Name: Monica Rajkumar

Term: Summer 2021

Course: CGN 5935: Special Topics in Civil Eng.

Instructor: Dr. Ramesh Teegavarapu

Project: Shoreline & Coastline Extraction from UAS Imagery and determination of sea turtle concentration

Date of Submission: 01 August 2021

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Executive Summary

Being ever-changing and most important feature of coastal landscape, Shoreline reflects the natural processes of erosion as well as deposition, and hence extracting the shoreline is of paramount importance. Coastline is the line that separating water and shore while shoreline is the line separating the shore and land. They are essential attributes of the earth surface that are considered as complex, dynamic, and unstable geomorphic components in the coastal environment. The dynamic nature is due to factors such as wave actions, sedimentation by longshore currents, natural disasters like tsunamis, dangerous waves and coastal erosion, variations in water level in the ocean and man-made events. However, shoreline and coastline extraction process are mostly manual and time-consuming. This process can be improved by developing a custom Geoprocessing tool through automated Python scripts that would help in extracting shoreline as a feature class. The ability of the developed tool is to make use of Red Edge Band to generate Normalized Index and thereby extract the shoreline features in a short span of time without much human intervention. The study area considered for this research is 120-acre Jupiter Inlet Lighthouse Outstanding Natural Area (JILONA) that has more than 3500 feet of dynamic shoreline and the required UAS data has been collected using Micasense Multispectral Sensor Package. After performing Drone data processing using 'Pix4D', 'ArcGIS Pro' and 'ArcPy' has been used to automate the extraction process of shoreline and coastline. The extracted shoreline can be further used in performing change detection and in computing the volume of soil erosion for a timeseries of data. As a result, the shoreline and coastline for the region could be extracted as vector data without any effort on manual digitization. In order to determine the stranding of sea turtles, hot spot analysis on the extracted shoreline and coastline is being performed using ArcGIS Model Builder.

Introduction

Coastline and Shoreline are two important features of the coastal landscape. The Visualization of ever-changing coastline and shoreline, along the Jupiter Inlet Lighthouse Outstanding Natural Area (JILONA) region is an important factor in case of determining the shoreline change detection and the volume of soil erosion. and hence extracting the coastline and shoreline is very much required. As of now, this extraction process is being done manually which is labor intensive and takes a lot of time. This process can be improved by developing a custom Geoprocessing tool developed through automated Python scripts that would help in extracting both coastline and shoreline as a feature class. The area considered for this research is the Jupiter Inlet Lighthouse Outstanding Natural Area (JILONA) region and the required Unmanned Aircraft System (UAS) data has been collected using drone with Micasense Multispectral Sensor Package in September 2020. Though being commercially valuable, sea turtle stranding is a common problem along the coastal regions. It is caused due to cold-stunning, diseases from various sources, boat collisions and entanglement in fishing equipment as result of man-made catch and marine debris. The output of the shoreline and coastline extraction is being analyzed in such a way, that the concentration of sea turtle stranding can be determined precisely.

Background

In spite of being a volatile environment, the coastal area provides considerably high economic, social, and recreational opportunities, thereby being an important landscape to study and maintain.

Due to the acceleration of changes in the coastal landscape, there is a huge need in terms of effective and timely acquisition of both coastline and shoreline information. Remote sensing satellite images have been extensively used to monitor position of shore zones and coastline, which deliver repeated and consistent statistics of coastal variations. Manual digitization of this shoreline is time consuming, and accuracy depends on interpreter knowledge. Today, to extract coastline from satellite imagery, many methods exist, but in order to render the shoreline features with more accuracy, satellite images with higher resolution is required. This in turn is not a cost-effective solution. Hence, an extraction tool has been developed from the collected UAS data using python scripts, which enables the shoreline and coastline of a region to be extracted as vector data without much human intervention.

For more than 100 million years sea turtles have covered vast distances across the world's oceans, filling a vital role in the balance of marine habitats. Over the last 200 years, human activities have tipped the scales against the survival of these ancient mariners. Sea turtles suffer from poaching, over-exploitation, habitat destruction, accidental capture and most importantly, climate change. Hence, this project has been extended to add to the conservation of the sea turtles.

Purpose and Scope

Coastal regions are quite fragile landscapes as they are most vulnerable to climatic changes and natural disasters. Because of their dynamic nature, there is a need to understand the rate of change in coastal landforms and shoreline position for a wide range of coastal studies, such as development of coastal management planning, hazard zoning and erosion-accretion patterns. Erosion control is one of the important aspects of coastal zone management and the degree of management required depends on density of population, extent of development of the region and the intensity of erosion.

A Geoprocessing tool that would automate this process of extracting the coastline and shoreline which would serve the purpose of coastal zone management is the need of the hour.

In addition to this, nearly all species of sea turtle are now classified as endangered, with three of the seven existing species being critically endangered. As a result, several researches were being conducted based on sea turtle populations and its stranding to rescue, rehabilitate and release them into shore. Hence, a model is developed to know the concentration of sea turtle along the coastal region of JILONA, with the help of the extracted shoreline and coastline output.

Literature Review

Coastline extraction and mapping has been done using Edge detection and Optimization procedures through active contours. Automated workflow for extracting shoreline features has been investigated using aerial imageries. This is being achieved through image processing techniques and thereby eliminating noise distortion and applying region segmentation to split land and sea regions separately by *Vasilis Paravolidakis, Lemonia Ragia, Konstantia Moirogiorgou and Michalis E. Zervakis in 2018*. Automated coastline extraction is done by *Rhea Jackson during ESRI Developer Summit 2021* using ArcGIS API for Python and the ArcGIS Notebook Server. A Python package called Sentinelsat was used to search Sentinel-2 data and serve as input to extract the coastline. To automate this process, the author has created an ArcGIS Task workflow, that executes every Monday at noon. A Case study was done based on the number of sea turtles that have stranded from 2013 till 2015 in the Galveston region of Texas, to display the areas where the turtles are most vulnerable to stranding based on shore proximity and boat ramps. The author found that there exists a direct correlation between the location of boat parking and turtle stranding.

Objective

The primary objectives of this project are as follows:

1. To automate the process of extracting the coastline and shoreline as a vector data in the JILONA region by developing a geoprocessing tool using Python.
2. To build a model using ArcGIS Model Builder in order to find the concentration of sea turtles along the coast of JILONA region which would help in further studies on stranding of commercially highly valuable sea turtles.

Software used

- **Citrix Server - GPU Desktop**
  - Citrix Server is a virtual application delivery tool that enables users to access the required applications from anywhere, without considering the fact of hardware that they use
  - GPU desktop is a remote desktop that can be connected through the citrix server, which helps in accessing all the windows application present in the system
- **ArcGIS Desktop - ArcGIS Pro**
  - ArcGIS Pro, a Desktop software helps in working with all kinds of geospatial information
  - It allows to create, view, edit and query the spatial data in both two dimension and three dimensions

    - It provides an infrastructure for GIS data management and manipulation of necessary tasks

- **Pix4D**
    - Professional photogrammetry drone mapping software
    - Drone Data processing to generate accurate and georeferenced Orth mosaics, three dimensional meshes, elevation models and point clouds
- **Geoprocessing**
    - Framework/ Process to run a series of specialized software tools, to create a new dataset after analysis and manipulation
    - It helps in performing a set of operation on vector and raster datasets to create a processed output dataset
- **ArcPy**
    - Python script to automate any available tools in the ArcGIS desktop software (ArcMap, ArcGISPro etc.,)
    - A Python site package that can be built on any ArcGIS scripting module, providing productive way to perform GIS analysis
- **ArcGIS Model Builder**
    - It is used in creating models and model tools, by integrating a sequence of tools for execution
    - A Series of geoprocessing tools can be modelled one after other, so that it can be useful in the future runs

Data Source

Data for this "**Shoreline and Coastline Extraction**" project has been collected from very high-resolution drone imagery. The **Unmanned Aircraft System** (UAS) data used in this project was collected using drone with Micasense Multispectral Sensor Package in September 2020. The Sea turtle stranding data for Florida was acquired from the Florida Geographic Data Library (FGDL) meta data explorer website. The stranding points of sea turtle from the year 1986 till 2017 was found in the downloaded layer, which was added to **FGDL** metadata explorer Database on 17th May of 2020 by Florida Fish and Wildlife Conservation Commission, of Fish and Wildlife Research Institute.

Figure 1: Micasense Multispectral Sensor Package (Source: Micasense)

The following table represents the specification of the sensor used in the aircraft for collecting data in the JILONA region for two separate regions namely JILONA North and JILONA South.

Table 1: RedEdge-MX Camera Specifications (Source: Micasense)

Weight	**231.9 g (8.18 oz.) - (Includes DLS 2 and cables)**
Dimensions	8.7 cm x 5.9 cm x 4.54 cm (3.4 in x 2.3 in x 1.8 in)
Spectral Bands	Blue, green, red, red edge, near-infrared (NIR) (global shutter, narrowband)
Wavelength (nm)	Blue (475 nm center, 32 nm bandwidth), green (560 nm center, 27 nm bandwidth), red (668 nm center, 16 nm bandwidth), red edge (717 nm center, 12 nm bandwidth), near-IR (842 nm center, 57 nm bandwidth)
RGB Color Output	Global shutter, aligned with all bands
Ground Sample Distance (GSD)	8 cm per pixel (per band) at 120 m (~400 ft) AGL
Capture Rate	One capture per second (all bands), 12-bit RAW
Interfaces	Serial, 10/100/1000 ethernet, removable Wi-Fi, external trigger, GPS, SDHC
Field of View	47.2° HFOV
Triggering Options	Timer mode, overlap mode, external trigger mode (PWM, GPIO, serial, and Ethernet options), manual capture mode

