GREEN ASSESSMENT STAGE 1: RAPID MAPPING

Geospatial Training On Rapid Mapping for Green Assessment

The geospatial training manual aims to teach geospatial practitioners on a particular method of developing a Stage 1 Green Assessment map to quickly determine the land surface changes, which has occurred after an extreme of exceptional event such as a severe typhoon, deforestation, or revegetation.

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Philippines Sustainable Interventions for Biodiversity, Oceans, and Landscapes (SIBOL)

Geospatial Training On Rapid Mapping for Green Assessment

Green Assessment Stage 1: Rapid Mapping

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Acronyms

AOI	Area of Interest
CNCH	Cleopatra's Needle Critical Habitat
GA	Green Assessment
GEE	Google Earth Engine
GIS	Geographic Information System
GPS	Global Positioning System
GT	Groundtruth
HCVA	High Conservation Value Area
IPCC	Intergovernmental Panel on Climate Change
LGUs	Local Government Units
NDVI	Normalized Difference Vegetation Index
NICFI	Norway's International Climate and Forests Initiative
NTFP	Non-Timber Forest Products
PCSD	Palawan Council for Sustainable Development
PPSRNP	Puerto Princesa Subterranean River and Natural Park
QGIS	Quantum Geographic Information System
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
ROI	Region of Interest
SIBOL	Sustainable Interventions for Biodiversity Oceans and Landscapes
USGS	United States Geological Survey

Preface

The Green Assessment Framework was developed to determine the magnitude of typhoon-related damages to biodiversity, ecosystems, and ecosystem services. It is currently being piloted in SIBOL's key sites, Puerto Princesa Subterranean River National Park and Cleopatra's Needle Critical Habitat in Palawan, and Siargao Island Protected Landscape and Seascape in Surigao Del Norte. The framework is now for adoption by the Department of Environment and Natural Resources (DENR) for gathering pre and post disaster biodiversity and ecosystem information that will provide the basis for the formulation of management recommendations for green resilience planning. USAID SIBOL, together with DENR Climate Change Service (CCS) as coordinator, will conduct training workshops to build the capacities of DENR on conducting green assessments by maximizing the collection of ecological and socio-economic data to inform strategic planning in post-disaster scenarios.

The Green Assessment Framework has four (4) stages. Stage 1 is the rapid appraisal, which makes use of GIS and RS technology to generate data on vegetation cover and identify any changes in forest surface cover. Stage 2 employs both centralized and citizen science-driven streams of data gathering and actual ground validation surveys. Stage 3 is analyzing the information gathered from Stages 1 and 2 and estimating the extent of damage and changes in land use. Stage 4 involves developing green resilience plans for damages to biodiversity and ecosystem assets.

To start the national capacity development, training on rapid appraisals (stage 1) will be conducted to improve the skills of DENR employees in utilizing geographic information system (GIS) and remote sensing (RS) technologies to capture the difference in vegetation at a phenological status in the aftermath of the typhoon. The results of the rapid appraisal can provide managers with the information needed to identify immediate interventions and direct environmental management efforts. The results will also allow participants to pinpoint damaged hotspots for ground validation surveys in stage 2.

The capacity development activities aim to teach geospatial practitioners on a particular method of developing a Stage 1 green assessment map to quickly determine the land surface changes, which has occurred after an extreme or remarkable event such as a severe typhoon, deforestation or revegetation. Capacity development and mentoring should continue even after the participants have returned to their respective offices to ensure replicability and sustainability. Each regional office is expected to produce maps showing pre-event vegetation index of the identified "pilot" area of interest and post-event vegetation index map (especially for regions that have been recently impacted by typhoons), and preliminary findings from overlapping vegetation change or damage with management zones or other land use plans. Regular meetings will be scheduled with the participants to mentor and monitor their progress and ensure the quality of their outputs.

