DELAWARE URBAN DEVELOPMENT

Utilizing NASA Earth Observations to Assess Coastline Replenishment Initiatives and Shoreline Risk Along Delaware's Coasts

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DEVELOP

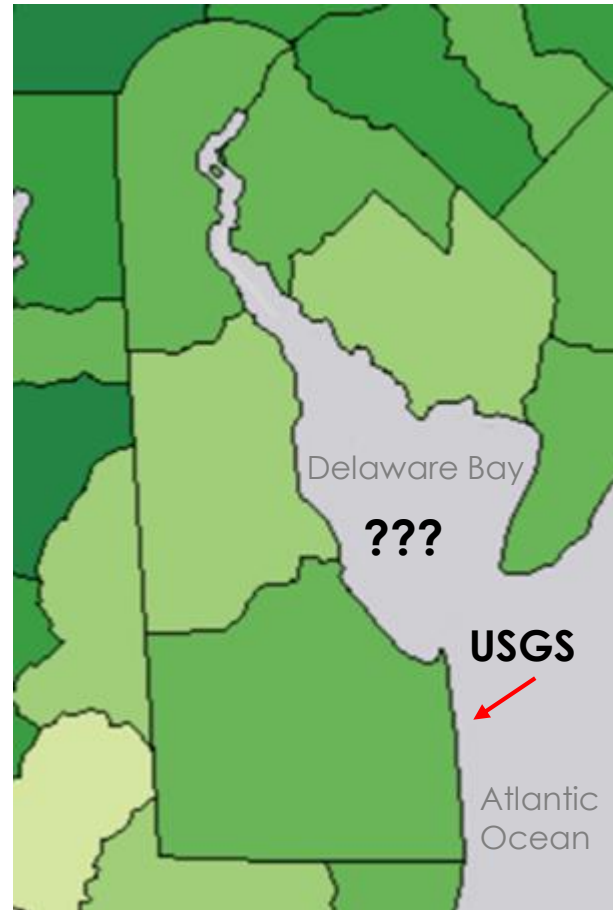Alabama – Marshall | Fall 2019

PROJECT OVERVIEW

▸ Study Area

One-mile buffer along Delaware's coast.

▸ Study Period: **1988-2018**

▸ Partners: **Delaware Department of Natural Resources and Environmental Control (DNREC)**

COMMUNITY CONCERNS

- Economy
  - **Tourism** & **Recreation**

- Ecology
  - Crucial **Habitat**

- Under-studied

Delaware Bay

???

USGS

Atlantic Ocean

Source: Rob Posse

Delaware's Median Household Income;
Source: US Census Bureau

Median Household Income

- $22,679 - $39.941
- >$39,941-$43,518
- >$48,518-$57,355
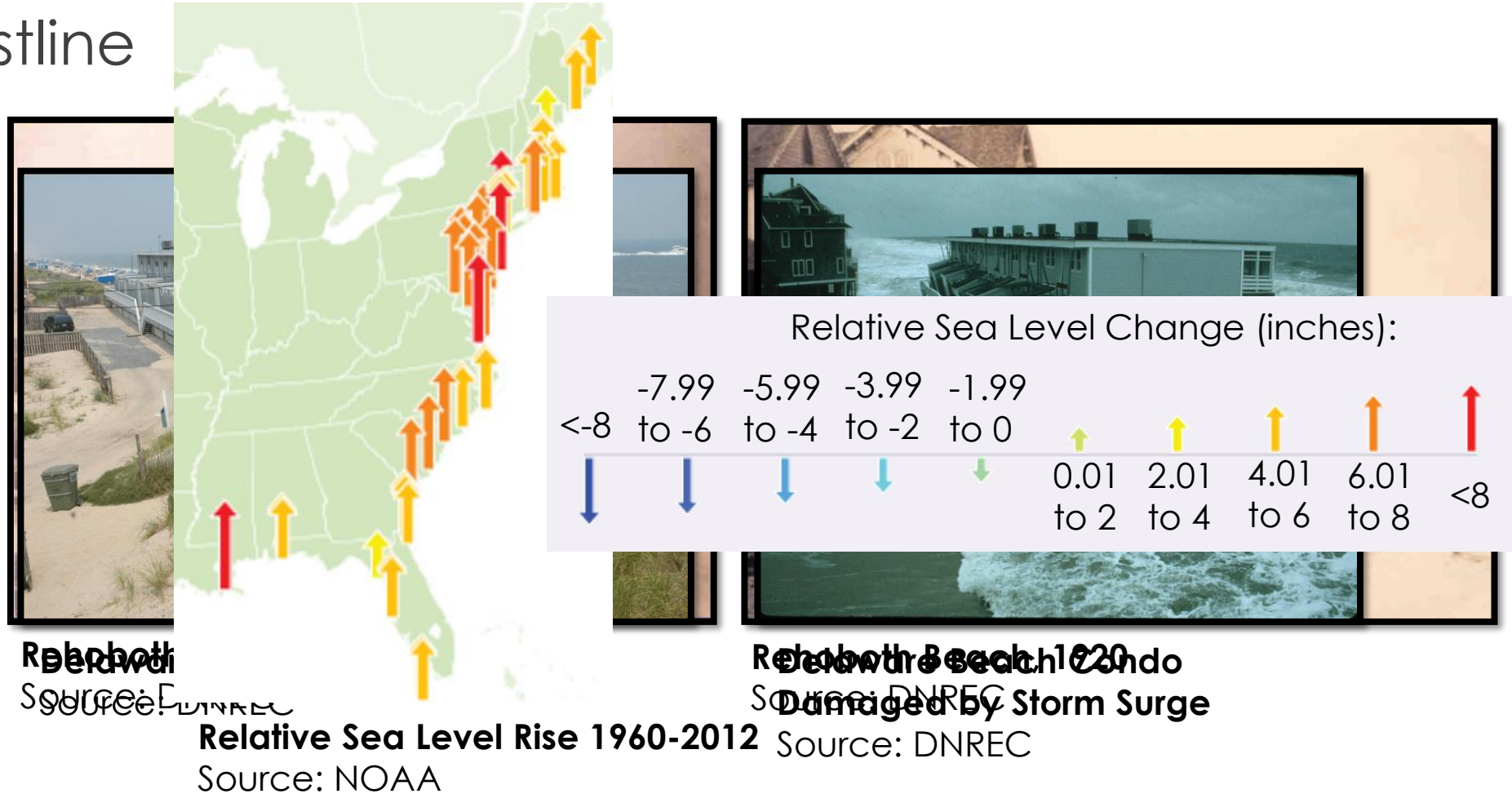- >$57,355-69,581
- >$69,581-$83,149
- >$88,149-$136,191

on Pickering Beach;

COMMUNITY CONCERNS

▸ Threats to Coastline
  ▸ Erosion
  ▸ Storm Surge
  ▸ Sea Level Rise
  ▸ Subsidence