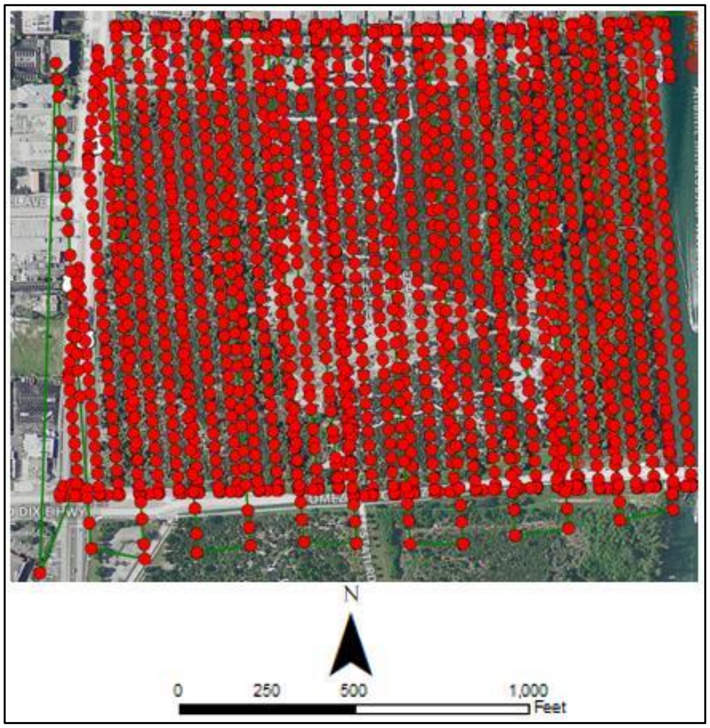


Figure 2: JILONA North

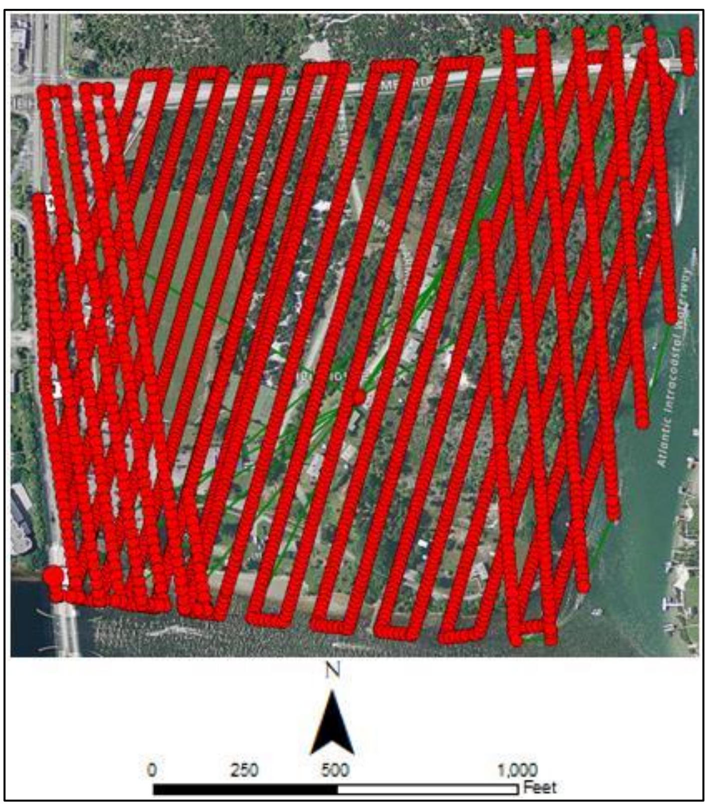


Figure 3: JILONA South

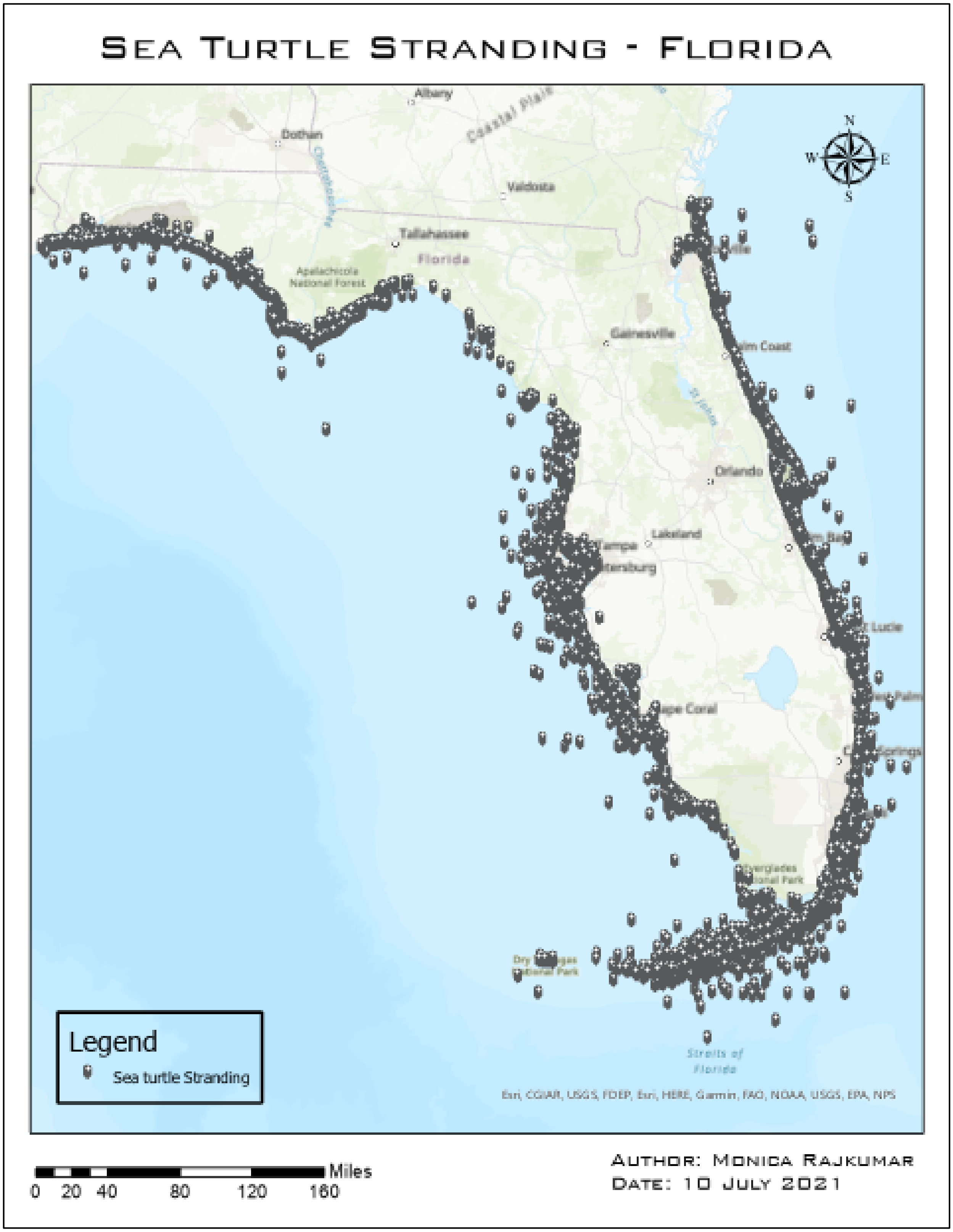


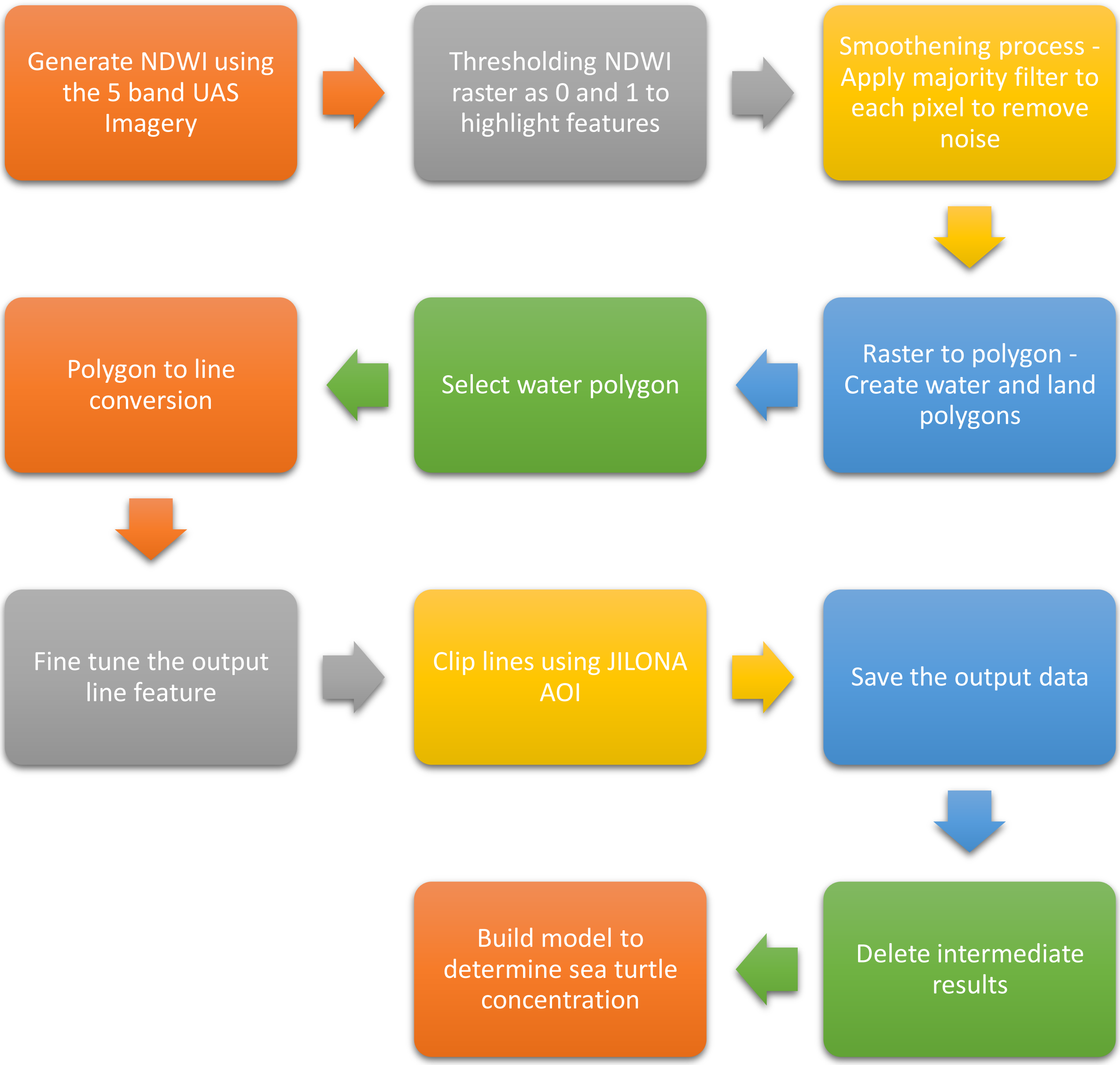
Figure 4: Sea turtle Stranding locations

Workflow

The initial step of this study is to generate the modified Normalized Difference Water Index (NDWI) from the five band (Blue, Green, Red, Red Edge, Near Infrared) UAS Imagery obtained from the high-resolution camera. Modified NDWI can be calculated using Green and Red Edge bands from Micasense Red Edge Multispectral sensor. It is then followed by thresholding. In order to remove the unnecessary noise present in the imagery, majority filter needs to be applied, so that the imagery gets smoothened. Now, the smoothened and filtered imagery can be used to generate polygons by separating land and water. Line feature can be brought in picture, by selecting the largest polygon from the extracted water polygon. From the extracted line data, further fine-tuning process was carried out.

Finally, line feature was clipped to the shore extent of the JILONA region, which resulted with the required shoreline and waterline output. The extracted output was then saved to the desired folder. Once saved, the intermediate results generated during the overall process was removed from the temporary database.

Using ArcGIS Model Builder, a series of geoprocessing tasks were carried out to form a model. The developed model helps in determining the sea turtle concentration along 0.5 miles of the JILONA shoreline. Geoprocessing tools such as Merge, Buffer, Intersect and Theissen polygon generation, followed by two analyses namely Kernel Density Analysis and Optimized Hotspot Analysis were used for this research.


Generate NDWI using the 5 band UAS Imagery
Thresholding NDWI raster as 0 and 1 to highlight features
Smoothening process - Apply majority filter to each pixel to remove noise
Raster to polygon - Create water and land polygons
Select water polygon
Polygon to line conversion
Fine tune the output line feature
Clip lines using JILONA AOI
Save the output data
Delete intermediate results
Build model to determine sea turtle concentration

Project Area

The geographic region of interest for this project work is defined as **Jupiter Inlet Lighthouse Outstanding Natural Area** (JILONA). It is located in the northern Pam Beach County on the Atlantic coast of South Florida. JILONA is one of the parts of Bureau of Land Management's 27-million-acre National Conservation Lands and being the only complete unit in east of Mississippi River. It is adjoined by the Loxahatchee River and the Indian River Lagoon and a half mile from the Atlantic Ocean. It is situated 14 miles north of West Palm Beach and it is present at approximately of 2 hours duration from the north of Miami via Interstate 95. The total land cover area of JILONA region is about 120 acres of open space.