Training Design

1.1 Overview

This five-day workshop covers lectures and numerous exercises such as: discussions on basic QGIS; principles of remote sensing; land cover and change detection due to an extreme or exceptional event; sourcing, downloading, processing and spatial analysis of satellite imagery; establishment of reference points for ground-truthing and land cover classification; and producing of map layouts. These exercises are geared towards achieving the objectives of the training, as described in Section 1.2.

General Workflow for Performing the Rapid Appraisal Mapping Process

The facilitators shall discuss the rapid appraisal mapping process on green assessment following the workflow on Figure 1 to provide the participants with a better overview of the lectures and exercises that will be conducted.

The training starts with the fundamentals of knowing how to create simple map layouts with the appropriate coordinate reference systems (Review of Basic QGIS). This can be a new knowledge and skill gained for those who do not have any prior experience with mapping, but a refresher for those, who have the previous knowledge of the basic concepts and skills in creating the map layouts.

Facilitators levels-off with the participants' understanding of the concepts by introducing some important definitions of terms in rapid mapping (*Noteworthy terms to ponder*). Once the basic mapping and standard terms are established, discussions on the principles behind the science and technology of Remote Sensing are presented (*Principles of Remote Sensing*).

With the established principles of Remote Sensing, participants are now able to map the vegetation of the pre-, post-event and detect change in their target areas (*Land cover and change detection due to an extreme or exceptional event).* Once participants understand how to do the mapping and the calculations, they will then be oriented on the online data catalogues from provided data at no cost (*Sourcing of notably free satellite images).* The facilitators then demonstrate several ways of seeking and downloading satellite data images *(Satellite image download).* The downloaded satellite images are then processed to provide a vegetation index to rapidly map the forest damage or change in the land cover *(Processing of satellite image).*

Having gained the knowledge and skill on basic mapping, participants will use the vegetation index maps to do terrain analysis, which will be the first exercise on spatial analysis in the training. The aim of this analysis is to find sites where urgent action to visit and render help to the ecosystem can be prioritized. The criteria to find those sites can be set or they can opt to follow the example presented by the facilitators so they can have a quick plan for rapid assessment (*Spatial analysis for identifying regions of interest*). Facilitators will set the categories to reclassify the raster values according to the range of index values to approximate the land cover type participants will visit--possibly based on the most damage sustained by the forest ecosystem (*Reclassifying satellite image values*).

In preparation for Stage 3, in which participants will translate the satellite image (pre- or post-event) into actual land classes found on the ground, they need to undergo Stage 2. This latter stage pertains to the ground-truthing (GT) component to gather enough field data to get to Stage 3. The GT team will have to prepare a map with information consisting of reference points randomly selected on a stratified basis. The area of focus for the region to be worked on should already have been determined on the prior exercises. To be able to standardize the land cover classes to prepare reference points, trainers shall describe a hierarchy of land cover classification according to the Intergovernmental Panel on Climate Change. From these reference points, which the GT team can ground-truth under Stage 2, they can, consequently, prepare training data needed for Stage 3 (*Establishment of reference points in preparation for Stage 2 ground-truthing and Stage 3 land cover classification*). The last exercise for the participants is to prepare map layouts of the: vegetation index, change detection and reference points (*Produce map layouts*).