Rehoboth Beach
Source: DNREC

Relative Sea Level Rise 1960-2012
Source: NOAA

Relative Sea Level Change (inches):

<-8	-7.99 to -6	-5.99 to -4	-3.99 to -2	-1.99 to 0		0.01 to 2	2.01 to 4	4.01 to 6	6.01 to 8	<8

Rehoboth Beach 1920
Delaware Beach Condo
Source: DNREC
Damaged by Storm Surge
Source: DNREC

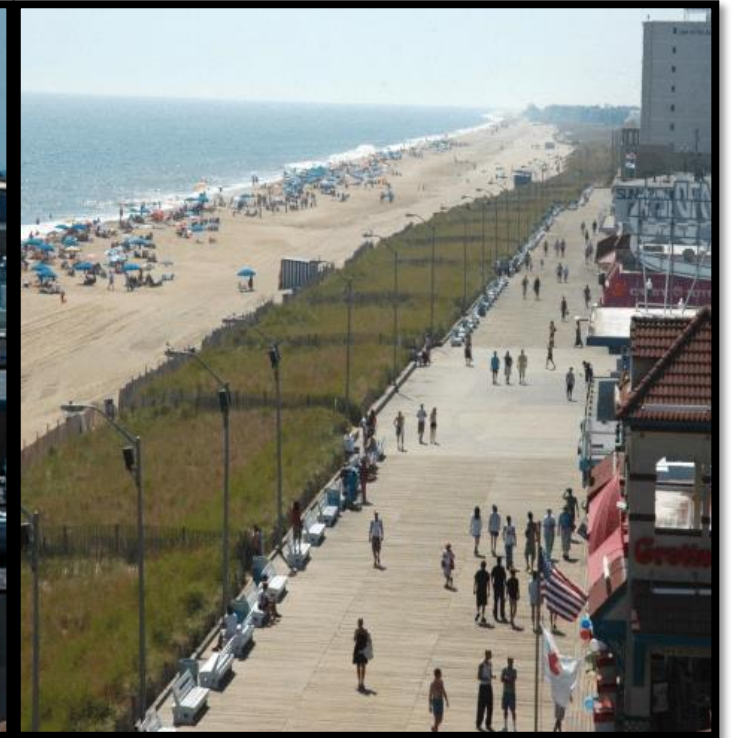# PROTECTING DELAWARE'S COAST

- Policy Loss Prevention Programs
  - Dune protection Beach Preservation Act of 1972
  - Hard structures Regulatory Ordinances
    - dikes, jetties, groins
  - Beach nourishment and fill
 - Living shorelines
- Public Involvement
  - Adopt-A-Beach Program

Rehoboth Beach, Pre-2005; Source: DNREC

Rehoboth Beach, Post-2005; Source: DNREC

METHODOLOGY

- Step 1: **Coastal Land Loss Susceptibility Map**
  - Where is the coastline most **vulnerable**?

- Step 2: **Coastal Land Loss Time-Series Map**
  - How has the **coast changed** with respect to beach management projects?

- Step 3: **Statistical Analyses**
  - Are there land change **trends**?

- Step 4: **Story Map**
  - What is the narrative behind the fight to preserve the coast?
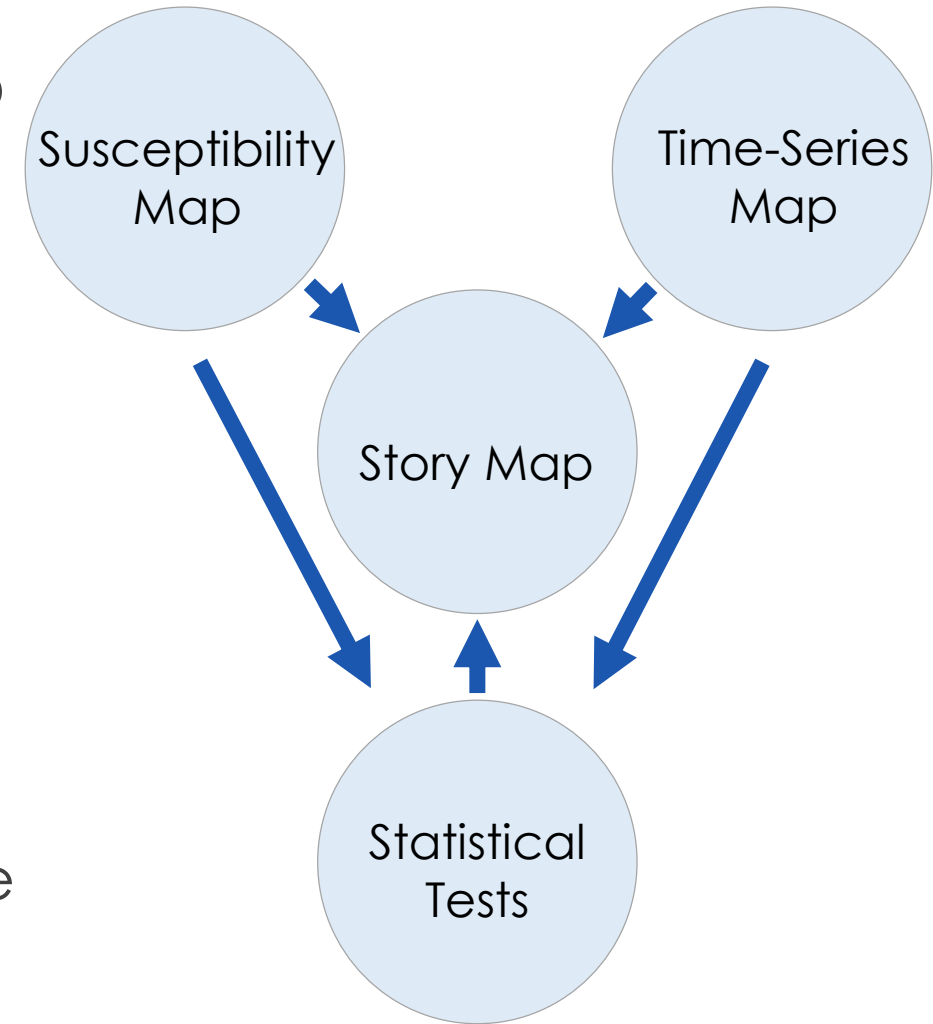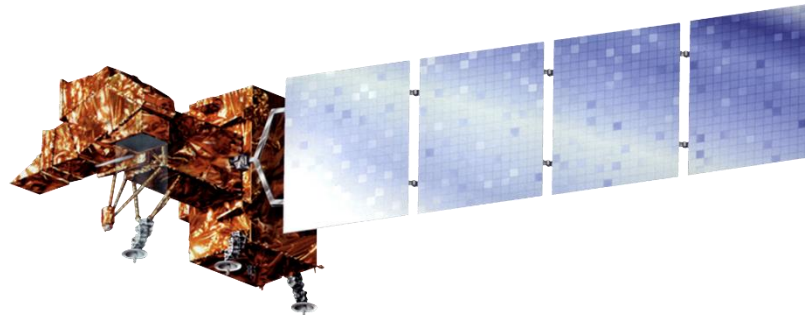
NASA EARTH OBSERVATIONS