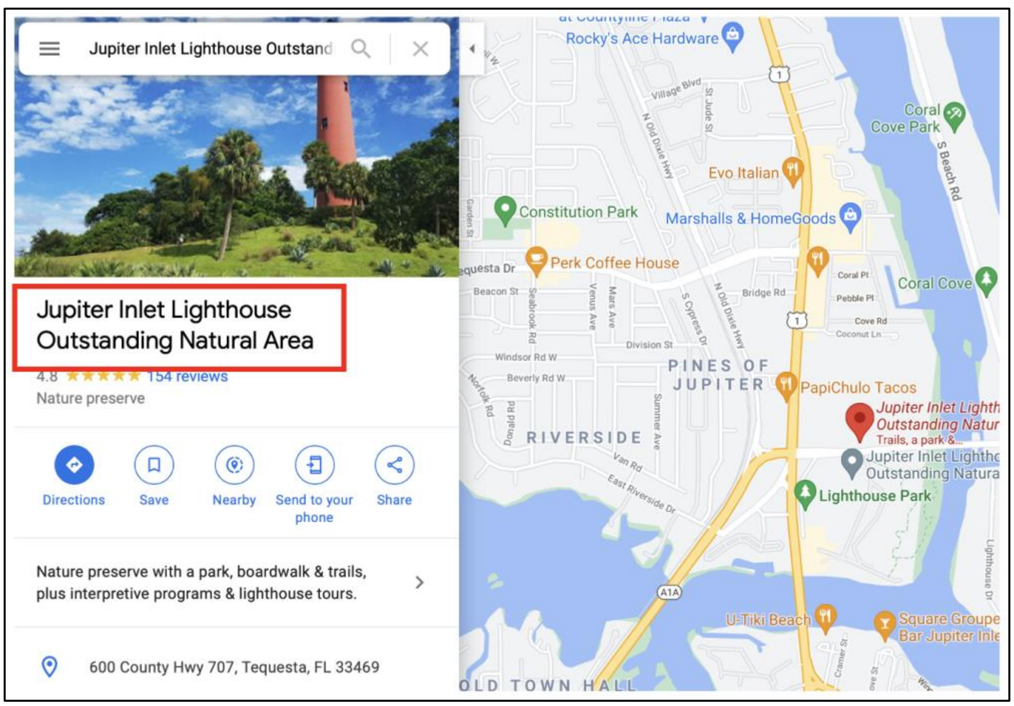
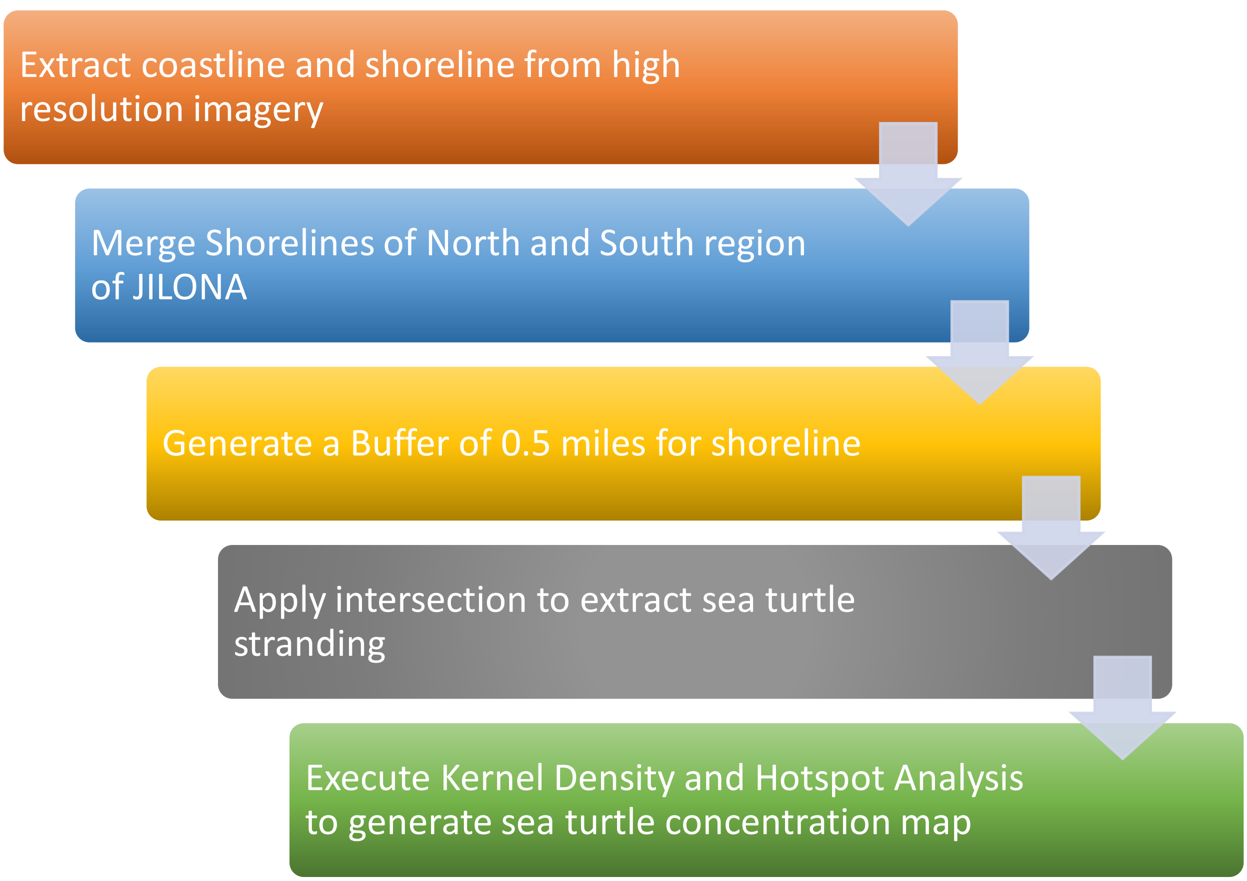


Figure 5: JILONA region in Google Map

Figure 6: JILONA AOI

Methodology

The necessary UAS data was acquired from the Micasense Red Edge Multi spectral camera through which the coastline and shoreline is being extracted. The sea turtle stranding points was collected from the FGDL metadata explorer website. With the help of the extracted output shoreline features along the JILONA region, the concentration of sea turtle stranding is determined. Initially, shoreline extracted from North and South part of JILONA is being merged and then a buffer for 0.5 miles is generated so that the sea turtle stranding points within the specified region can be filtered. Finally, the concentration of sea turtle can be visualized through Kernel Density and Optimized Hotspot Analysis.



Procedure

The sea turtle stranding point data from FGDL is used to find its concentration through model builder, along the JILONA shore region after extracting shoreline and coastline features from the high resolution, five band imagery data via custom Python tool.

Data Preprocessing

As an initial step, the collected data must be cleaned up for further processing. The raw data from the Mica sense Red edge camera was processed using Pix4D software, which resulted in high resolution imagery.

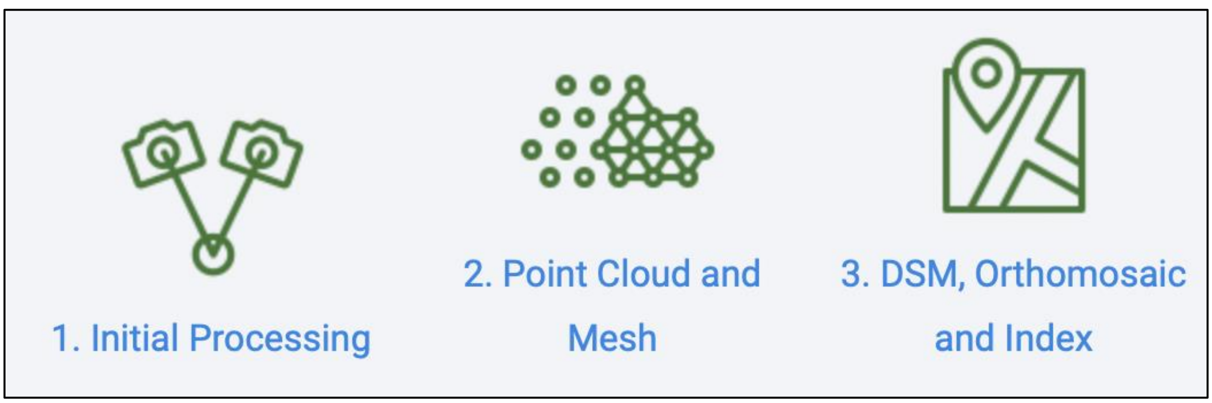


Figure 7: Steps to generate orthomosaic image

The steps shown in figure 7 need to carried forward in order to convert the raw data to orthomosaic data. Initial processing is to mark all the ground control points on the data, so that all the other points get automatically matched up, which would finally result in DSM, DTM and orthomosaic after several hours of processing.

Coastline and Shoreline Extraction tool

A custom geoprocessing tool was developed using ArcPy, through which both the coastline and shoreline can be extracted by giving the high-resolution multispectral imagery consisting of 5 bands namely Blue, Green, Red, RedEdge and Near InfraRed.

Required Tools

All the required tools are being imported at the beginning, so that extraction process can make use of these and result in a better outcome. As an initial step, "**Spatial Analyst**" Extension has to be enabled in order to perform all kinds of spatial operations and access the spatial analyst tools available in the ArcGIS Pro.

1. ArcPy
2. Spatial Analyst from ArcPy
3. Raster to polygon conversion from ArcPy
4. Raster domain for three dimensions from ArcPy

Modified NDWI

Modified Normalized Difference Water Index (NDWI) uses **Green** and **Red Edge** bands of the images acquired from Micasense Red edge camera. It is commonly used in order to differentiate and highlight liquid features from land. The actual two formulae for NDWI are as,

$$NDWI = \frac{X_{NIR} - X_{SWIR}}{X_{NIR} + X_{SWIR}} \qquad (1)$$

$$NDWI = \frac{X_{Green} - X_{NIR}}{X_{Green} + X_{NIR}} \qquad (2)$$

However, for more accurate results, combination of red edge and green sensor values have been used in this study and hence the Modified Normalized Water Index (M-NDWI) is defined as,

$$MNDWI = \frac{X_{Green} - X_{RedEdge}}{X_{Green} + X_{RedEdge}} \quad (3)$$

"**Band Arithmetic**" tool is used to extract individual band information from the multi-spectral imagery, which is then followed by reclassifying the raster based on a defined range using "**Remap value**" option in "**Reclassify**" tool.

Smoothening process

To remove unnecessary noise from the data, majority filter is being applied. During this process, randomly present pixels get classified based on the majority value i.e., most occurring value of the neighborhood cells. In "**Majority Filter**" tool, filter's kernel size is given as "**Eight**", which will take a three-by-three window to access the neighbor cells by finding value for the destined cell, wherein "**Half**" is the replacement threshold being used. This means that, to determine a value for each cell, at least half of its neighbor cells needs to be present in a considered value.

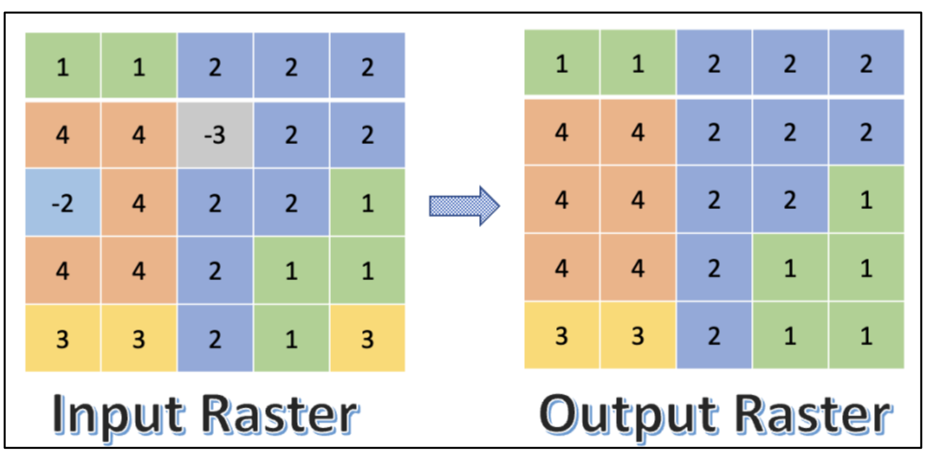


Figure 8: Majority Filter

Polygon conversion

Using the smoothened raster data, the whole imagery is then converted and simplified to vector data as polygons through "**Raster to Polygon**" tool. From the generated polygons, the water polygons with maximum shape area needs to be chosen, in order to split land and water polygons by making use of the "**Select Layer By Attributes**" option.