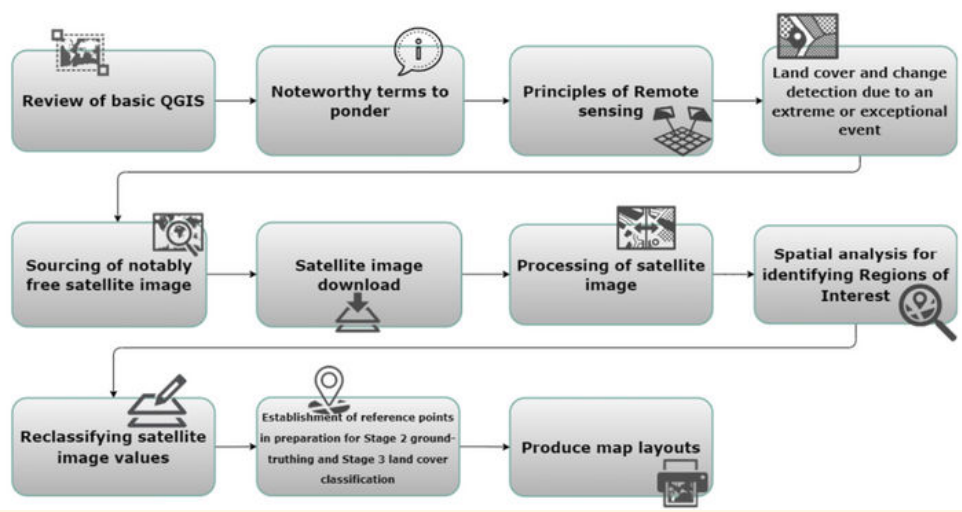

Figure 1. Workflow for Stage 1 of Green Assessment

1.2 Objectives

The capacity development activities aim to improve the management effectiveness of conservation areas by strengthening decision-making instruments which will lead to improved governance of natural resources management. The objectives of this training for the Stage 1 of Green Assessment are the following:

- For participants to be familiarized with the green assessment framework and replicate the methodologies in their respective areas;
- For participants to advance their knowledge and utilization of remote sensing and GIS in conducting rapid appraisals for post-disaster scenarios;

Objectives

- For participants to enhance their skills in using open source software in executing satellite image processing and analysis; and
- For participants to learn how to pinpoint damaged areas using processed satellite images.

1.3 Expected Outputs

The following are the expected outputs during and after the training:

Expected Outputs During the Training	Expected Outputs After the Training
Expected Outputs During the Training	Expected Outputs After the Training
Locator map of Area of Interest (AOI) for the training exercise	Locator map of Area of Interest (AOI) for the specific work area of the participants
Pre- event vegetation map of AOI	Pre- event vegetation map of AOI
Post-event vegetation map of AOI	Post-event vegetation map of AOI
Vegetation Index Difference map for change/damage detection of AOI	Vegetation Index Difference map for change/damage detection of AOI
Overlaps of change/damage with management zones	Overlaps of change/damage with management zones
Plan for post-training outputs, including the area of concern, event of focus (e.g., typhoon, deforestation, forest fire and other events resulting in forest ecosystem changes)	

Table 1. Expected Output from this Stage 1 Training

1.4 Target Participants

Qualifications and Requirements for Participants:

- Bachelor's degree in natural sciences (e.g., Biology, Forestry, Environmental Science, Geology, and related backgrounds);
- Has knowledge on performing basic statistics and basic mapping;
- Able to follow technical instructions on mapping;
- Prior experience in conducting biodiversity surveys and monitoring is desired, but not required;
- Participants must bring their personal or work laptops during the training; and
- Participants must complete an online pre-registration form before attending.

1.5 Venue Requirements

The venue must have the following:

- very stable internet connection, preferably at high speed;
- have at least 2 screens and projectors;
- very good sound system;
- can hold at least 40 participants;
- classroom-type seating arrangement;
- extension wires for each table; and
- Participants must be checked in the same venue/accommodation for the training duration.

1.6 Training Resources

The following materials are provided to the participants:

- Training Kit (Programme, Lanyard, Notes, Pen, and Paper);
- Wifi Passwords;
- Extension Wires; and
- USBs with QGIS Installer and Data Sets (one provided in each table/team).

Each participant are required to bring one laptop unit or workstation with the following minimum requirements:

- Hard drive: at least 500 HDD;
- Memory: at least 16GB RAM;
- Processor type: at least Intel core i7 processor;
- 32/64 bit; and
- Operating system: at least Windows 7.

1.7 Course Methodology

Different approaches will be employed to the topics covered during the training. For instance, while there will be lectures for all the topics, some will involve exercises to measure the learning of the participants, and presentation of case studies to demonstrate the application of GIS on Green Assessment for Ecosystems disaster mapping.

