**Haiti Agriculture II**

*Evaluating the Success of Reforestation Practices in Haiti*

**Project Team**

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**Project Overview**

***Project Synopsis:***

The Haiti Agriculture II team partnered with the Haiti Reforestation Partnership (HRP) to guide micro-level planting operations to address food insecurity using Earth observation data. While the first DEVELOP term analyzed the success of the past 37 years of reforestation efforts, the second term built a habitat suitability model to guide future silvicultural decisions in local communities. The project provided large scale static maps to inform field workers, a 3D model to visualize elevation for planting accessibility, a guidebook for local workers, and a video highlighting this partnership to provide exposure for both the partners and the local community.

***Abstract***

The Caribbean country of Haiti has an extensive history of deforestation and environmental degradation stemming from French colonization. Over the past 33 years, the Haiti Reforestation Partnership (HRP) and their partners, Comprehensive Development Program (CODEP), have planted approximately 15.52 million trees. However, these efforts lacked scientific guidance to ensure successful forest stand survival. The NASA DEVELOP team partnered with the HRP to create a habitat suitability model (HSM) by using PlanetScope and Sentinel-2 Multispectral Instrument (MSI) imagery. The team also incorporated Landsat 8 & 9 OLI surface temperature, Centre National de L’Information Geo-Spatiale (CNIGS) Airborne Lidar, and ancillary datasets to analyze areas suitable for future reforestation efforts. The habitat model suggested locations with higher forest stand survival based on topography, soil health, climate, and feasibility to access suggested locations. The results from HSM model were compared with enhanced vegetation index (EVI) to check areas with higher EVI value to validate our model. Areas with lower EVI values and higher suitability based on HSM were suggested for planting as they don’t have good forest stand, but have optimum conditions. Through the creation of the HSM, the team provided the HRP with static maps of high suitability, a 3D printed elevation model, and a guidebook for animators. Additionally, the team provided a structured video highlighting the HRP’s efforts. Effective reforestation and better forest stand survival would help to achieve the goal of securing community food security. This would also serve as a guide to expand planting efforts into other locations and communities.

***Key Terms:***

remote sensing, Habitat Suitability Model (HSM), PlanetScope, Sentinel-2, forest stand survival, watershed analysis, topography, vegetation indices

***National Application Area Addressed:*** Agriculture

***Study Location:*** Haiti

***Study Period:*** January 2015 – June 2022

***Community Concerns:***

* Haiti’s food insecurity is globally one of the highest at 4.4 million, nearly half the population of Haiti. It is driven by both degraded lands and the dependence on exported food. The dependence on imported food affects Haitians due to rising inflation, supply variability, and price volatility.
* Haiti is highly susceptible to earthquakes, floods, hurricanes, and landslides due to its geographical location. These natural disasters contribute to food insecurity by degrading the land and stunting the process of tree growth. The country ranks third on the 2020 Climate Risk Index, with increasing severity over time.
* Deforestation has large impacts on resources and income. Without support to reforest areas, the community is unable to sustain itself or further expand forestry education for future generations.

***Project Objectives:***

* Develop printable large-scale maps of the suitability model for usage by CODEP field workers
* Produce a high-resolution habitat suitability model to guide future planting decisions
* Produce a high-resolution habitat suitability model to develop large-scale static maps that guide future planting decisions for CODEP field workers and partners.
* Create an informational project video to highlight the HRP’s efforts as an organization as well as the DEVELOP partnership
* Print a 3D elevation model to inform partners on the accessibility of suitable habitat areas
* Provide a guidebook for animators on environmental predictor variables to bridge the gap between local and scientific communities

***Previous Term:***

2022 Spring (GA) – Haiti Agriculture

**Partner Overview**

***Partner Organization:***

|  |  |  |
| --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** |
| **Haiti Reforestation Partnership** | Michael Anello, Executive Director  Bill Hathaway, Board Chair  Hunter Brown, Board Member  Jamie Rhoads, Board Member | End User |