Generate lines

With the help of the generated polygons, all the features need to be converted into lines using "**Polygon to Line**" tool. This is an example of vector-to-vector data transformation. The transformed line data is stored as a feature class, so that it can be reused to perform further analysis.

Filter lines

Once the line data is generated, it needs to be filtered so that only the necessary data is used for further processing. Thereby exists three important components that are to be considered on filtering the line information. Firstly, all the linear rings from the data must be removed using "**Select Layer by Attributes**" tool, which can be done by collecting all the object ids of features whose starting and ending point is the same and this is given as a condition to the tool. Secondly, the filtered data needs to be sent to "**Unsplit Line Management**" tool, in order to merge the lines that have common ends, so that the length of existing lines gets larger. Finally, the lines have to be sorted in descending order based on its length using "**Sort Management**" tool, through which the line satisfying the given minimum length condition can be filtered out. Only the resulting lines after all these filtering process will be used further to extract the shoreline from the given imagery.

Clip lines

The lines obtained as a result of the filtering process needs to be clipped using “**Clip**” tool under the “**Analysis**” toolbox based on the shore region of the study area considered and saved as a feature class to proceed with further analysis. This process is done to extract only those lines that covers the shore, leaving out the lines present in the land side.

Remove intermediate results

When performing all the above-mentioned processes, there are several intermediate outputs that gets generated and added to the default geodatabase of the ArcGIS Project file. These results need to be removed from the default geodatabase after checking the existence of the layer using “**Delete Management**” tool, so that the database gets cleaned up after each time the shoreline extraction tool runs completely.

Geoprocessing tool

With the code prepared by integrating all the necessary tools, a geoprocessing tool can be modelled to extract the shoreline and the coastline from any given multi spectral imagery with the green and Red edge bands as a mandatory requirement for JILONA region.

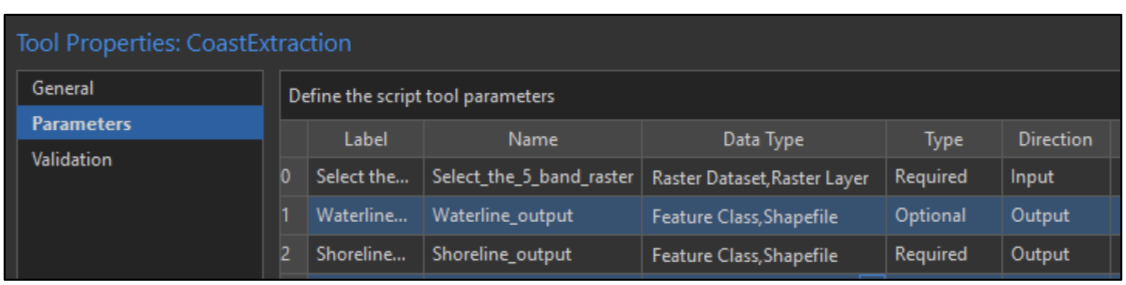


Figure 9: Parameters of the GP tool

The developed GP tool takes three inputs from the user and produces two outputs as results. Shoreline and Coastline are finally obtained upon giving the five band multi spectral imagery acquired from Micasense Red Edge camera, output feature class paths for shoreline and coastline as inputs.

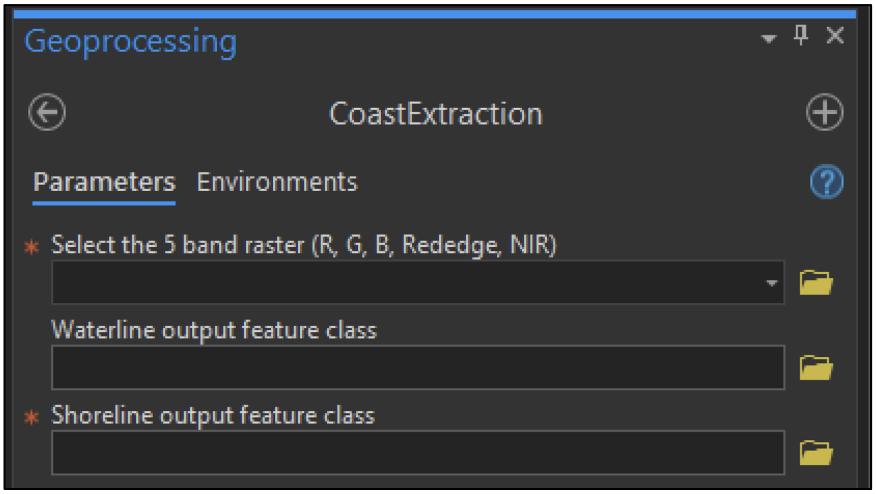


Figure 10: Developed Geoprocessing to

Sea Turtle Concentration

A very large population of sea turtles are threatened and prone to danger in the region of Florida. Amongst this scenario, it would be really great if one can interpret and visualize the concentration of sea turtle stranding's along the shore region in order to safeguard it's nestles. The extracted shoreline for both North and South part of JILONA is used as an input for this analysis after merging its results using "**Merge**" Geoprocessing tool. A polygon region is created in the shore, by generating a buffer of shoreline feature for nearly 0.5 miles using "**Buffer**" Geoprocessing tool. The sea turtle stranding is then filtered by intersecting all stranding points in Florida with the generated buffer using "**Intersect**" Geoprocessing tool. Kernel Density and Hotspot analysis is performed using the refined sea turtle stranding points.

Kernel Density Analysis

Taking a known quantity of any certain phenomenon and spreading them across a particular landscape at every location and establishing a spatial relationship based on the location of measured quantity is often termed as **Density Analysis**. In common, three kinds of density analysis are available namely **Point**, **Line** and **Kernel**. In point and line density analysis, the density of the quantity around each cell is calculated based on the specified neighborhood, whereas Kernel density analysis spreads out the known quantity for each cell from the point location. In other words, Kernel density helps in calculating density of point and line features around each output raster cell, based on the available neighborhood features.

$$Density = \frac{1}{(radius)^2} \sum_{i=1}^{n} \left[\frac{3}{\pi} \cdot pop_i \left(1 - \left(\frac{dist_i}{radius} \right)^2 \right)^2 \right]$$

For $dist_i < radius$

where:

- i = 1,…,n are the input points. Only include points in the sum if they are within the radius distance of the (x,y) location.
- pop_i is the population field value of point i, which is an optional parameter.
- $dist_i$ is the distance between point i and the (x,y) location.

Figure 11: Kernel Density

Optimized Hotspot Analysis

Optimized Hotspot analysis works by calculating "**Getis-Ord Gi**" statistic for each cell or a feature in any given dataset. This results in two outputs namely **z-scores** and **p-values**, where z-score represents standard deviation and p-value represents probability. These two results help in establishing a spatial relationship of features based in its clustering on either high or low values.

Clustering concentration is directly proportional to the values of z-scores i.e., smaller the z-score values, intense of cold spot clusters will be more and higher the z-score values, intense of hot spot clusters will be more. Confidence level of cell purely depend on z-score and p-value

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{\frac{\left[n \sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j} \right)^2 \right]}{n-1}}} \qquad (1)$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \qquad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - \left(\bar{X}\right)^2} \qquad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Figure 12: Optimized Hotspot Analysis

Model to visualize sea turtle concentration

With the help of extracted shoreline for North and South part of JILONA region, a series of geoprocessing and density analysis tools in ArcGIS are being used in order to determine the concentration of sea turtle stranding points along the shore. This process involves Merge, Buffer, Intersect, Kernel density and Optimized Hotspot analysis tools.

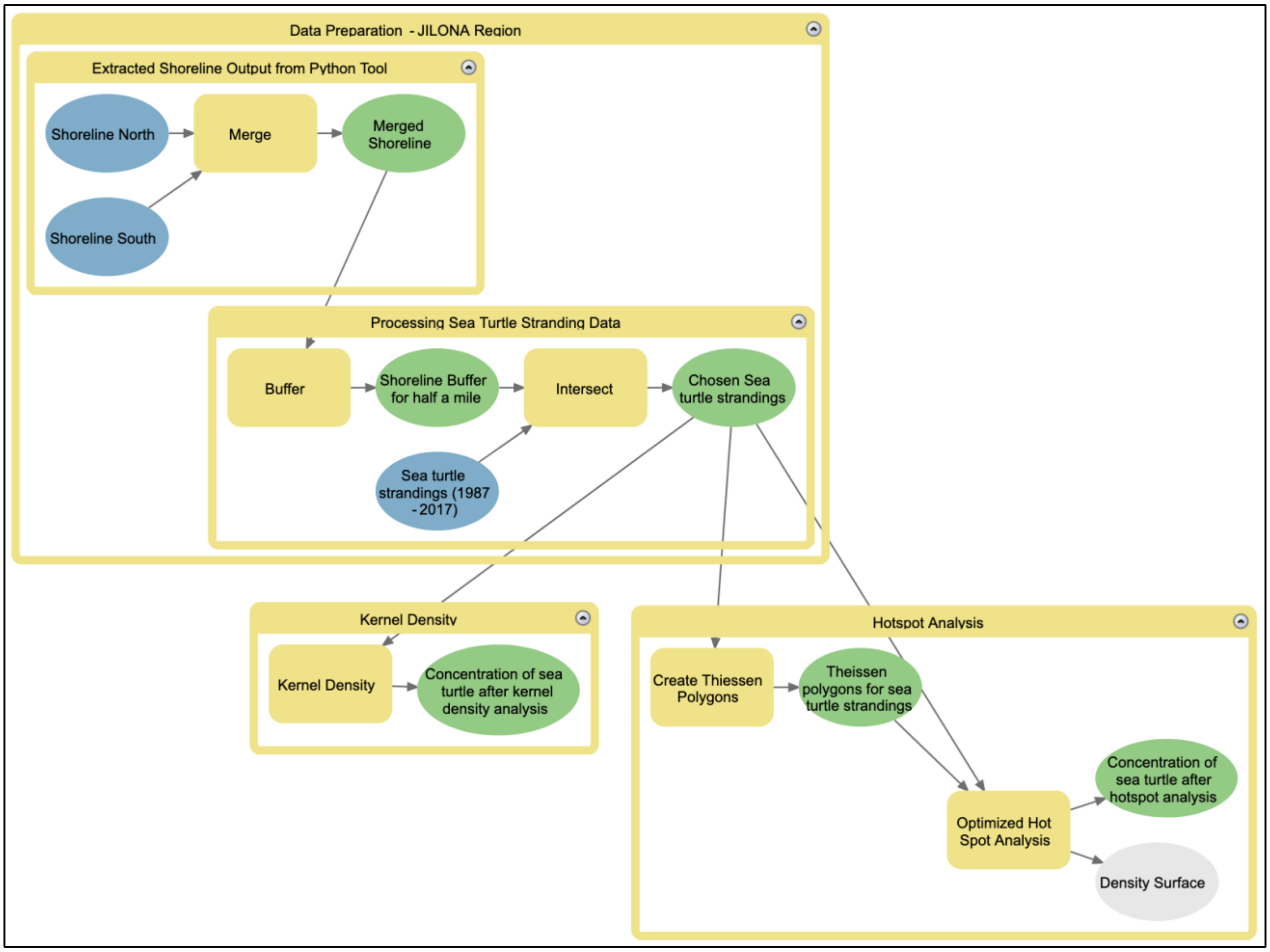


Figure 13: Model to determine sea turtle concentration

There exist five major steps in the above developed model using ArcGIS Model Builder. They are as follows:

<u>Step 1:</u> Data Merging

Input: Shorelines of North and South part of JILONA

Tool Used: Merge

Output: Merged shoreline of JILONA region

<u>Step 2:</u> Data Merging

Input: *Merged s*horeline of JILONA region, Sea turtle stranding of Florida

Tool Used: Buffer (0.5 miles), Intersect

Output: Sea turtle stranding within 0.5 mile of shoreline

<u>Step 3:</u> Density Analysis

Input: Sea turtle stranding within 0.5 mile of shoreline

Tool Used: Kernel Density

Output: Sea turtle concentration along the JILONA shore

<u>Step 4:</u> Generate Thiessen Polygons

Input: Sea turtle stranding within 0.5 mile of shoreline

Tool Used: Create Thiessen Polygons

Output: Thiessen polygons for sea turtle stranding points

<u>Step 5:</u> Hotspot Analysis

Input: Thiessen polygons for sea turtle stranding points

Tool Used: Optimized Hotspot Analysis

Output: Sea turtle concentration along the JILONA shore

Generated Results

The two major outcome of this research is the shoreline, coastline feature along the region of JILONA and the sea turtle stranding concentration along the shore. A well-defined map has been generated to visualize the outputs in a better way.

