**Visayan Islands Ecological Forecasting**

*Identifying and Evaluating Changes in Land Use and Land Cover on the Visayan Islands over Time for Reintroduction of the Visayan Warty Pig (Sus cebrifons) and Visayan Spotted Deer (Rusa alfredi)*

**VPS Title:** Have you Spotted my Deer Pig? Reintroduction of the Visayan warty pig and spotted deer

**Project Team**

***Project Team:***

Ryan Slapikas (Project Lead)

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***Advisors & Mentors:***

Dr. Marguerite Madden (University of Georgia, Department of Geography)

Dr. Sergio Bernardes (University of Georgia, Department of Geography)

**Project Overview**

***Project Synopsis:*** Habitat degradation and other anthropogenic factors have contributed to pandemic level extinction of some Philippines endemic species. There are believed to be only two suitable locations within the Visayan Islands for Visayan spotted deer *(Rusa alfredi)* and Visayan warty pigs *(Sus cebifrons*). Using NASA Earth observations, this project analyzed forest cover change over time to distinguish potential habitat locations for the aforementioned species and forecasted land use and land cover for the years 2030 and 2050. Results provided information that will benefit species reintroduction and establish public awareness of the need for conservation.

***Abstract:***

The islands of Negros and Panay in the Philippines contain the last existing habitat for the critically endangered Visayan spotted deer (*Rusa alfredi*) and Visayan warty pig (*Sus cebifrons*). NASA DEVELOP partnered with the Arizona Center for Nature Conservation – Phoenix Zoo, International Union for Conservation of Nature Species Survival Commission, and Talarak Foundation Inc. for this study. The initiative was to analyze and map changes in vegetation health in order to identify potential habitat areas for the reintroduction of the warty pig and spotted deer species to the Visayan Islands. The study utilized Landsat 5 Thematic Mapper (TM), and Landsat 8 Operational Land Imager (OLI), Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) data acquired from Google Earth Engine (GEE). GEE was used to perform historical Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) analysis along with land classifications. RStudio was used for NDVI and EVI forecasting and supervised classification comparison. The team also used TerrSet Land Change Modeler and QGIS MOLUSCE to forecast land use and land cover (LULC) for the years 2030 and 2050. This methodology allowed the team to predict future land cover and potential habitat areas for the reintroduction of the two species. The LULC classification forecasts revealed a potential decrease in primary forests on the islands of Panay and Negros. Favorable habitats were also identified using buffer analysis based on habitat preferences for the Visayan warty pig and spotted deer.

***Keywords:***

Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), ecological forecasting, vegetation, Landsat, forest cover

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Visayan Islands, Central Philippines

***Study Period:*** January1987 to September 2019, Forecasting to 2030 and 2050

***Community Concerns:***

* Globally, the Philippines is placed high among the priority countries for wildlife conservation due to a large number of endemic species; the West Visayan islands are given the highest priority because they host about half of the endangered species in the Philippines.
* Being the country with the least remaining forest cover and losing 97 percent of its original vegetation led the Philippines to be ranked fourth worldwide for its number of severely threatened species.
* A number of factors, such as continual habitat destruction through illegal logging and clearing for agriculture along with excessive hunting pressure and poaching, have driven these species to the verge of extinction.
* Compared to other deer species worldwide, the Visayan spotted deer is considered the most endangered, and the trading of this species is protected under Appendix I of the Convention on International Trade of Endangered Species (CITE).
* Presently, the majority of Visayan warty pig and the spotted deer are conserved in captive breeding programs.
* A combination of social and economic differences and lack of education surrounding environmental health and issues resulted in community apathy and limited involvement towards conservation efforts.

***Project Objectives:***

* Generate 1987 to 2019 NDVI and EVI time series maps to assess the status and trends of vegetation health
* Produce land use and land cover classification maps in 10-year intervals from 1987 through 2019 to evaluate the changes over time and identify remaining potential areas for the reintroduction of Visayan warty pigs and spotted deer
* Forecast land use and land cover classifications to the years 2030 and 2050 to show the future landscape and habitat status
* Provide partners with written materials detailing the application of land use and land cover classification forecasts

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Arizona Center for Nature Conservation – Phoenix Zoo** | Dr. Jan Schipper, Field Conservation Research Director | End User | Yes |
| **The International Union for Conservation of Nature, Species Survival Commission** | Dr. Johanna Rode-Margono, Wild Pig Specialist Group Chair | End User | Yes |
| **Talarak Foundation Inc.** | Matt Ward, Field Ecologist and *In Situ* Project Manager | End User | Yes |

***Decision-Making Practices & Policies:***

The Arizona Center for Nature Conservation – Phoenix Zoo partnered with Talarak Foundation Inc. to keep track of human and species movement within the forest of the Visayan Islands using camera traps. Unfortunately, this initiative is not always successful. During eight months of observations from 8 camera traps in one of the three national parks in the study area, not a single Visayan warty pig nor Visayan spotted deer was observed. The Talarak Foundation Inc. has been monitoring exemplary species such as the Javan warty pig *(Sus verrucosus)* and Persian fallow deer *(Dama mesopotamica)* to provide beneficial information for the Visayan spotted deer and the Visayan warty pig, as these species possibly share a similarity in their habitat preferences. The International Union for Conservation of Nature (IUCN), Species Survival Commission provides information on species, their habitats, and their status to create public awareness and protection for these species. Talarak Foundation Inc. provides educational initiatives such as outreach and awareness programs through projects to increase community empathy. Furthermore, the lack of available GIS resources on the Visayan Islands forced end users to rely on outside GIS expertise and maps from Google Earth for their conservation efforts.