- ▶ Landsat 5 TM, 7 ETM+, & 8 OLI
  - ▶ Surface Reflectance

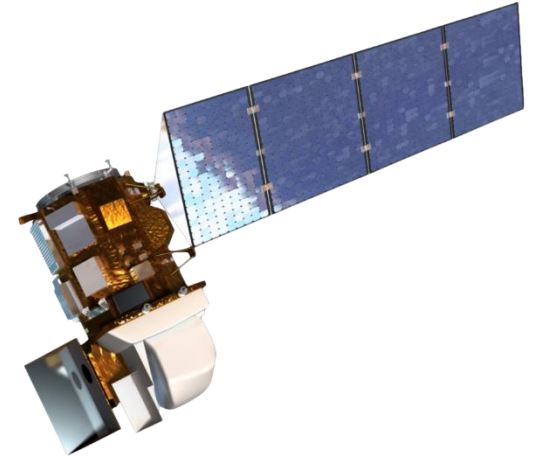- ▶ Terra ASTER
  - ▶ Digital Elevation Model (DEM)
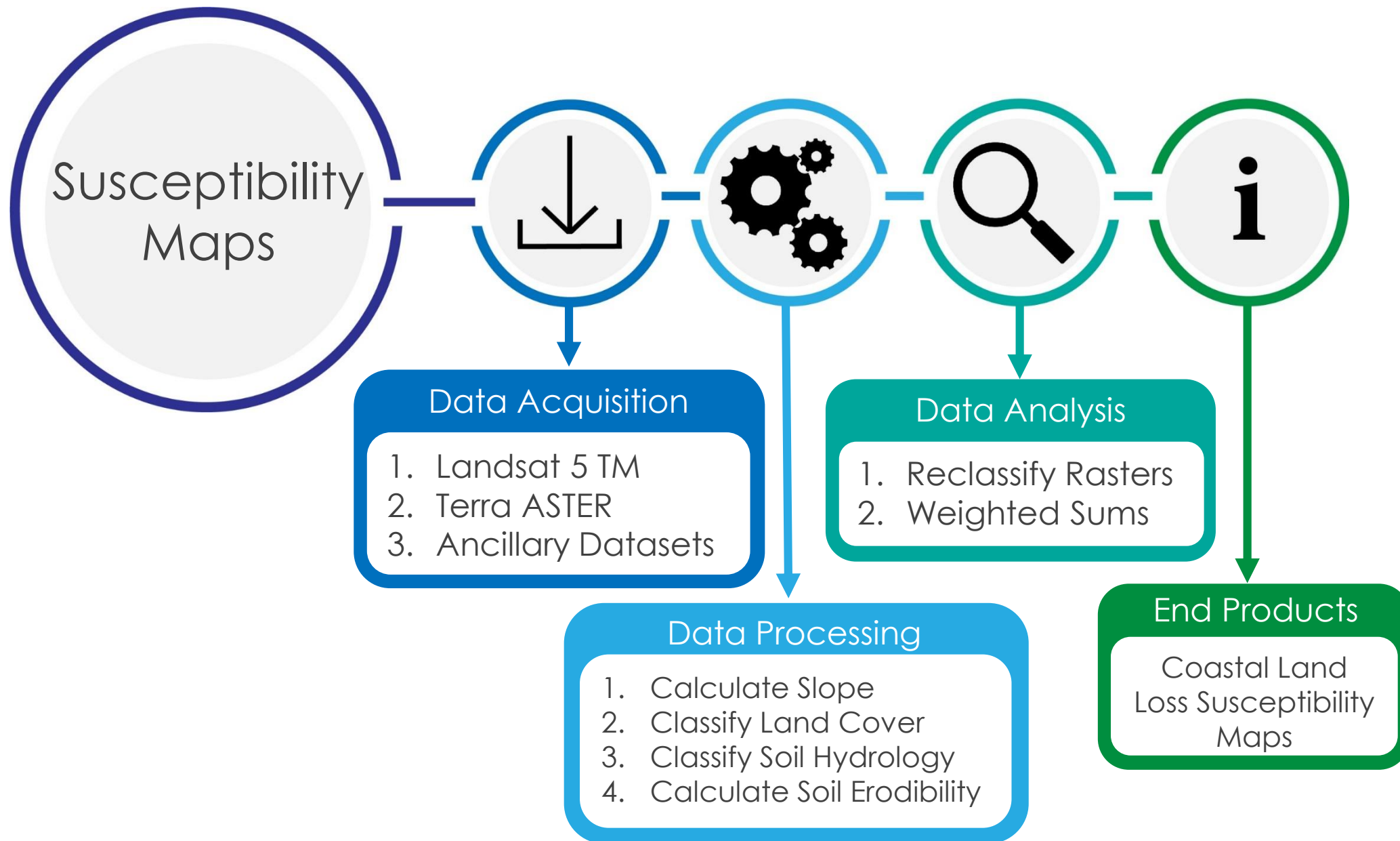 - ▶ Slope
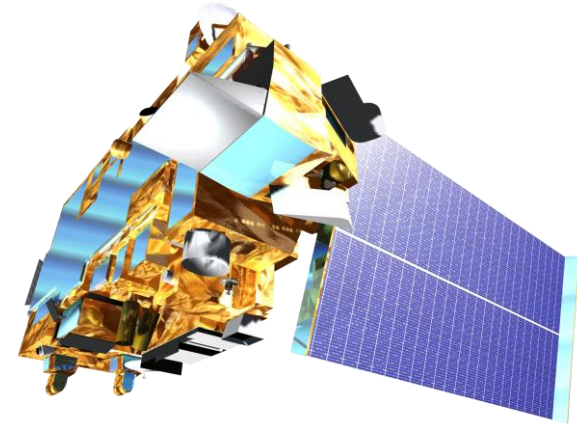
Terra