Figure 14: Shoreline output

Figure 15: Coastline output

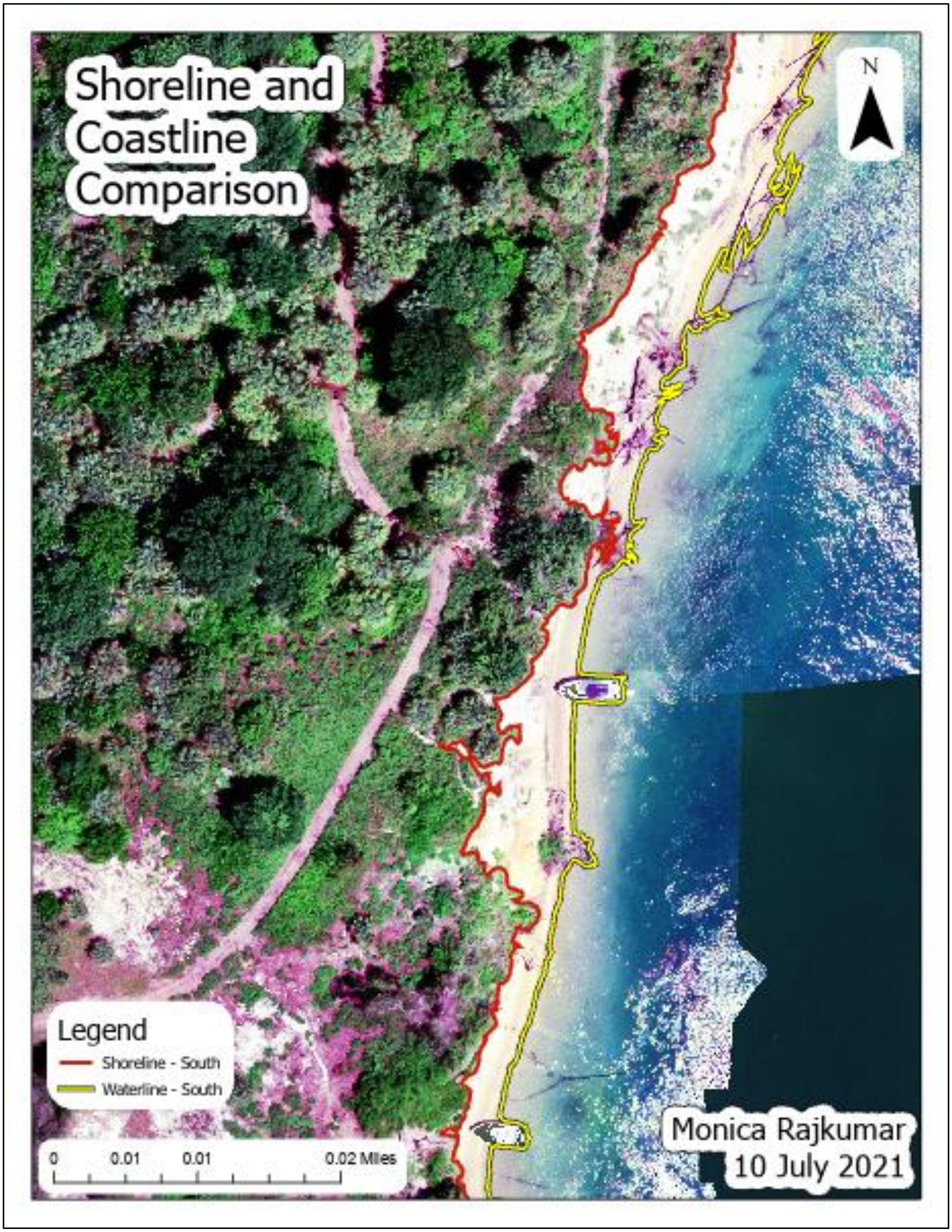


Figure 16: Shoreline and coastline comparison

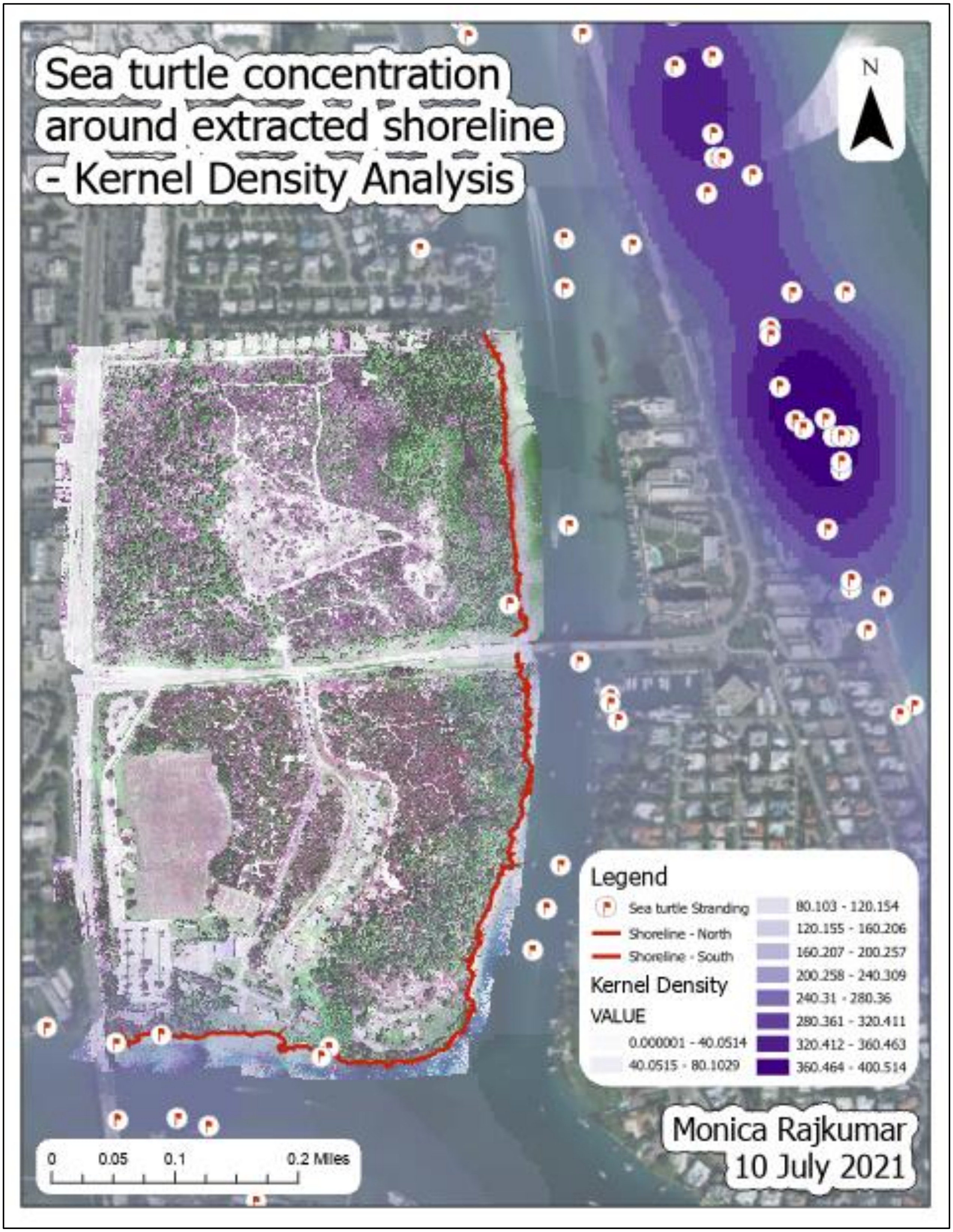


Figure 17: Kernel Density output

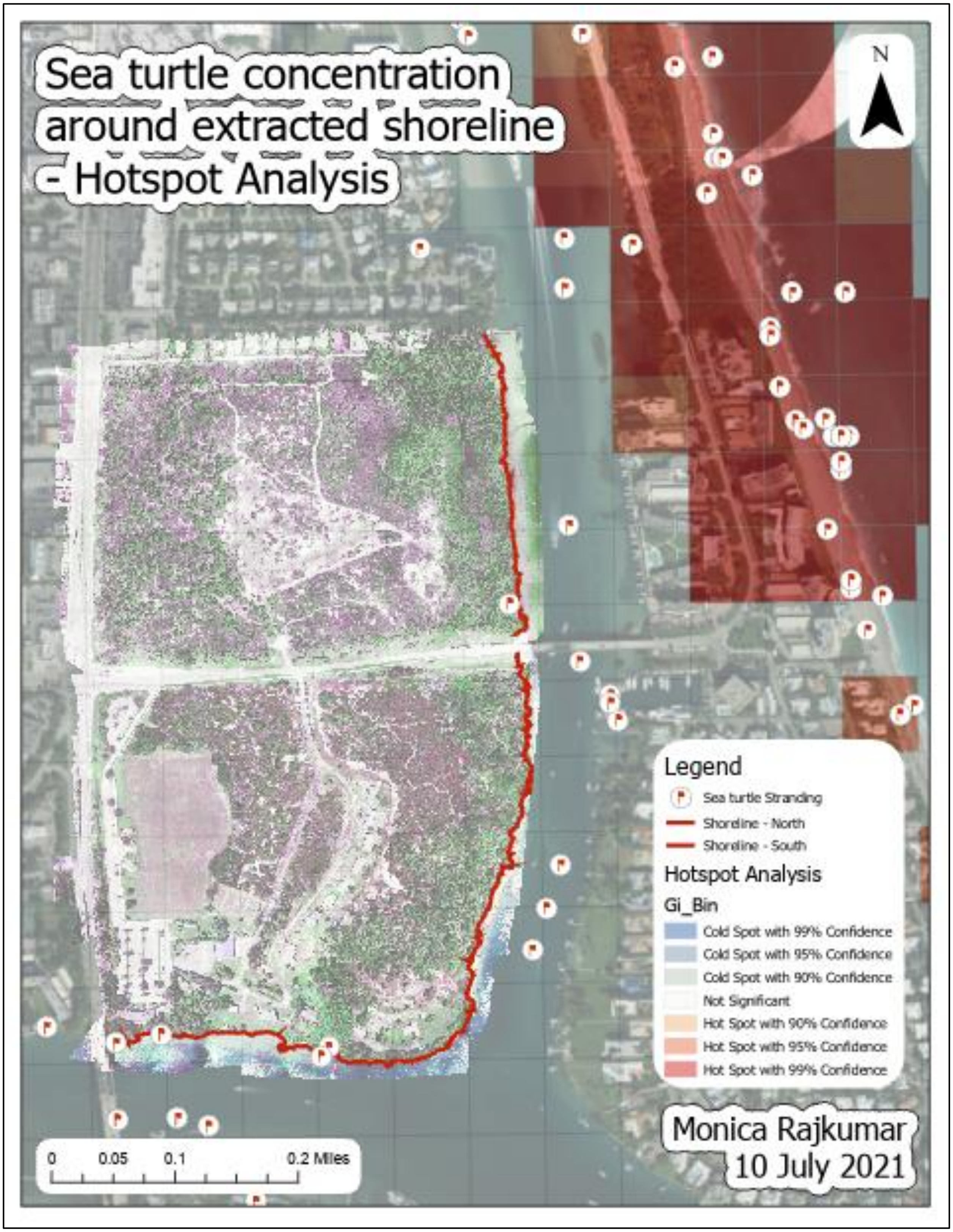


Figure 18: Hotspot Analysis output

Conclusion

The process of extracting the coastline and shoreline as a vector data in the JILONA region was automated by developing a geoprocessing tool using Python, which will help in easing work on digitization. A model to determine the concentration of sea turtle along the shoreline was developed using ArcGIS Model Builder, so that it will be useful in supporting the recovery of stranded turtles by rescuing, rehabilitating, and releasing them into the shore, which would help in further studies on stranding of commercially highly valuable sea turtles. Both the developed extraction tool and the model, that maps the sea turtle concentration through this study, will be of more time and cost efficient.