Topics	Targets	Approach
Introduction to Green Assessment Framework	• To learn how the Green Assessment framework was developed. • To be introduced to four stages of the green assessment framework • To be familiar with the expected outputs from the four stages of green assessment	Lecture with powerpoint presentations (showing sample maps and other fieldwork video materials)
Introduction to GIS	• 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	Lecture with powerpoint presentation
Introduction to QGIS	• 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)	Lecture with powerpoint presentation; demonstration of the use and navigation of the software; hands-on mapping activity; and Discussion on the participants' mapping output presentation

Table 2. Course Methodology

Training Design: 1.7 Course Methodology, Table 2

Topics	Targets	Approach
Land Cover, Land use and Land classification	To differentiate land cover, land use and land classification	Lecture with powerpoint presentation
Land cover classification for Green Assessment	To familiarize with six different land cover classifications defined together with the Palawan Council for Sustainable Development	Lecture with powerpoint presentation
Principles of Remote Sensing	• To learn about the basic theory and concepts of remote sensing and its importance in rapid mapping • To familiarize with different remote sensing technologies and their advantages and disadvantages	Lecture with powerpoint presentation
Sourcing of Notable Free Satellite Images: • Google Earth Engine as a Data Source and Image Processor • Using the Sentinel 2 Data Collection of Google Earth Engine • Using the Sentinel 2 Data Collection of Google Earth Engine	• To familiarize with the different free satellite imagery sources • To download satellite images for rapid assessment • To familiarize with the different free satellite imagery sources • To download satellite images for rapid assessment	Lecture with powerpoint presentation; on-the fly demonstration of image downloading; and hands-on activity
Processing of Satellite Images	• To learn about different band combinations using QGIS • To compare satellite images of different imagery dates using image stacking	Lecture with powerpoint presentation, on-the fly demonstration of image downloading and hands-on activity

Training Design: 1.7 Course Methodology, Table 2

Topics	Targets	Approach
Spatial Analysis for Identifying Regions of Interest by Working with Raster	To identify regions of interest for green assessment by working with raster and vector data	Lecture with powerpoint presentation, on-the fly demonstration of image downloading and hands-on activity
Reclassifying satellite image values	To visually represent the land cover from satellite images by reclassifying satellite's raster image values according to NDVI thresholds for each land cover class	Lecture with powerpoint presentation, on-the fly demonstration of image downloading and hands-on activity
Spatial Analysis for Identifying Regions of Interest by Working with Raster	To identify regions of interest for green assessment by working with raster and vector data	Lecture with powerpoint presentation, on-the fly demonstration of image downloading and hands-on activity
Establishment of Reference Points	To determine reference points for ground-truth survey	Lecture with powerpoint presentation, on-the fly demonstration of image downloading and hands-on activity
Producing maps	To layout and export maps of reference points and area of interest using QGIS	Lecture with powerpoint presentation, on-the fly demonstration of image downloading and hands-on activity

1.8 Training Content

1.8 Training Content

The Geospatial training on rapid mapping for Green Assessment covers the following topics:

Green Assessment Framework

This section discusses how the Green Assessment framework was conceptualized from the extent of damages of Typhoon Odette in Palawan. The maps comparing the satellite images of pre-Odette and post-Odette in Palawan were showing their respective Normalized Difference Vegetation Indices (NDVI), indicating the complete transformation of the surrounding vegetation indicating a new perspective of responding to calamities in the country, which are ecosystems-based. This emphasizes the need for a green assessment framework to improve the disaster response to calamities brought about to our ecosystems. The four stages in achieving the green assessment framework were also discussed based on how it was implemented in the pilot sites of Palawan.

Basic GIS Concepts

This provides a brief introduction to the basic concepts of the geographical information system (GIS) and its real-life geospatial representation.