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

For the last 33 years, the Haiti Reforestation Partnership (HRP) has provided funding, information, and expertise to the Comprehensive Development Program (CODEP), which is comprised of local Haitian neighborhoods. The HRP is responsible for providing aid via funding for operational expenses and on-the-ground resources such as tools and equipment. The HRP gives expert knowledge and guidance to the CODEP reforestation efforts regarding forestry and agricultural best practices. There is little information regarding the number and locations of specific tree species planted. While there is minor documentation surrounding the total number of trees planted, the HRP uses geospatial data to track forest stand coordinates. The product of partnership spatial analysis will assist in determining high suitability areas for enhancing the HRP’s reforestation efforts.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 9 OLI-2** | Surface temperature | Landsat 9 OLI-2 derived surface temperature was used as a parameter for the habitat suitability model. |
| **Landsat 8 OLI** | Surface temperature | Landsat 8 OLI derived surface temperature was used as a parameter for the habitat suitability model. |
| **Sentinel-2 MSI** | True color composites (RGB), NDMI, NDVI, EVI | Sentinel-2 MSI spectral indices will be used to assess changes in vegetative health over time to identify suitable planting areas. |
| **PlanetScope & RapidEye** | True color composites (RGB), NDVI, EVI | PlanetScope & RapidEye provided high resolution imagery to assess changes in vegetative health over time to identify suitable planting areas. |

***Ancillary Datasets:***

* Digital Chart of the World Server, Haiti Administrative Boundaries – Geographic context to habitat suitability maps
* Open Street Map – Geographic context to habitat suitability maps
* Centre National de L’Information Geo-Spatiale (CNIGS) 1.5 m Haiti Digital Terrain Model, World Bank – Topographic layer from which to derive stand success factors such as elevation, slope, aspect, roughness, basins, and stream data to use as a parameter in the habitat suitability analysis
* SoilGrids Database – Percent soil organic carbon data (SOC); proxy to soil health
* CODEP, GPS Zone – Haitian CODEP zones that define the planting boundaries that account for 75% of the planting effort (as mentioned by project partners)

***Modeling:***

* Habitat Suitability Model (Contact: Dr. Sergio Bernardes) – Investigate how environmental variables correlate with forest stand success

***Software & Scripting:***

* Google Earth Engine JavaScript API – Used to create surface temperature, NDMI, NVDI, and EVI rasters for the habitat model
* Esri ArcGIS Pro 2.9 – Used to create habitat suitability model and static maps
* Adobe Premiere Pro – Used to create and edit the video
* QGIS – Used for watershed analysis and DEM base map of the 3D model
* Autodesk Fusion 360 – Used to design the 3D elevation model
* Ultimaker Cura – Used to 3D print the elevation model

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Tropical Deciduous Tree Habitat Suitability Maps** | Landsat 9 OLI-2  Landsat 8 OLI  Sentinel-2 MSI  PlanetScope & RapidEye | The HRP will use these static maps to evaluate which areas in the present day may be most suitable for further reforestation efforts and allow for smoother planting operations on the ground. | N/A |
| **Project Highlight Video** | Landsat 9 OLI-2  Landsat 8 OLI  Sentinel-2 MSI  PlanetScope & RapidEye | The HRP will use the project video to promote their ongoing efforts, highlight the partnership with NASA DEVELOP, and inform the community on reforestation work. | N/A |
| **3D Printed Elevation Model** | N/A | The HRP will use the 3D elevation model to predict the accessibility of suitable habitat areas for local workers with limited transportation and resources. | N/A |
| **Guidebook for Animators** | Landsat 9 OLI-2  Landsat 8 OLI  Sentinel-2 MSI  PlanetScope & RapidEye | The HRP will use the guidebook to increase scientific understanding of local workers and? aid citizens' concerns of generational education. | N/A |

***Product Benefit to End User:*** The HRP provides essential economic and environmental support to the village of Fondwa. Pinpointing the most suitable locations for future planting efforts within this area will result in micro-level planting guidance to address food insecurity in the local community. Hard copy maps created from the HSM will be distributed amongst ground workers in Haiti, bridging the gap between the local and scientific communities. A 3D printed elevation model and environmental variable guidebook will provide additional context to local leaders, addressing the accessibility of areas while providing the knowledge for future teaching. Additionally, a video highlighting the project will act as a resource for informing the HRP’s audience on their ongoing reforestation efforts, as well as the importance behind their work. All end products will equip Haitian citizens in this area with the ability to make long term impacts on their environment, taking them a step closer to a self-sustaining silvicultural community.

**References**

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