Landsat 5

Landsat 7

Landsat 8

Image Source: NASA

ANCILLARY DATASETS

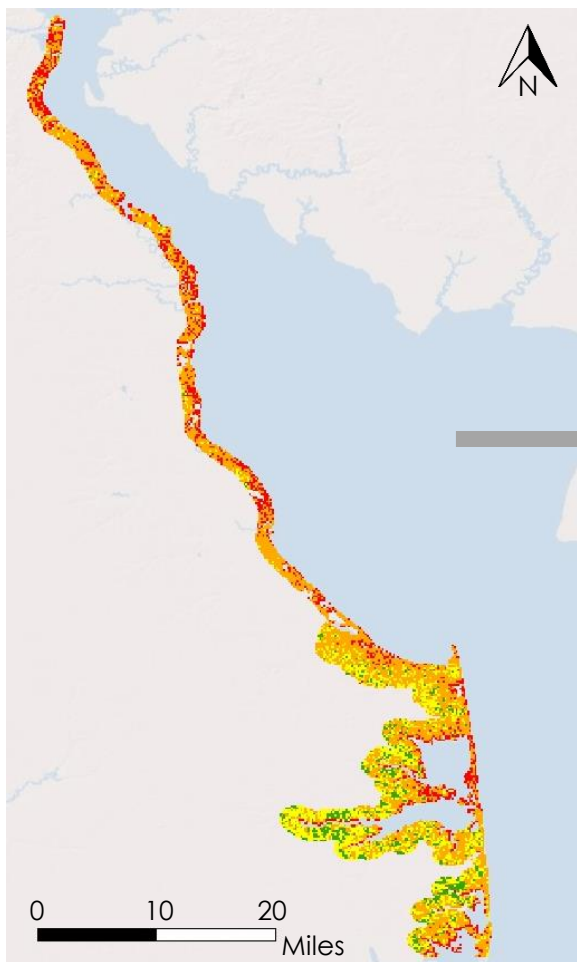| Data Type	Source
Soil Hydrologic Group	USDA Gridded Soil Survey Geographic (gSSURGO)
Land Cover Type	NOAA Coastal Change Analysis Program (C-CAP)
Wind Speed	Delaware Environmental Observing System (DEOS)
Wave Height	CB&I Coastal Planning & Engineering, Inc. via DNREC
Relative Sea Level Rise Rate	NOAA Tides & Currents Database
DNREC Beach Management Project	DNREC

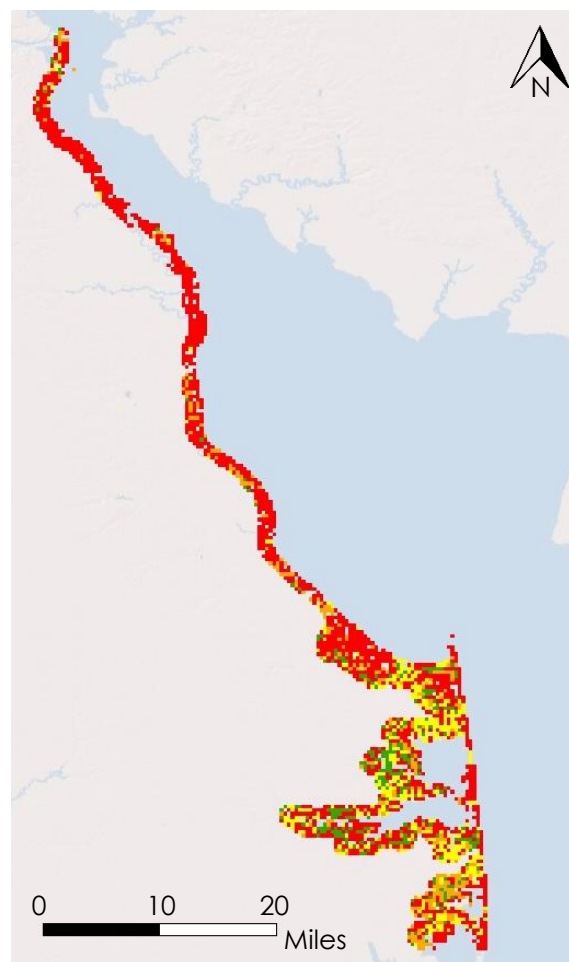# LAND LOSS SUSCEPTIBILITY: METHODS

Susceptibility Maps

Data Acquisition
1. Landsat 5 TM
2. Terra ASTER
3. Ancillary Datasets

Data Processing
1. Calculate Slope
2. Classify Land Cover
3. Classify Soil Hydrology
4. Calculate Soil Erodibility

Data Analysis
1. Reclassify Rasters
2. Weighted Sums

End Products
Coastal Land Loss Susceptibility Maps

LAND LOSS SUSCEPTIBILITY: FACTORS

Elevation:

Slope:

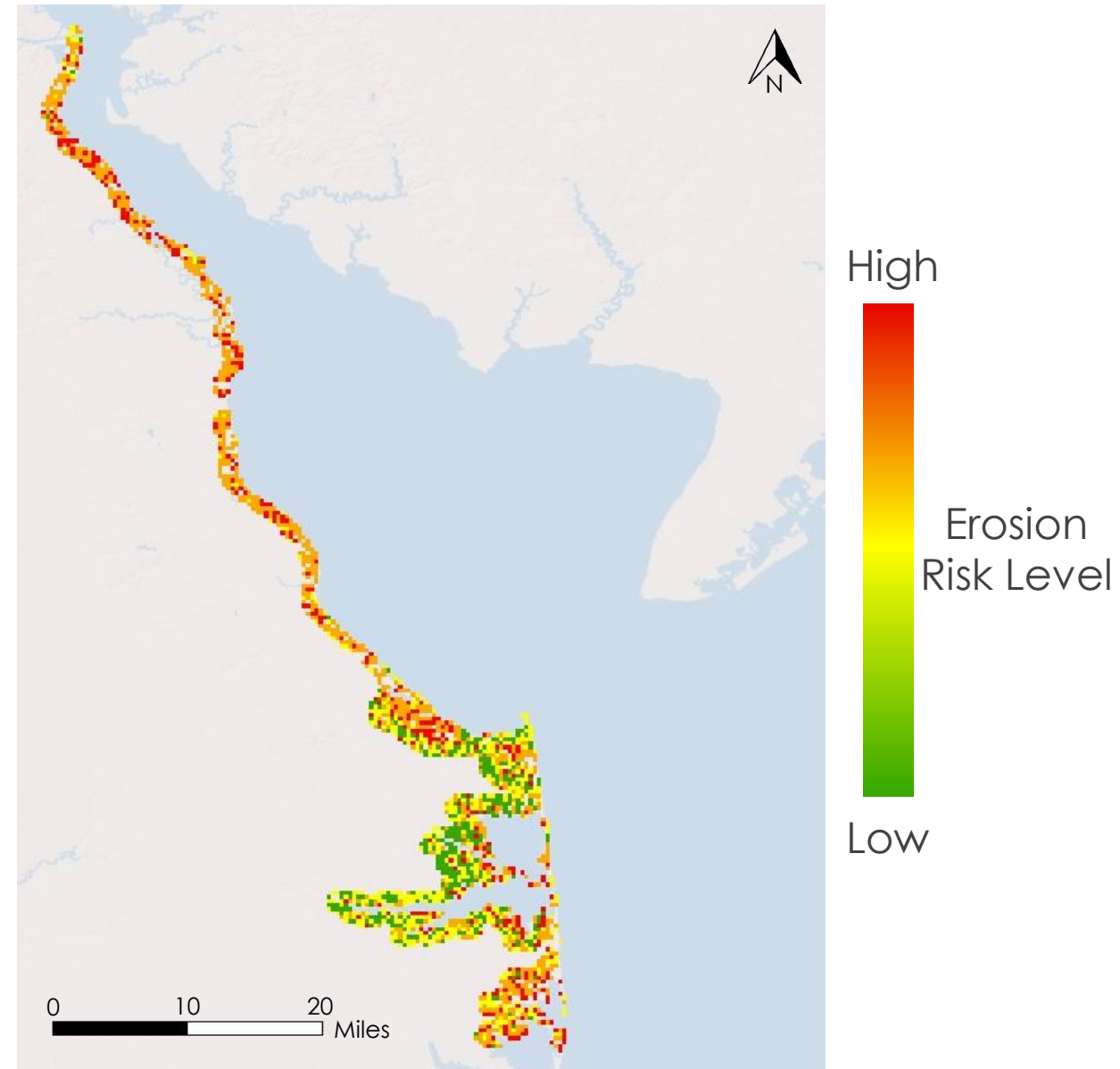**Land Cover:**
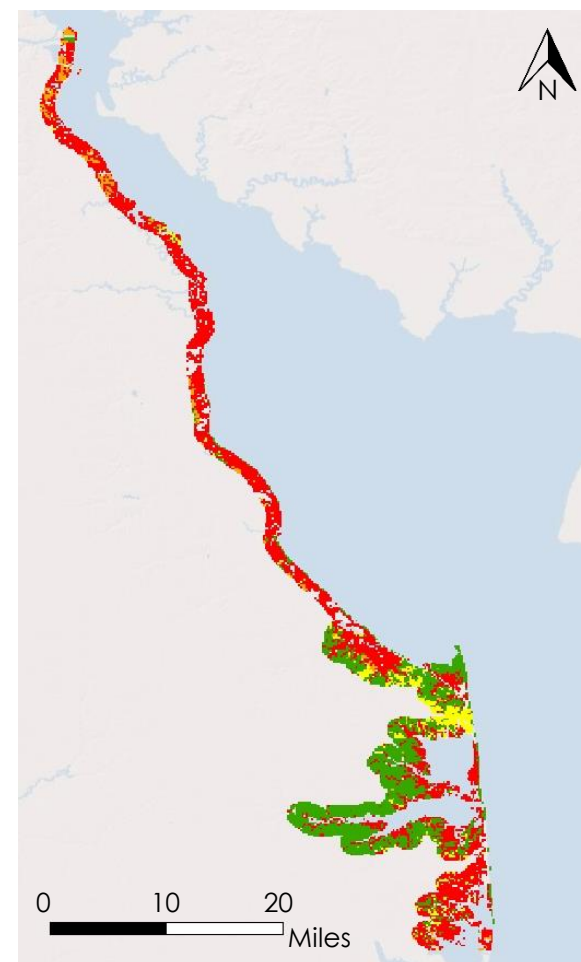
Soil Hydrology:

Susceptibility Level

Low   High

$$\text{Susceptibility to Erosion} = \text{Slope} + \text{Land Cover} + \text{Soil Hydrology}$$