***Project Benefit to End User:***

The Arizona Center for Nature Conservation, the IUCN Species Survival Commission, and Talarak Foundation Inc. will share these results with various individuals and government agencies, such as the Department of Environment and Natural Resources, natural park officials, and local village leaders. The end users will use the land use and land cover classification maps and forecasts to select sites for habitat restoration and to reintroduce the Visayan warty pig and spotted deer. The end products will provide the baseline data from which to monitor the progress of reforestation and conservation efforts for the habitats of these species. The change detection maps will help to address habitat loss for these endangered species in the Visayan Islands and assist in educating the population, enacting policies, and fostering initiatives to mitigate detrimental activities and enhance restoration efforts.

**Earth Observations & End Products Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** | surface reflectance | 1987 to 1999 Landsat 5 TM imagery was used to conduct NDVI and EVI indices to calculate changes in vegetation health. |
| **Landsat 8 OLI** | surface reflectance | 1999 to 2019 Landsat 8 OLI imagery was used to classify and conduct vegetation health indices for land use and land cover classifications and determine the health of vegetation. |
| **Terra MODIS** | NDVI  EVI | 2000 to 2019 Terra MODIS imagery was used to evaluate vegetation health indices to produce a time series. |

***Ancillary Datasets:***

* The Database of Global Administrative Areas (GADM) Aklan, Antique, Capiz, Guimaras, Iloilo, Negros Occidental, and Negros Oriental Administrative Boundaries in the Philippines – Shapefiles used to acquire the study area
* Protected Planet Protected Areas on Land in the Philippines – Shapefiles used to delineate protected areas
* Roads, rivers, cities and Digital Elevation Models Shapefiles from GADM − Used in TerrSet Land Change Modeler for forecasting
* Talarak Foundation Inc. Shapefiles of Rice and Sugarcane Plantations – Partner provided GPS points used to validate training points collected from Google Earth Pro

***Modeling:***

* Clark Labs TerrSet Land Change Modeler (POC: Dr. Sergio Bernardes, University of Georgia) – Forecast land use and land cover change to 2030 and 2050
* RStudio 1.2.1135 (POC: Ryan Slapikas) − NDVI and EVI forecasting
* QGIS 2.18 (POC: Ryan Slapikas) – Forecast land use and land cover change

***Software & Scripting:***

* Google Earth Engine API – Image processing, from image enhancement to mosaicking, supervised classification, and accuracy assessment
* Esri ArcGIS 10.6 – Map creation, training points, and buffer analysis
* RStudio 1.2.1135 – Grey Level Co-occurrence matrices and supervised classification comparison

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **NDVI and EVI Time Series Analysis and Change Maps** | Landsat 5 TM  Landsat 8 OLI | The partners used these maps to evaluate historical trends in the vegetation cover and changing landscape of the islands Negros and Panay. | I |
| **Land Use and Land Cover Classification Maps** | Landsat 5 TM  Landsat 8 OLI | Classified maps provided more insights into the different land cover classes and helped to determine potential areas for the reintroduction of the Visayan warty pig and spotted deer. | I |
| **Time Series Graphs** | Terra MODIS | The partners will use these graphs to observe the trends in primary and secondary forests cover from 1987 to 2019. | I |
| **2030 and 2050 Forecasted Forest Cover** | Landsat 8 OLI | The partners used the results of these forecasted forest cover maps to determine areas most at risk of expected changes and where the reforestation efforts can be concentrated. | I |
| **LULC and Forecasting analysis tutorials** | N/A | The tutorials enabled the partners to further understand the map products and analysis and possibly produce more outputs, if needed. | N/A |

**Project Handoff Package**

***Transition Plan:***  The handoff was conducted via Google Hangouts on November 19th and organized by the Visayan Islands Ecological Forecasting team for the Arizona Center for Nature Conservation – Phoenix Zoo, IUCN-Species Survival Commission, and Talarak Foundation Inc. The Visayan Islands Ecological Forecasting team explained the final results from the analyses. All materials excluding code were sent to the partners through Google Drive.

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***Handoff Package:***

* Poster
* Presentation
* Project Summary
* Project Video
* Technical Paper
* Study Area Shapefiles
* NDVI and EVI Time Series Analysis and Change Maps
* LULC and Forecasting analysis tutorials
* Time Series Graphs
* Land Use and Land Cover Classification Maps
* 2030 and 2050 Forecasted LULC

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