Results and Discussion

Through this project, a geoprocessing tool has been created, that automates the extraction of both shoreline and coastline from the high resolution five band imagery data. This was achieved by calculating NDWI, which outperformed all other indexes such as NDVI, NDRI etc., The output vector dataset of shoreline and coastline, that is being extracted is more than 6000 feet which can be further used in various processes such as volume of soil computation to detect erosion, change detection of shoreline and coastline with its patterns etc., Since the developed tool can generate the result within a short span of time, it helps human in saving time and effort as a lot of man hours is needed in digitizing the coastline and shoreline features. Using this model, output can be generated whenever a same kind of five band multispectral imagery is given as input. Apart from this, a custom model was created through which the sea turtles stranding concentration can be visualized effectively and the result can be used for further studies on their populations and habitats. The concentration map clearly shows that there is not much sea turtle stranding seen along the shoreline of JILONA. Both the Kernel Density and Hotspot analysis outclassed the Point and Line density analysis during this study.

Statistics

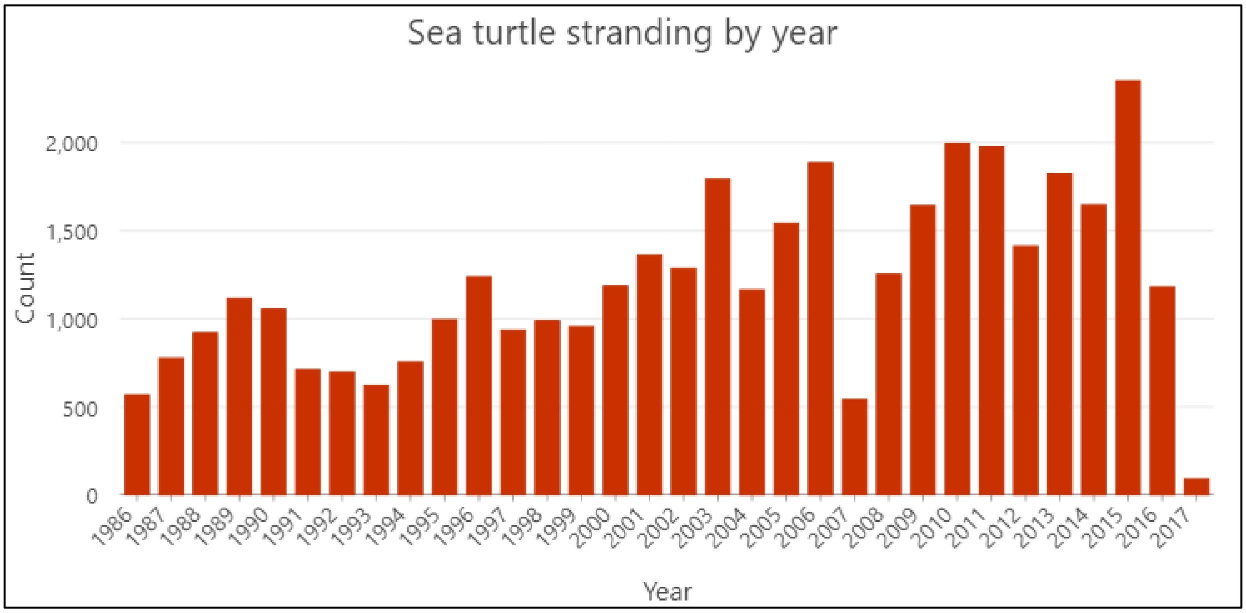


Figure 19: Total Sea turtle stranding in Florida shore

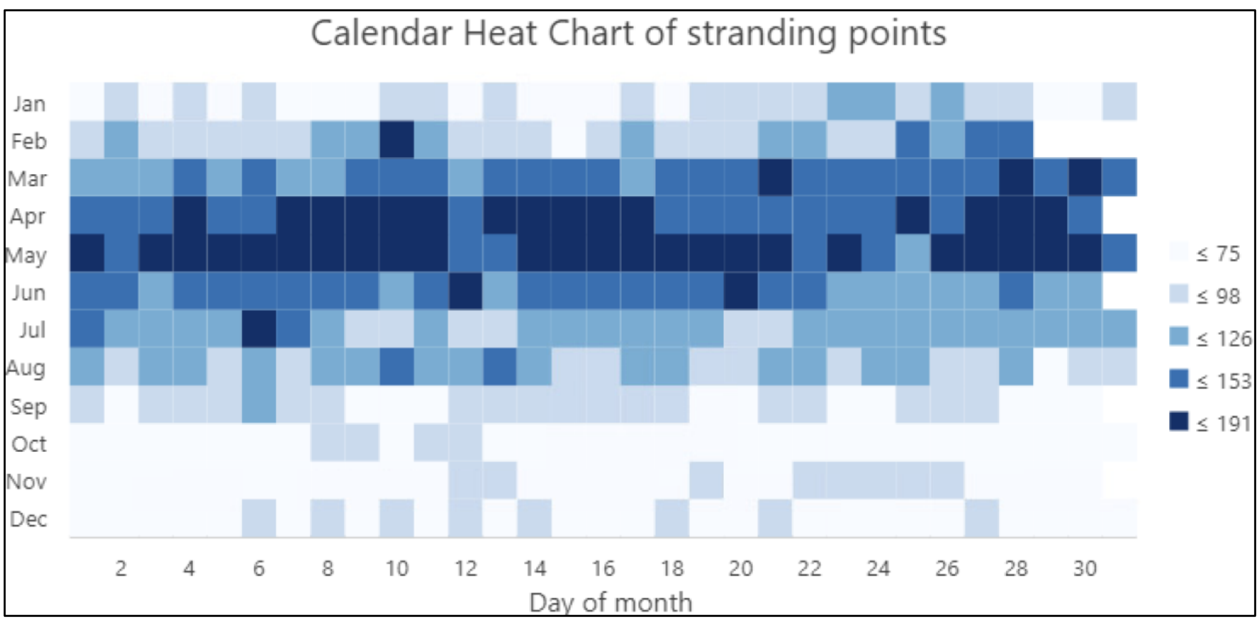


Figure 20: Stranding points throughout the years

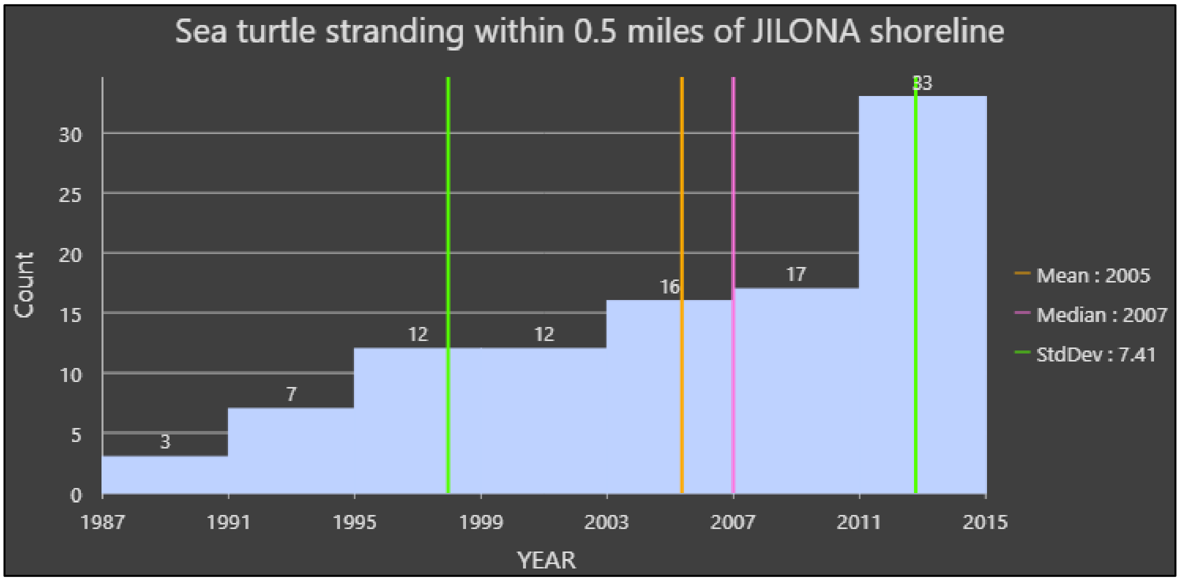


Figure 21: Stranding within the AOI

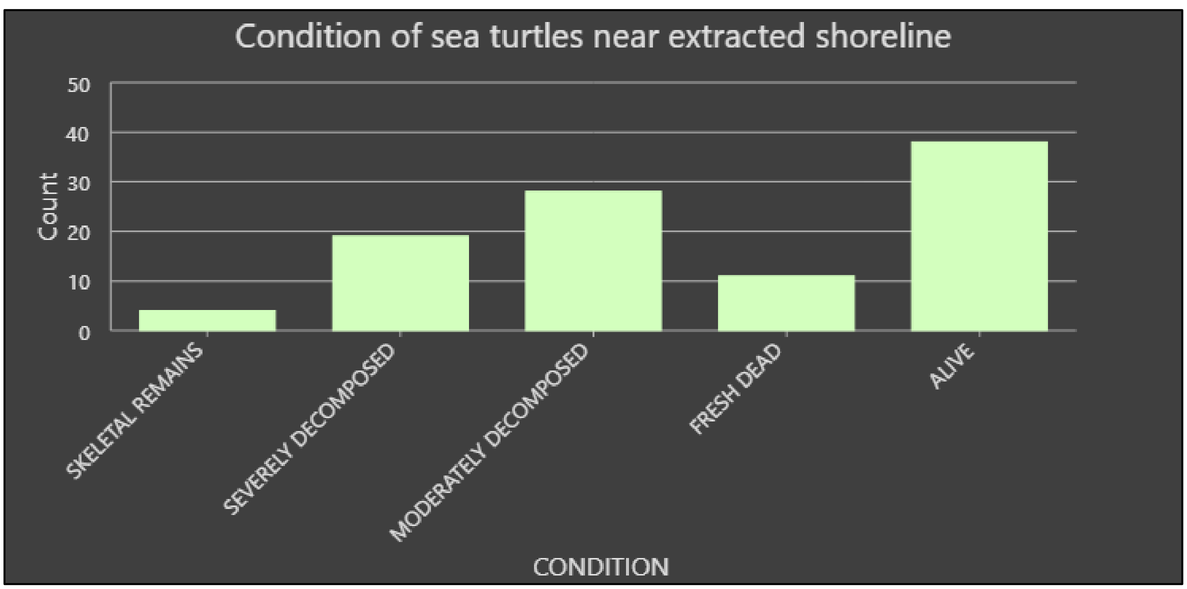


Figure 22: Condition of turtles along shoreline

Future Scope

The extracted output from this research can be further used in performing change detection of the shoreline and in computing the volume of soil erosion using a series of data. This project can be further extended to extract the whole coast / shore region from the given input high resolution imagery. The developed model can be modified in such a way, it generates a accurate extraction of coastline and shoreline, even when a three band imagery is given as an input. Deep Learning models like UNet, MaskRCNN etc., can be implemented in extraction process, which will result in higher accuracy of the generated output dataset. Through the generated sea turtle concentration map, a further analysis related to the threats for sea turtle can be carried out and a study can be done to understand its behavior pattern due to the climatic change effects along the shore of any region, which can be extended.

