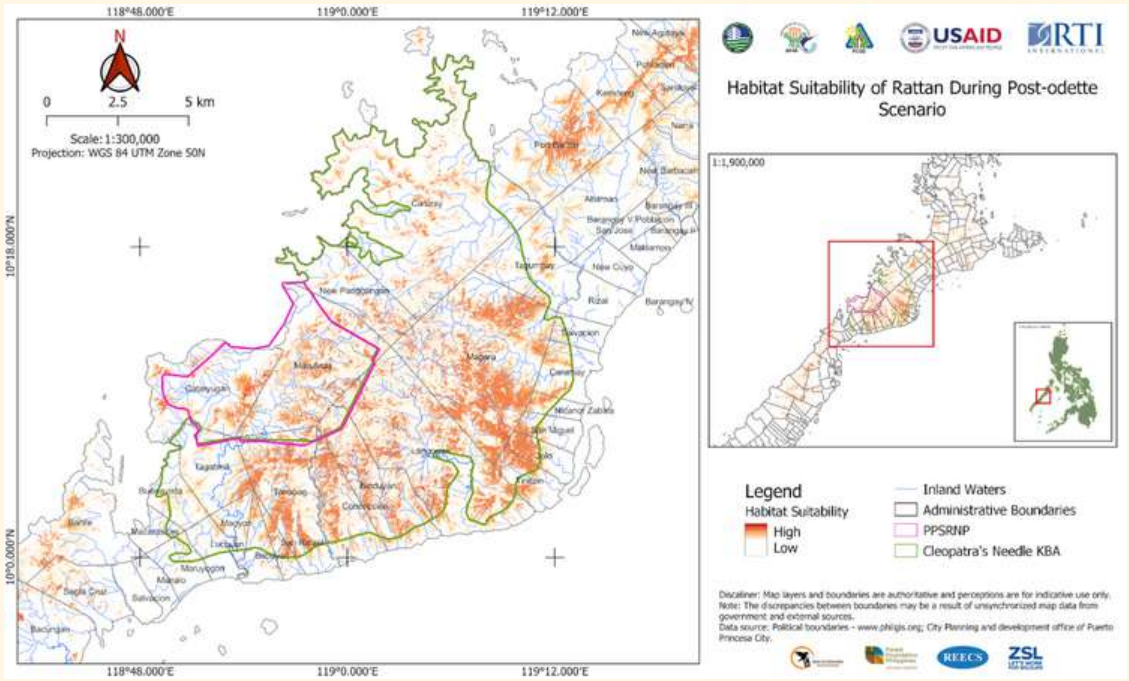

Figure 41. Habitat Suitability of Rattan during Post-Odette (2022)

Stage 4: Green Reconstruction and Resilience Planning

This is the last stage of the Green Assessment Framework where all the interpreted and analyzed maps will be fed into the reconstruction and resilience plan.

Lesson 2.1
Introduction to Geographic Information System

Duration	Purpose of Learning
15 minutes	• To review on the basic concepts of GIS and the different real-life data that can be represented as GIS data GIS data • To differentiate spatial and non-spatial data • To be familiar with projections and different coordinate systems • To distinguish Projected Coordinate System (PCS) with Geographic Coordinate System (GCS) and know when to use them

Requirements:

- Lecture with powerpoint presentations
- Laptop
- QGIS (latest most stable version)
- Center for Conservation Innovation Philippines' Manual for the Introduction to Geographic Information Systems and Basic Quantum GIS

About this lecture

Since this training manual mainly focuses on the Stage I of the Green Assessment Framework, which is the Rapid Appraisal, most of the activities will involve basic mapping, remote sensing and processing using QGIS. This lecture series covers a brief review on the relevance of GIS including the basic concepts and components of GIS (spatial data, non-spatial data and coordinate reference system).

For more information regarding the introduction to Geographic Information System, please refer to the CCIPH's Manual for for the Introduction to Geographic Information Systems and Basic Quantum GIS.

Lesson 2.2
Introduction to QGIS and Basic Map Layouting

Duration	Purpose of Learning
1 hour	• To familiarize with the QGIS interface and learn the advantage of using the software • To perform basic GIS processing using QGIS such as (adding the layers, navigating the map canvas, choosing appropriate symbologies, layouting of a basic map, and saving and exporting work)

Requirements:

- Lecture with powerpoint presentations
- QGIS (latest most stable version)
- Laptop
- Center for Conservation Innovation Philippines' Manual for the Introduction to Geographic Information Systems and Basic Quantum GIS

About this lecture

Most of the activities in the succeeding training modules for the Green Assessment will involve maps and processing using QGIS. In this section, you will be introduced to the QGIS general user interface, toolbars as well as the basic layouting and generating of maps, providing the beginners with QGIS a guide when performing the activities during this training.