Basic Quantum GIS Processes and Map Layout

This section covers the introduction to Quantum Geographic Information System (QGIS), as the open-source GIS application, recommended for use during the training, because this is more accessible to the local government units with limited financial capacity to obtain licenses for other GIS software. The software's interface and function are explored by navigating through the map canvas, changing layers' symbologies, and layouting and exporting the maps.

Land Cover, land use and land classification

To align the understanding among trainers and participants on relevant terms that is often used interchangeably, this section focuses on differentiating land cover, land use and land classification.

Principles of Remote Sensing

This part of the training focuses on explaining the basic theory and concepts behind the use of Remote Sensing technology and how these are important in the execution of rapid mapping. Real-life application of remote sensing technologies are also provided during this part of the training while highlighting how the electromagnetic spectrum and the type of sensors work for our purpose.

Land Cover and Change Detection due to an Exceptional or Extreme Event using the Electromagnetic Spectrum

This section emphasizes the use of satellite images for this training and how multispectral satellites work to detect and record the electromagnetic spectrum. It relates how the satellite images are being used to detect changes on the vegetation due to extreme events such as defoliation and depletion of leaves as a substantial indicator of the impact of typhoons on vegetation. After this then the trainer introduces the concept of the Normalized Difference Vegetation index or NDVI.

Sourcing of Notably Free Satellite Image

This part of the training presents the different websites and processes to source free satellite images that can be used in the rapid appraisal mapping of the affected area. This includes the more popular free-to-use satellite imagery repositories such as USGS/NASA Earth Explorer for Landsat images (30-m resolution) and ESA Copernicus Open Access Hub for Sentinel images (10-m resolution). The Google Earth Engine (GEE) is also introduced here as a repository where both Landsat and Sentinel images can be obtained and processed using scripts. Succeedingly, the Planet data catalogue, which can also be accessed using GEE by registering through Planet's website, is introduced in this section.

Merging Satellite Images

This section focuses on the merging of the downloaded satellite images using QGIS and how these can be visualized using different raster band colors.

Introduction to Raster Bands

Since some satellite images have too many raster bands, which sometimes are not needed in the analysis, raster band extraction is introduced in this section for a more efficient processing of satellite images. There are three methods for raster band extraction introduced here such as the use of a: semi-automatic classification plugin; raster calculator and the 'rearrange band' tool in QGIS.

Spatial Analysis

This section focuses on spatial analysis to solve the problem of identifying and prioritizing regions of interest (ROIs) by working both with raster and vector data. The sample criteria presented to identify these ROIs are NDVI difference, slope, aspect, land cover, proximity to road and city center, which can be combined cartographically using different QGIS tools to help solve the spatial problem.

NDVI Calculation

Using the satellite images, the trainors teach the extracting of RED and NIR bands in this section, which is necessary for the NDVI calculation of pre (2021) and post- Odette (2022). The steps to compute NDVI for both time periods using a raster calculator are demonstrated, where it involves stacking pre-NDVI and post-NDVI images using the Semi-Automatic Classification Plugin (SCP). The resulting layer of this process can indicate where NDVI values decreased from the two time periods by assigning raster symbologies. NDVI reclassification using a raster calculator is introduced, because this can be necessary in some situations where the assessments are being made.

Generation of Random points for Reference Points Map

This section demonstrates how random points can be generated using the QGIS tool called *Random Points in Layer Bounds* for picking reference points that will be used in the ground-truthing activity for the second stage of the Green Assessment.

1.9 Post-training Activities

After the training proper, the participants are asked to continue working on their outputs including maps showing the pre-event vegetation index of the identified "pilot" area of interest and post-event vegetation index map (especially for regions that have been recently impacted by typhoons), and preliminary findings from overlapping vegetation change/damage with management zones or other land use plans. Regular meetings should be scheduled with the participants to mentor and monitor their progress, and ensure the quality of their outputs. A face-to-face conference will be scheduled afterwards where the participants can present their results and make initial work plans for conducting the second stage of the green assessment.