Project Details

Power Point Presentation - Project Procedure Explanation

https://youtu.be/DVJ2P-mxIeA

Project Timeline

Table 2: Overall timeline of the project

TERM	MONTH	DATE	TASK
SUMMER 2021	**MAY**	18th - 23rd	Formulating the idea for project
		24th - 31st	UAS Data processing using Pix4D
	JUNE	1st - 10th	Research about the methodology
		11th - 14th	Project Proposal Preparation
		15th - 20th	Data preparation using ArcGIS
		21st - 30th	Extract the shoreline and waterline using ArcGIS tools
	JULY	1st - 15th	Automate the extraction process using Python
		15th - 20th	Test and deploy the developed 'Extraction tool'
		21st - 26th	Preparation of Project report
		26th - 31st	Preparation of Project PPT
	AUGUST	1st	Finalize and submission

References

JILONA Wikipedia - Accessed Jun 21, 2021.

https://en.wikipedia.org/wiki/Jupiter_Inlet_Light#Jupiter_Inlet_Lighthouse_Outstanding_Natural_Area

Nagarajan, Sudhagar, et al. **"UAS Based 3D Shoreline Change Detection of Jupiter Inlet Lighthouse ONA after Hurricane Irma**." International Journal of Remote Sensing, vol. 40, no. 24, 2019, pp. 9140–9158., doi:10.1080/01431161.2019.1569792

ESRI - Accessed Jun 21, 2021.

https://www.esri.com/arcgis-blog/products/product/imagery/on-map-scale-and-raster-resolution/

ArcGIS Pro Documentation - Accessed July 03, 2021.

https://pro.arcgis.com/en/

ArcGIS Story map for Automated Coastline Extraction - Accessed Jun 21, 2021.

https://storymaps.arcgis.com/stories/3b8aaaf0c8b043f7a6ec2d965f01bcbe/

Micasense Incorporated. 2020. Micasense Red Edge-MTM Multispectral Camera – Integration Guide - Revised November 1, 2020

https://support.micasense.com/hc/en-us/articles/360011389334-RedEdge-MX-Integration-Guide

Pix4D - Accessed July 03, 2021.

https://support.pix4d.com/

FGDL - Accessed Jun 27, 2021.

https://www.fgdl.org/metadataexplorer/explorer.jsp

ArcGIS Story map for Turtles, Boats and Stranding - Accessed Jun 27, 2021.

https://www.arcgis.com/apps/Cascade/index.html?appid=5fe69280a6ff4ed09e2d2ac4bc1b6e20

Sea turtle Wikipedia - Accessed July 10, 2021.

https://en.wikipedia.org/wiki/Threats_to_sea_turtles

Appendix A

FLORIDA GEOGRAPHIC DATA LIBRARY METADATA EXPLORER

ABOUT THE FLORIDA GEOGRAPHIC DATA LIBRARY (FGDL)

The **Florida Geographic Data Library (FGDL)'s Metadata Explorer** is a mechanism for distributing spatial (GIS) data throughout the state of Florida. The FGDL is warehoused and maintained at the University of Florida's GeoPlan Center, a GIS Research & Teaching Facility.

FGDL began in 1998 with 80 GIS layers. Today, there are over 400 current and historic GIS layers in the FGDL, from over 35 local, state, federal, and private agencies. FGDL includes data on Land Use/ Land Cover, Hydrography, Soils, Transportation, Boundaries, Environmental Quality, Conservation, Census, and more. FGDL contains primarily vector GIS data layers.

Data is available for download free of charge from the **FGDL METADATA EXPLORER** or our FTP site. New data layers are continuously added to the FGDL Metadata Explorer.

For imagery and raster data, such as DOQQs and DRGs, please see **LABINS**.

The FGDL has been compiled from data collected from numerous state and federal governmental agencies, as well as some nonprofit organizations and private companies. Currently, the Florida Department of Transportation (FDOT) is the lead agency contributing to the maintanence of FGDL. We also acknowledge the Florida Department of Environmental Protection (FDEP) for its contributions to the earlier versions of FGDL.

The FGDL supports the National Spatial Data Infrastructure (NSDI) through the following activities:

- Maintenance of Federal Geographic Data Committee (FGDC) compliant metadata for all data layers distributed.
- Maintenance of the FGDL Metadata Explorer, a GIS Catalog Portal, from which data can be shared, accessed, and searched by other portals and individuals free of charge.
- Participation in the Geospatial One Stop (GOS)/ geodata.dov, with FGDL metadata records regularly harvested by GOS.
- Participation as a Clearinghouse Node in the FGDC's Clearinghouse Registry.

FGDL DATA DISCLAIMER:
The Florida Geographic Data Library is a collection of Geospatial Data compiled by the University of Florida GeoPlan Center with support from the Florida Department of Transportation. GIS data available in FGDL is collected from various state, federal, and other agencies ("data sources") who are data stewards, producers, or publishers. The data available in FGDL may not be the most current version of the data offered by the data source. University of Florida GeoPlan Center makes no guarantees about the currentness of the data and suggests that data users check with the data source to see if more recent versions of the data exist.

Furthermore, the GIS data available in the FGDL are provided "as is". The University of Florida GeoPlan Center makes no warranties, guaranties or representations as to the truth, accuracy or completeness of the data provided by the data sources. The University of Florida GeoPlan Center makes no representations or warranties about the quality or suitability of the materials, either expressly or implied, including but not limited to any implied warranties of merchantability, fitness for a particular purpose, or non-infringement. The University of Florida GeoPlan Center shall not be liable for any damages suffered as a result of using, modifying, contributing or distributing the materials.

FGDL regularly updates as many of its data layers as we have time for, but with over 350 data layers, it is difficult to update every single data layer as the updated data becomes available. If you find an updated version of a data layer in FGDL, please contact us and we will try to get the layer into the FGDL. Thank you!