High

Erosion Risk Level
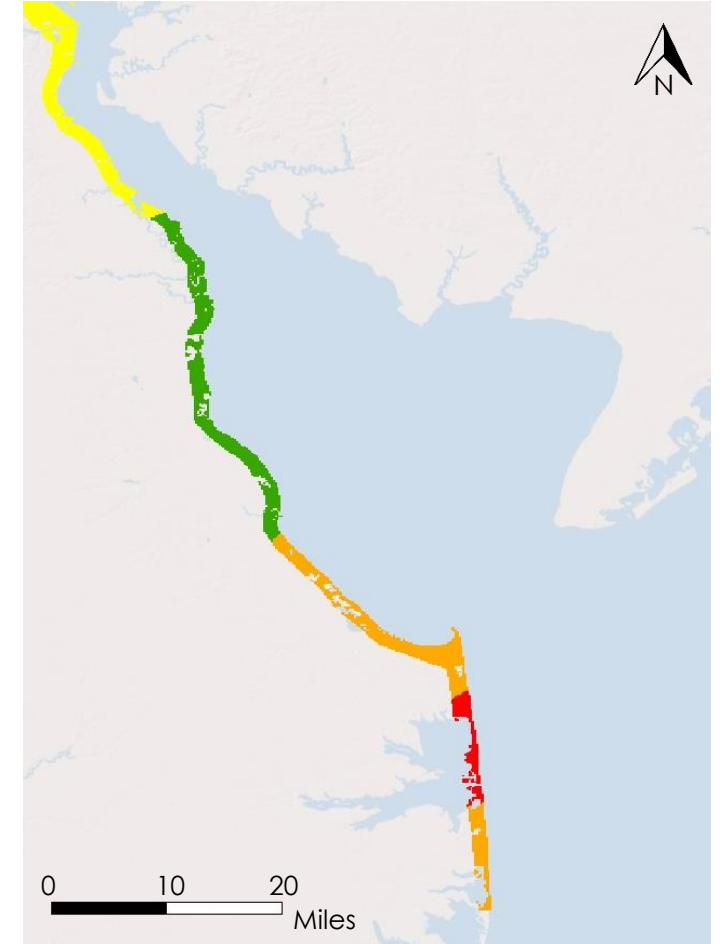
Low

0   10   20   Miles

LAND LOSS SUSCEPTIBILITY FACTORS

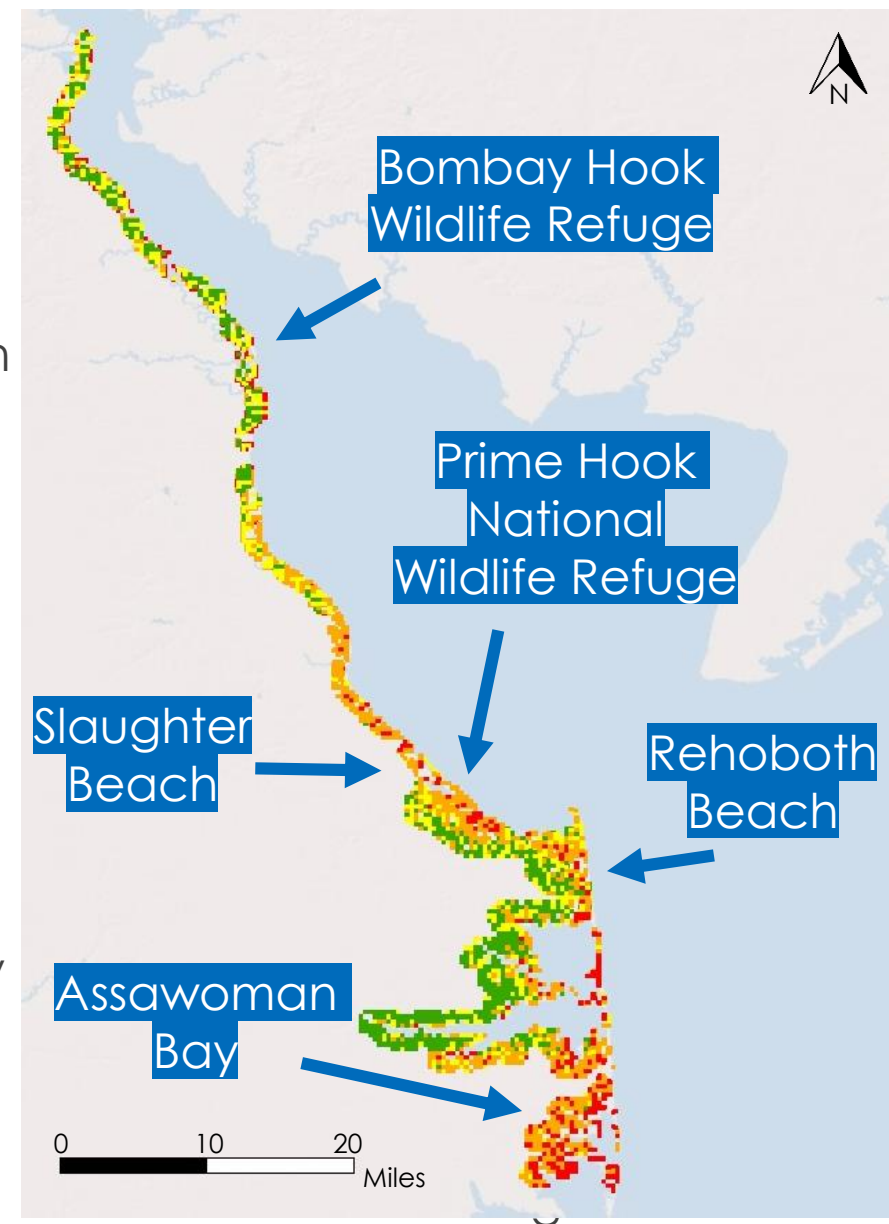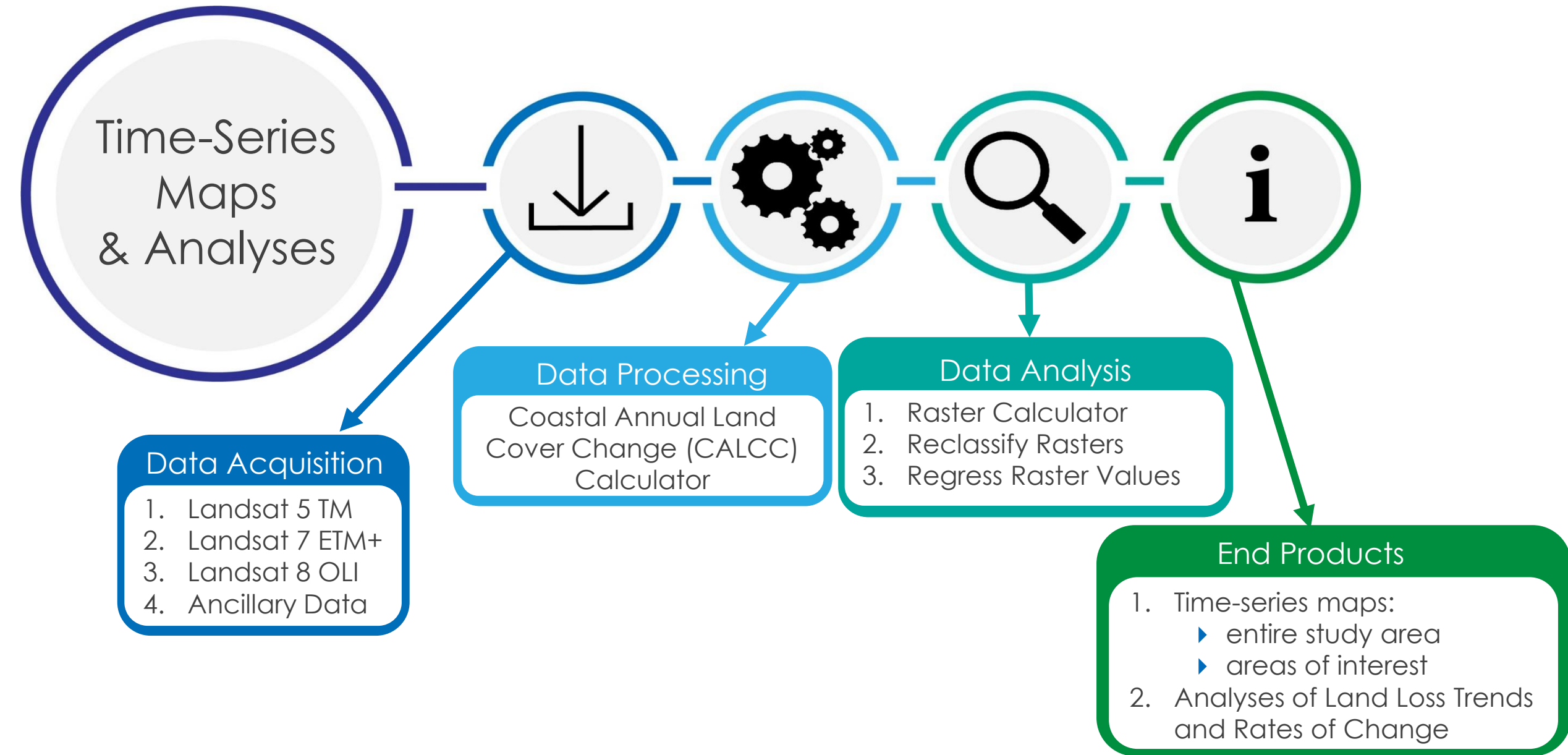**Relative Sea Level Rise:**
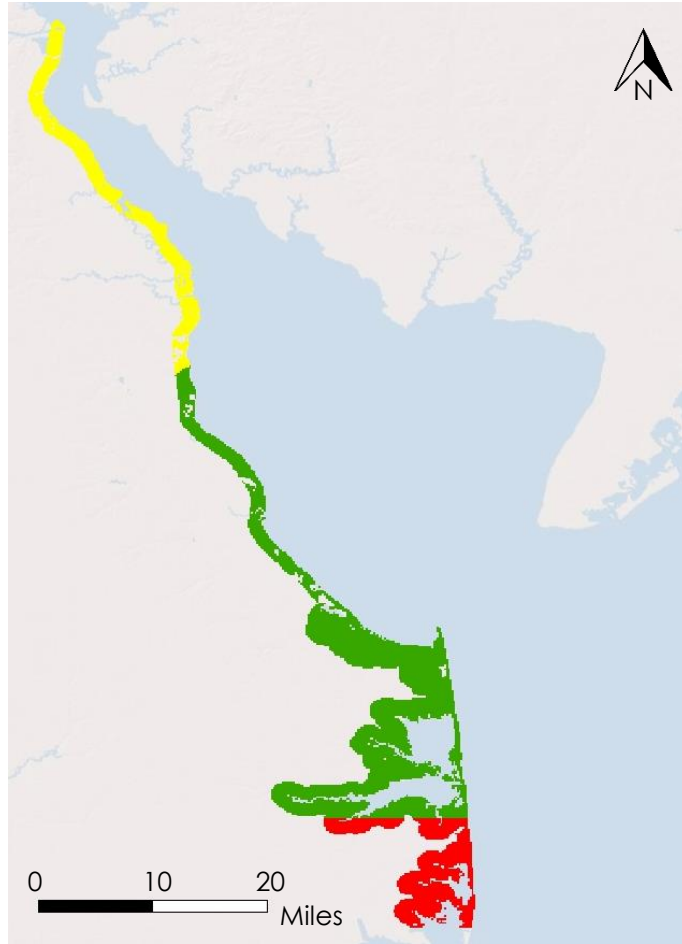
Wave Height:

Wind Speed:

Susceptibility Level

Low — High

$$\text{Overall Susceptibility} = \text{Suscep. to Erosion} + \text{Elevation} + \text{Wind \& Wave} + \text{Relative SLR}$$

- The most susceptible areas:
  - Bombay Hook and Prime Hook Wildlife Refuges
 - Rehoboth and Slaughter Beaches
  - Assawoman Bay

High

Susceptibility Level

Low

Bombay Hook Wildlife Refuge

Prime Hook National Wildlife Refuge

Slaughter Beach

Rehoboth Beach

Assawoman Bay

0   10   20 Miles

TIME-SERIES MAP: METHODS

Time-Series Maps & Analyses

Data Acquisition
1. Landsat 5 TM
2. Landsat 7 ETM+
3. Landsat 8 OLI
4. Ancillary Data

Data Processing
Coastal Annual Land Cover Change (CALCC) Calculator

Data Analysis
1. Raster Calculator
2. Reclassify Rasters
3. Regress Raster Values

End Products
1. Time-series maps:
   ▸ entire study area
   ▸ areas of interest
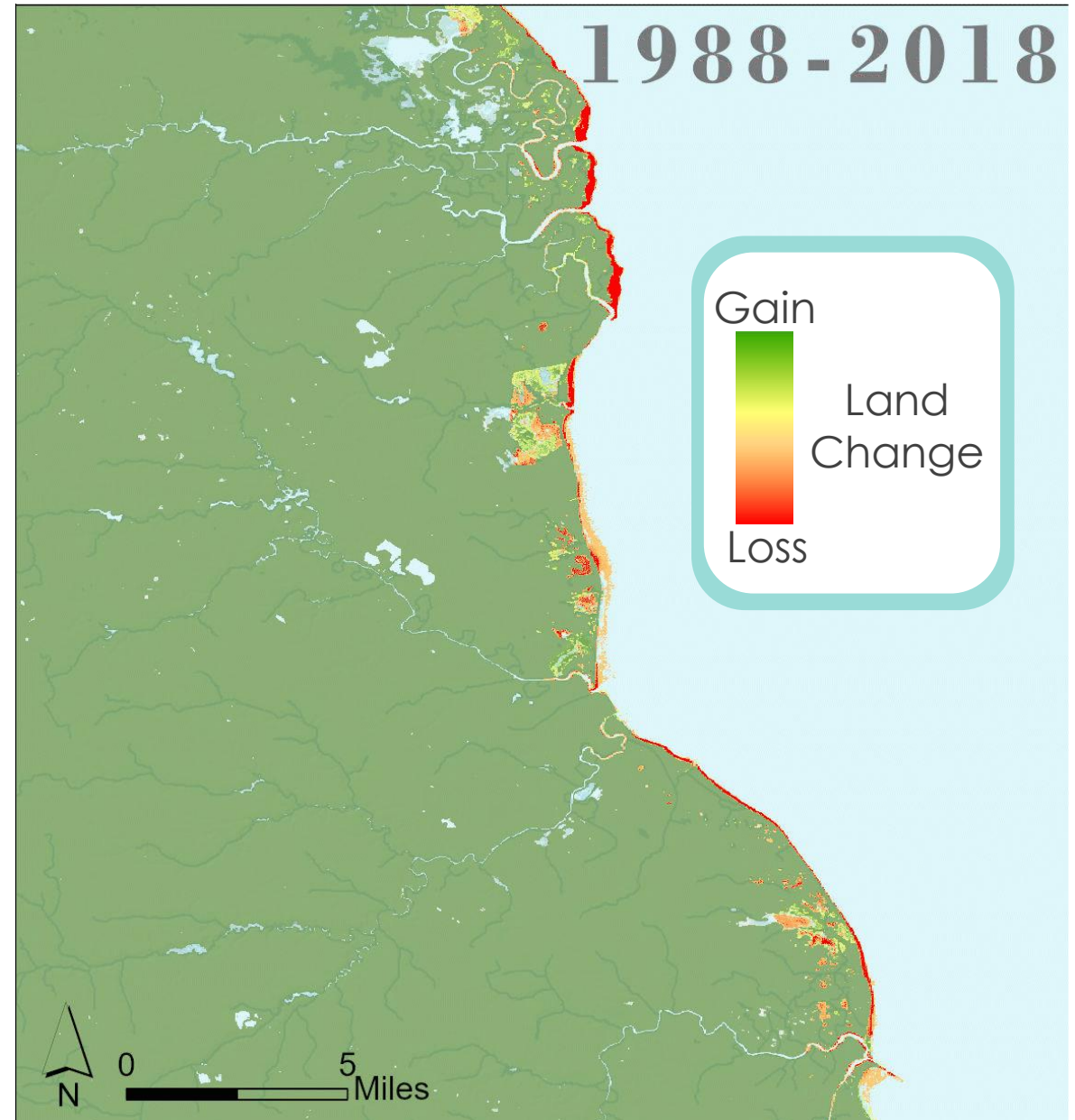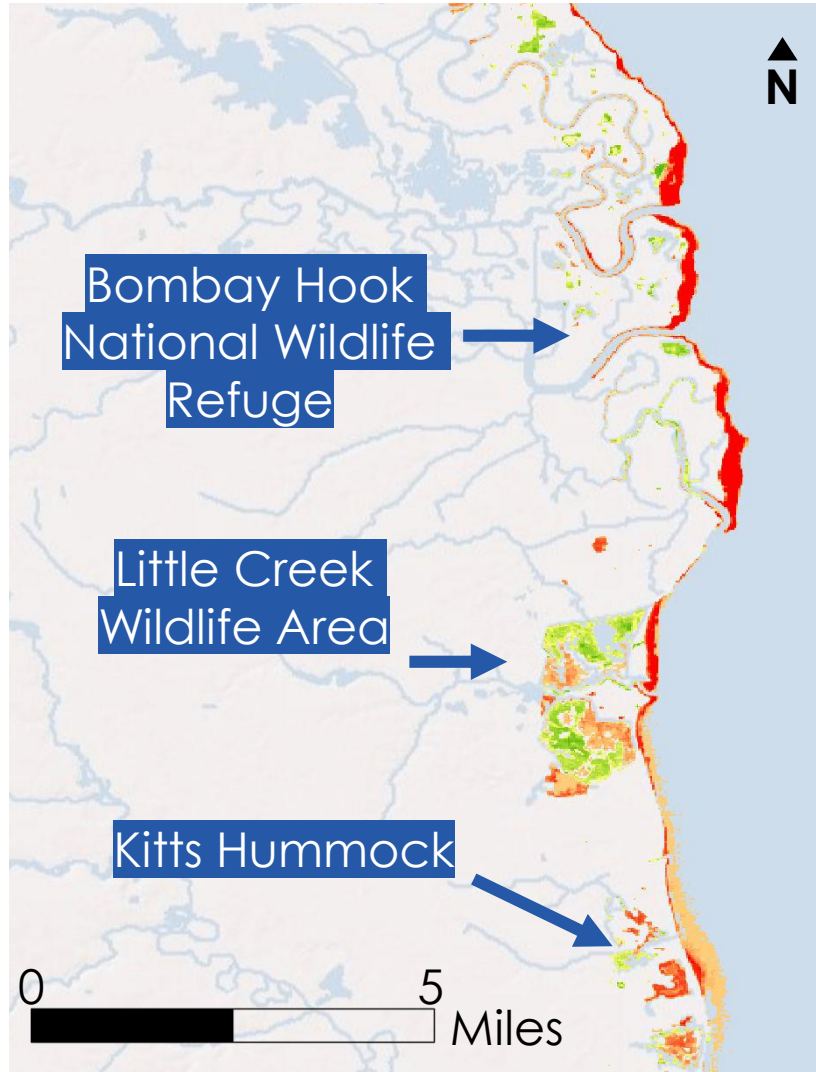2. Analyses of Land Loss Trends and Rates of Change