Lesson 1
Introduction to Green Assessment Framework

Duration	Purpose of Learning
30 Minutes	• To learn how the Green Assessment framework was developed • To be introduced to four stages of the green assessment framework • To be familiar with the expected outputs from the four stages of green assessment

Requirements:

- Lecture with powerpoint presentations (showing sample maps and other fieldwork video materials)

Since the series of training that will be conducted for SIBOL will revolve around Green Assessment, it is important that participants will be given an introductory lecture about the Green Assessment Framework, its stages, processes and outputs.

Green Assessment Framework

The Green Assessment Framework is a stepwise process developed by SIBOL in response to the aftermath of typhoon Odette or severe tropical storm Rai. This is an integration of High Conservation Value Area Assessment (HCVA) and post-disaster response. This is composed of four stages such as: rapid appraisal (stage 1); ground validation surveys (stage 2); analysis and interpretation (stage 3); and green reconstruction and resilience planning (stage 4). Processes, Input and Output of Green Assessment Framework are shown in the figure below.

Figures 2 & 3

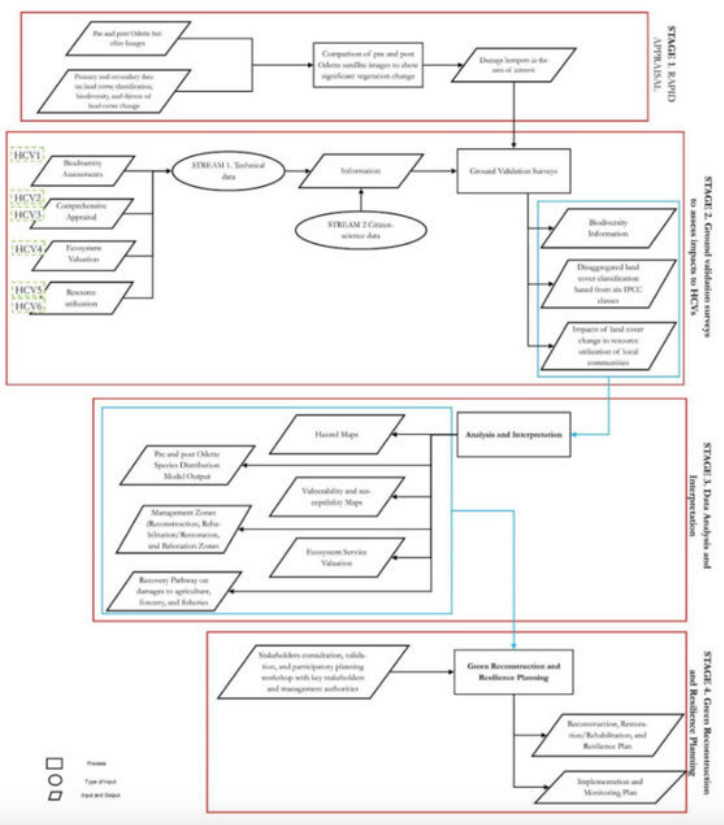

Figure 2. Processes, Input and Output of Green Assessment Framework

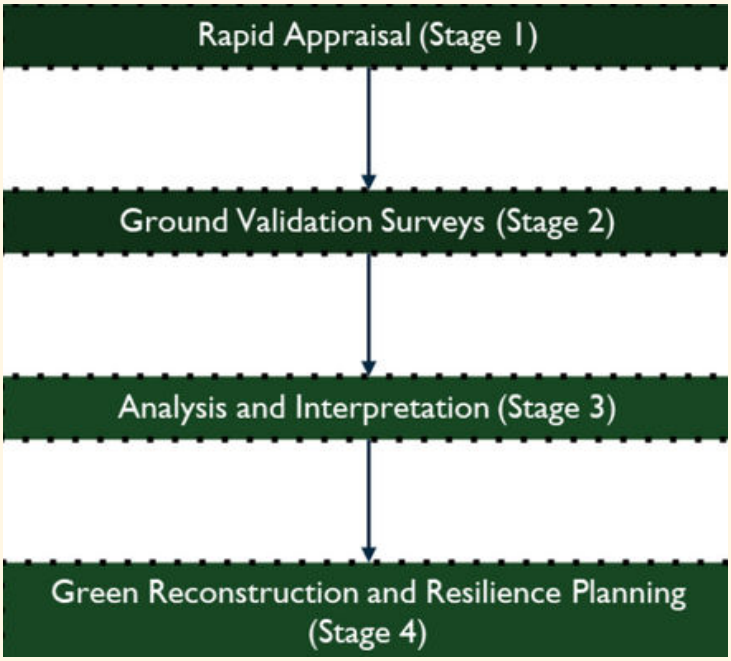