For more information regarding the introduction to Geographic Information System, please refer to the CCIPH's Manual for for the Introduction to Geographic Information Systems and Basic Quantum GIS.

Exercise 1: Creating a Map Layout

Duration	Purpose of Learning
30 minutes	• To create and export a basic map layout using QGIS

Requirements:

- QGIS (latest most stable version)
- Laptop
- Center for Conservation Innovation Philippines' Manual for the Introduction to Geographic Information Systems and Basic Quantum GIS shapefiles of area of interest (AOI) such as barangay boundary, mangroves, road network, watershed and DEM*

**If these shapefiles are not available, you may use the sample dataset provided by the facilitator for Exercise 1*

Expected Output:

- Basic map layout of the mangroves and watershed in Central Palawan

---

About this Exercise

In this activity, participants are encouraged to use the layers for their own regions but they may use the layers in the Exercise 1 folder provided to them.

Instructions

1. Load the following layers from your Exercise 1 folder using any of the three ways provided: barangay boundary UTM 50N.shp mangroves.shp road network UTM 50N.shp watershed UTM 50N.shp DEM.tif

2. Rearrange the layers by simply dragging the layers from your Layers Panel for the optimal view of all the layers that you wish to see in your map.

3. Uncheck the layers that you do not want to be shown on the map.

4. If you are already satisfied with the way the layers are shown in your map area, you may now proceed with the laying out of the maps using the Map Composer.

Continue

Instructions

In the *Legend* Item properties in the map composer set the following:

Main Properties

Title: Legend
Arrangement: Symbols on Left

Uncheck Resize to fit contents

Legend Items

Uncheck Auto Update

Rename the following:

- barangay boundary UTM 50N - Barangays
- mangroves.shp - Mangroves
- road network UTM 50N.shp - Roads
- watershed UTM 50N.shp - Watershed
- DEM.tif - Elevation

5. Follow the map layout discussed in Lesson 2.2.

For a detailed guide on map layout, check out the CCIPH manual on the Introduction to QGIS.

Lesson 3
Land Cover, Land Use and Land Classification

Duration	Purpose of Learning
10 minutes	• To differentiate land cover, land use and land classification

Requirements:

- Lecture with powerpoint presentations
- Center for Conservation Innovation Philippines' Manual for the Noteworthy Terms to Ponder

About this lecture

This lecture aims to differentiate the three concepts that are often used interchangeably such as land cover, land use and land classification through sample maps, which is vital in understanding the six land cover classification used for green assessment.

For more information regarding the introduction to Geographic Information System, please refer to the CCIPH's **Manual for the Noteworthy Terms to Ponder.**

Lesson 4
Land Cover Classification for Green Assessment

Duration	Purpose of Learning
10 minutes	• To familiarize with six different land cover classifications defined together with the Palawan Council for Sustainable Development

Requirements:

- Lecture with powerpoint presentations

Land Cover Classes for Green Assessment

The six broad categories of land cover classes used for Green Assessment such as *forestland, cropland, wetland, grassland, settlements* and other lands were worked out according to the classification hierarchy developed with the Palawan Council for Sustainable Development (PCSD), whose island province was one of the worstly devastated by Super Typhoon Odette. These categories are selected since these are reasonably consistent with the Intergovernmental Panel for Climate Change (IPCC) Guidelines and the requirements of Articles 3.3 and 3.4 of the Kyoto Protocol. It is also recognized that these land categories are a mixture of land cover (e.g., Forest land, Grassland, Wetlands) and land use (e.g., Cropland, Settlements) classes. To distinguish it from the "land use" term used in Comprehensive Land Use of the Philippines (CLUP), these are referred to as "land classes" or "land cover classes." These are also robust as a basis for carbon estimation and are reasonably mappable by remote sensing methods, while being a complete representation in the local setting, because all land areas can be represented in one or another category.

The general land cover classes must be carefully distinguished and identified between the rapid mapping without ground truthing of the Stage 1 of Green Assessment to mapping with ground-truthing through remote piloted aircraft survey and field inspection of the Stage 2 of Green Assessment. These land cover classes between Stage 1 and Stage 2 are shown in the succeeding figures.

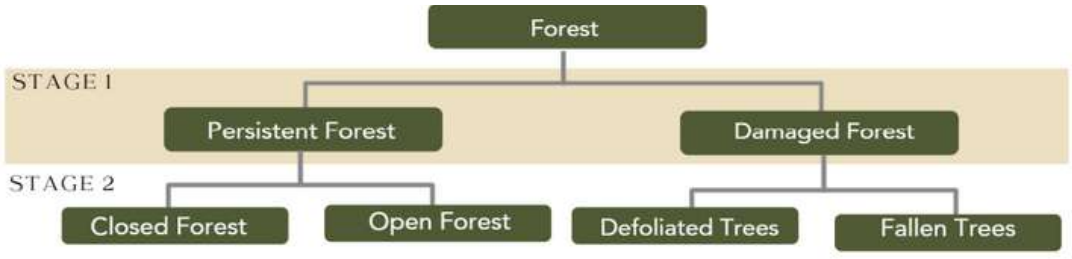

Figure 42. Forest classes for Stage 1 and Stage 2 of Green Assessment.