Figure 23: About FGDL

Appendix B

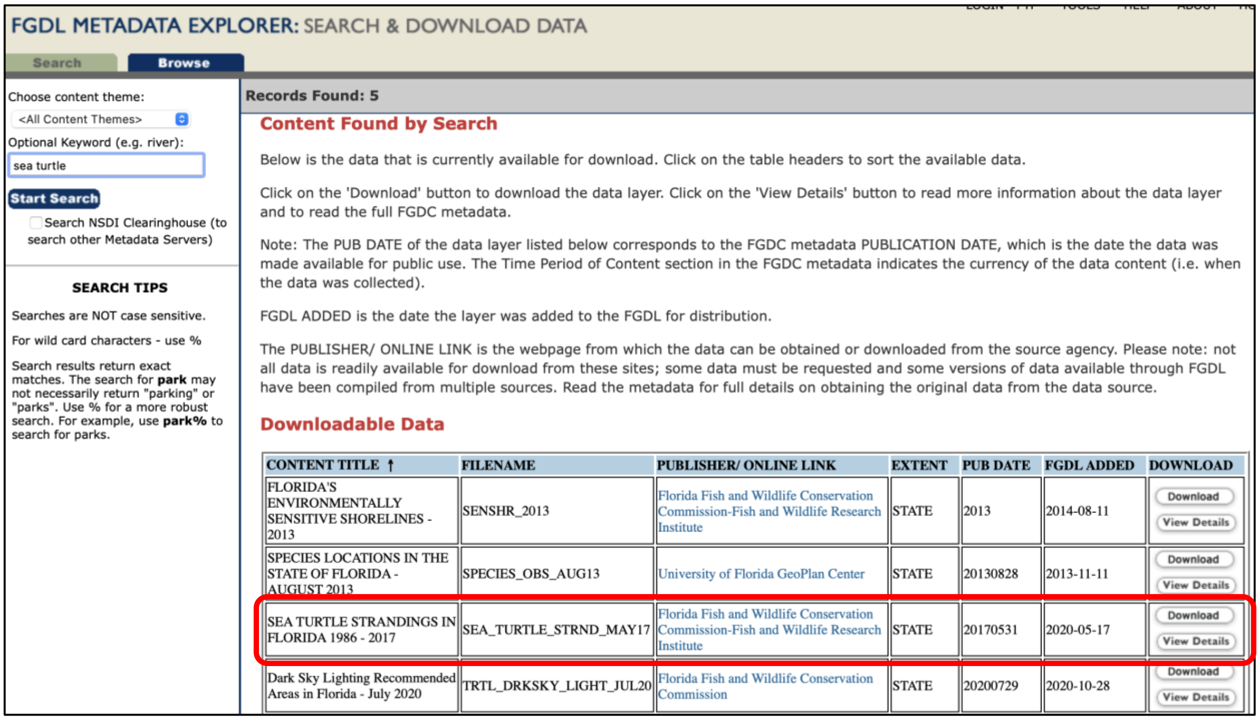


Figure 24: Sea turtle stranding data from FGDL

Appendix C

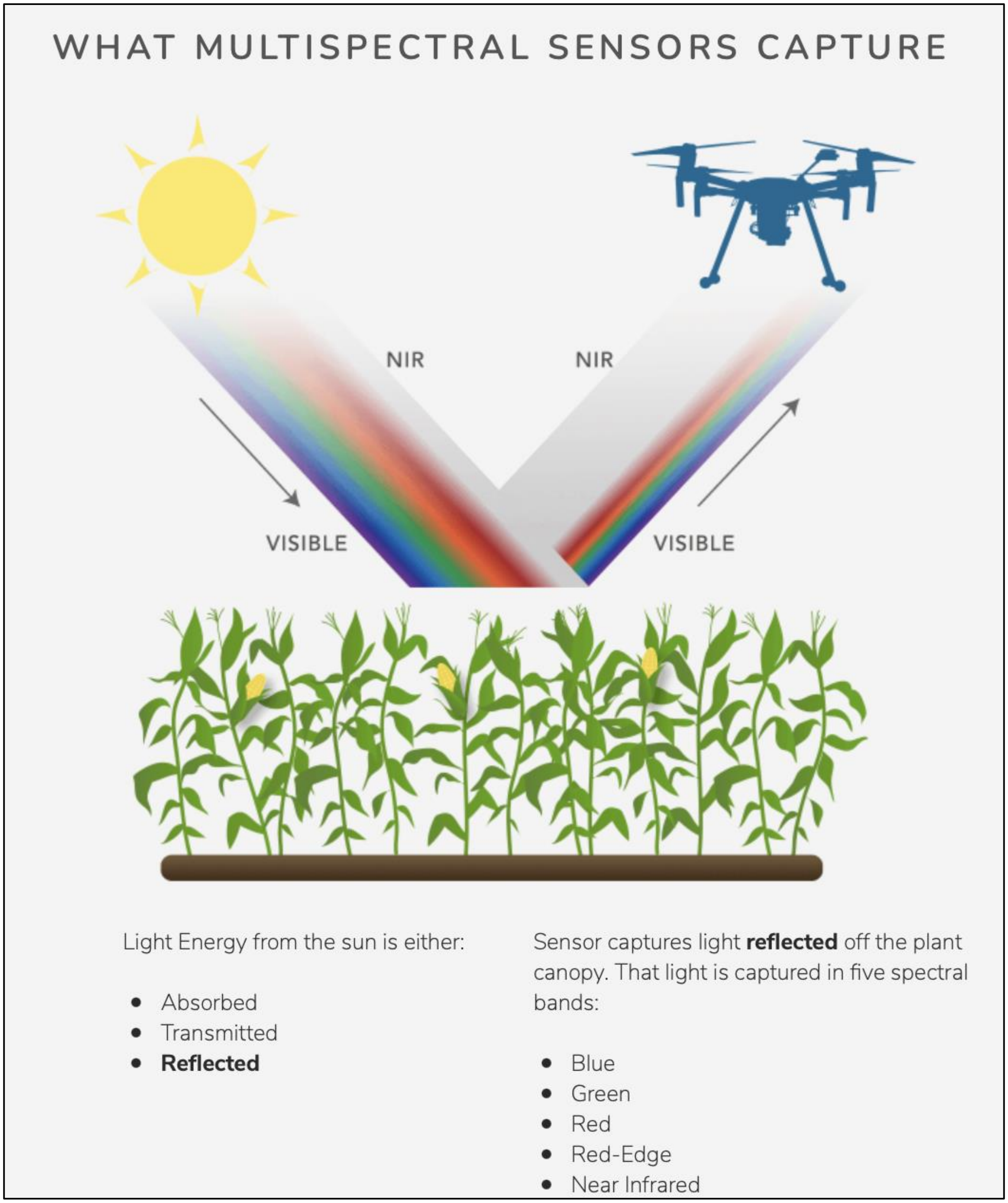


Figure 25: Micasense Red Edge sensor

Appendix D

Table 3: Band Wavelength information

Band Number	Band Color	WAVELENGTH	
		Center (nm)	Bandwidth (nm)
1	Blue	475	32
2	Green	560	27
3	Red	668	16
4	Red Edge	717	12
5	Near - IR	842	57

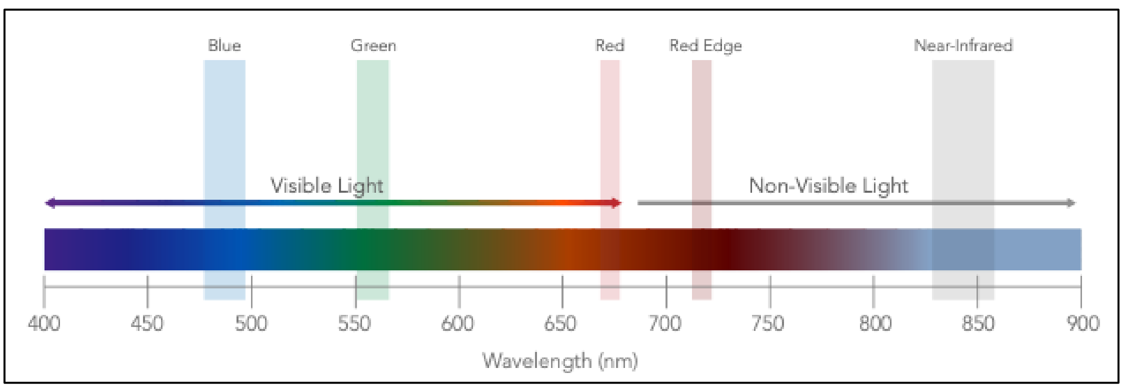


Figure 26: Visible to Non-visible Light Spectrum Range Represented (400 nm - 900 nm)

Appendix E

6 TOP THREATS TO SEA TURTLES

- **Entanglement in fishing gear:** Turtles get caught on long-lines, in shrimp nets, and get injured with bomb fishing.
- **Consumption and illegal trade of eggs and meat**: Turtle eggs are considered to be an aphrodisiac in many places (with no basis in science) and their meat (primarily green turtles) is still consumed, even though both are illegal in most countries.
- **Coastal development**: Building on nesting beaches, mangroves, and other important coastal areas can affect turtles ability to nest and feed and prevent hatchlings from surviving.
- **Plastic and other marine debris:** Turtles eat plastic, get caught in it, have to wade through it in the water and on beaches, and microplastic can affect nests and hatchlings.
- **Global warming**: Rising temperatures increase sand temperatures, which can cause only females to be born. Climate change also impacts sea level rise, which can erode nesting beaches, and cause coral bleaching, an important habitat for hawksbills.
- **Turtleshell Trade**: Hawksbill turtles in many places are prized for their shells, which are used as decorations or turned into products like jewelry and other crafts.

Figure 27: Sea turtle threats

Appendix F

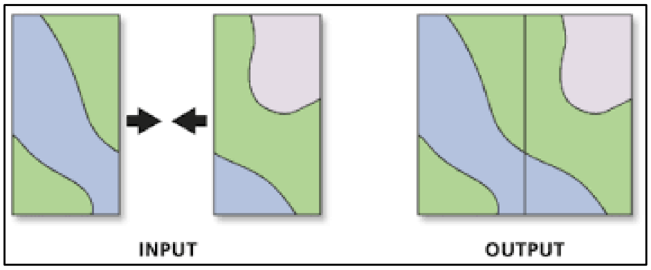


Figure 28: Merge

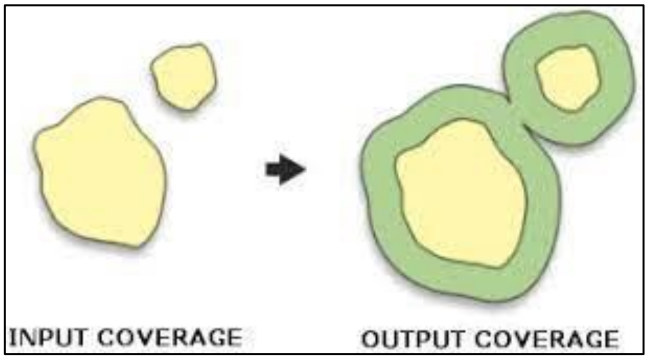


Figure 29: Buffer

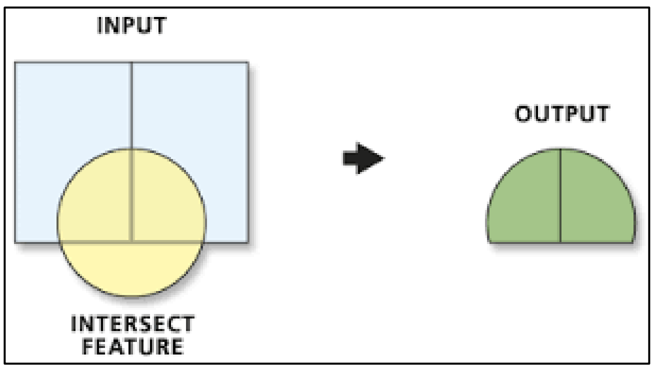


Figure 30: Intersect

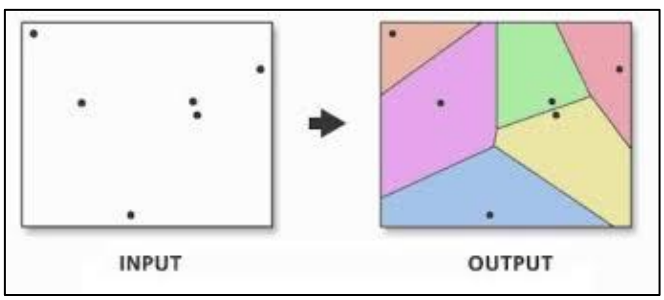


Figure 31: Thiessen Polygon generation

Appendix G

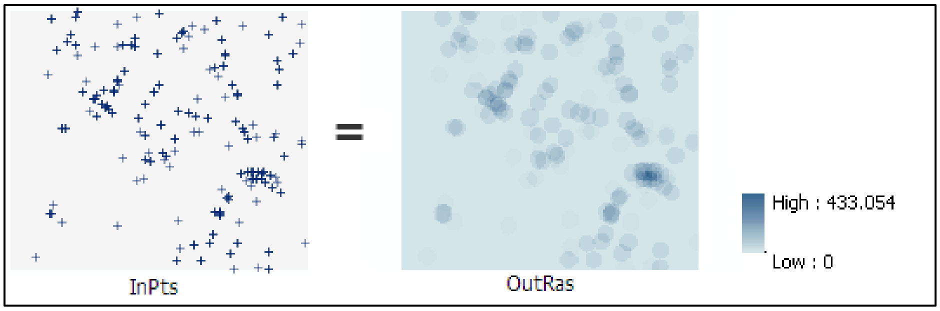


Figure 32: Point Density Analysis

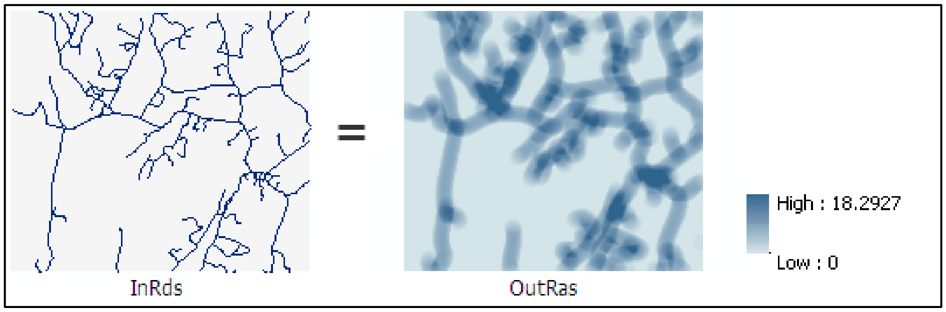


Figure 33: Line Density Analysis

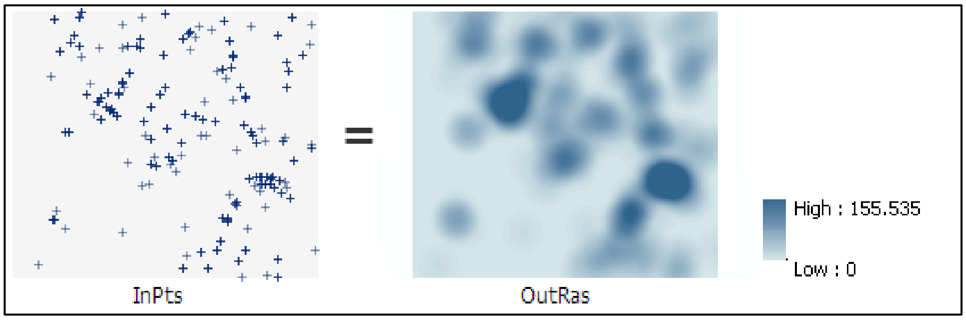


Figure 34: Kernel Density Analysis

Figure 35: Hotspot Analysis

Glossary

JILONA	-	Jupiter Inlet Lighthouse Outstanding Natural Area region
UAS	-	Unmanned Aircraft System
GPU	-	Graphics Processing Unit
NDI	-	Normalized Difference Index
NDWI	-	Normalized Difference Water Index
NDVI	-	Normalized Difference Vegetation Index
NDRI	-	Normalized Difference Red Edge Index
FGDL	-	Florida Geographic Data Library
ESRI	-	Environmental System Research Institute
DSM	-	Digital Surface Model
DTM	-	Digital Terrain Model
DEM	-	Digital Elevation Model
GP Tool	-	Geoprocessing tool of ArcGIS software, ESRI