Figure 3. Simplified Green Assessment Framework Stages

Green Assessment Framework Stages

Stage 1: Rapid Appraisal

This stage covers the standardization of methods and software for the initial step of the green assessment. The pre- and post-Odette satellite images are compared along with the primary and secondary data on land cover, classification, biodiversity, and drivers of land cover change to produce damage maps based on the significant vegetation change computed using the Normalized Difference Vegetation Index (NDVI).

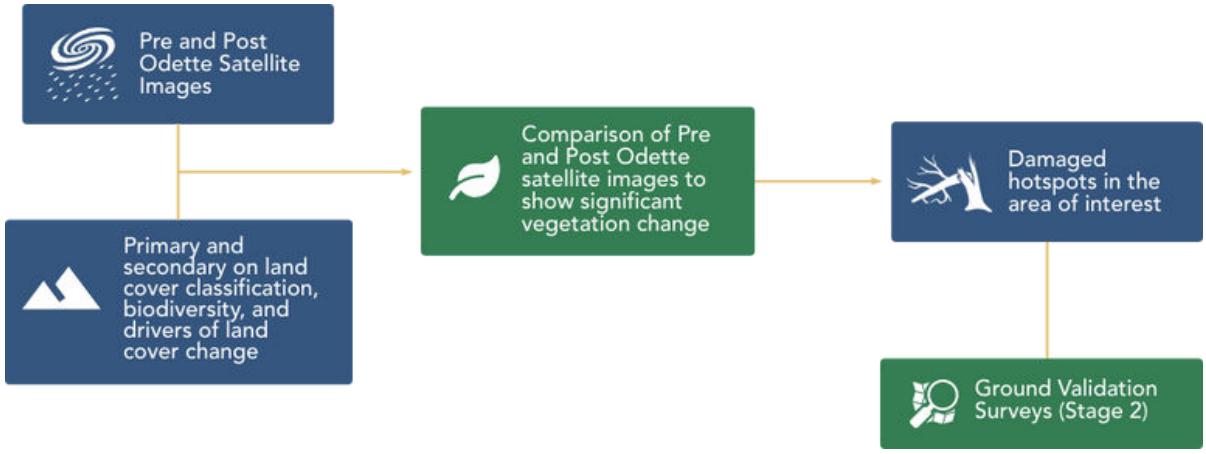

Figure 4. Green Assessment Stage 1 Rapid Appraisal

Case Study: Palawan Green Assessment Preliminary Results

The maps shown on Figures 5 to 7 are the results of the rapid appraisal mapping in the SIBOL's four pilot sites for Green Assessment: Puerto Princesa Subterranean River and Natural Park (PPSRNP), Cleopatra's Needle and Critical Habitat (CNCH) , Roxas and San Vicente. This is the area of interest (AOI) agreed upon with the Palawan Technical Working Group for analysis during the start of the year 2022.

The map on Figure 5 shows the normalized difference vegetation index (NDVI) for January 2021 to November 2021 which is eleven months and two weeks prior to the typhoon. Higher NDVI values may denote mixed vegetation and moderate to dense vegetation, while lower NDVI values are possibly cropland, settlements or non-forest vegetation.

Figures 5-7