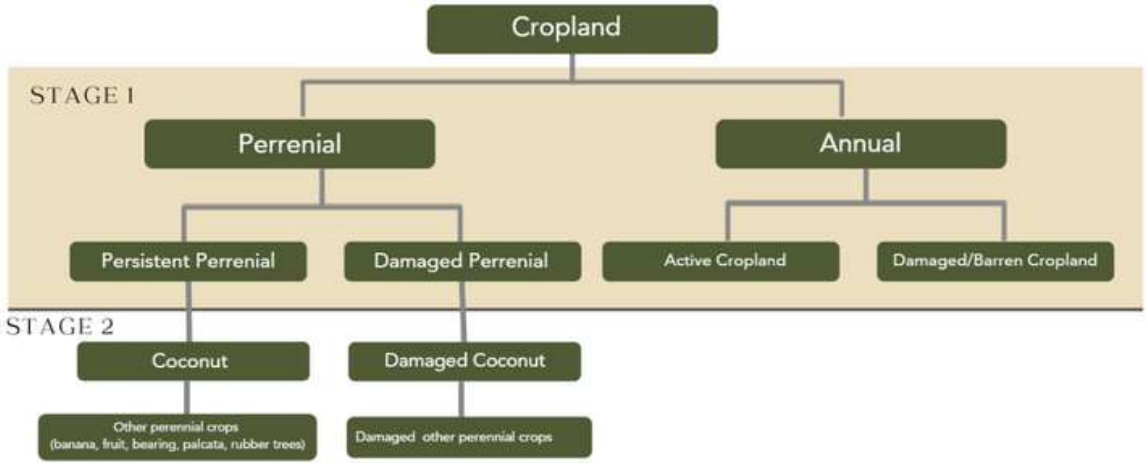

Figure 43. Cropland classes for Stage 1 and Stage 2 of Green Assessment.

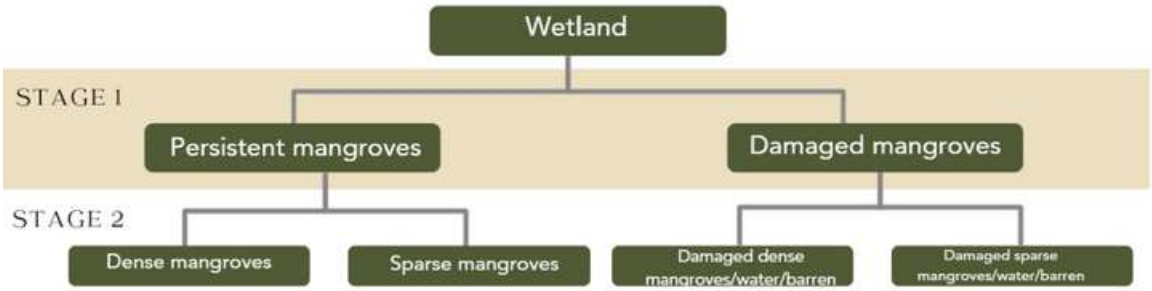

Figure 44. Wetland classes for Stage 1 and Stage 2 of Green Assessment.

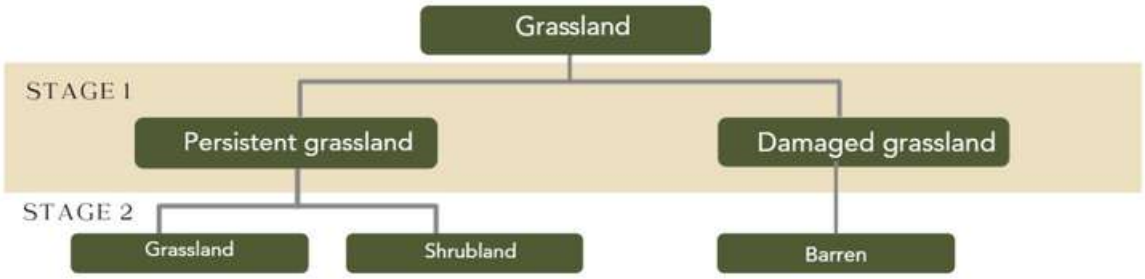

Figure 45. Grassland classes for Stage 1 and Stage 2 of Green Assessment