▶ This map illustrates **when** and **where** beach management projects occurred.

▶ This map can provide a **qualitative** understanding of the DNREC's **role** in **coastal management** over time.
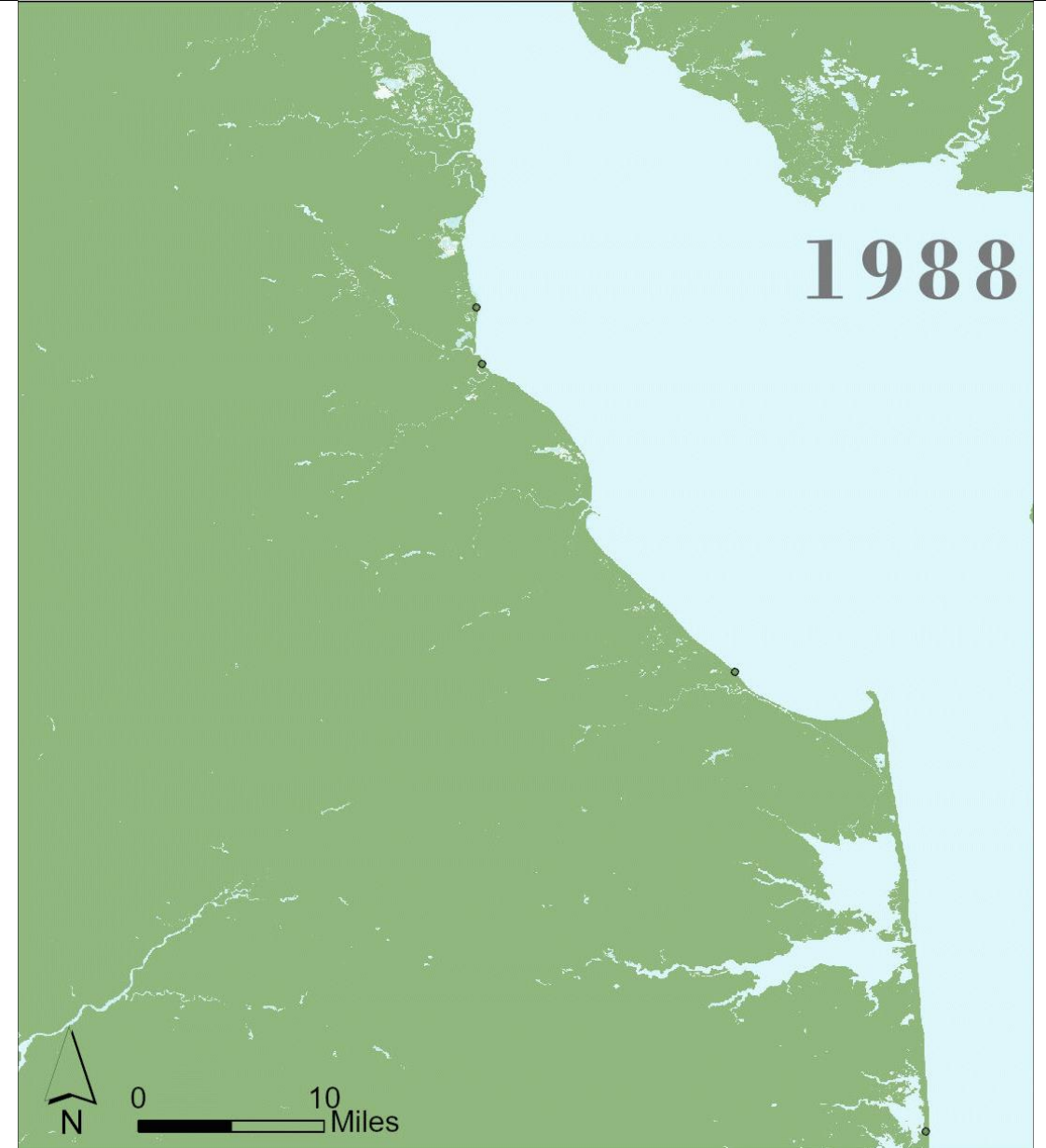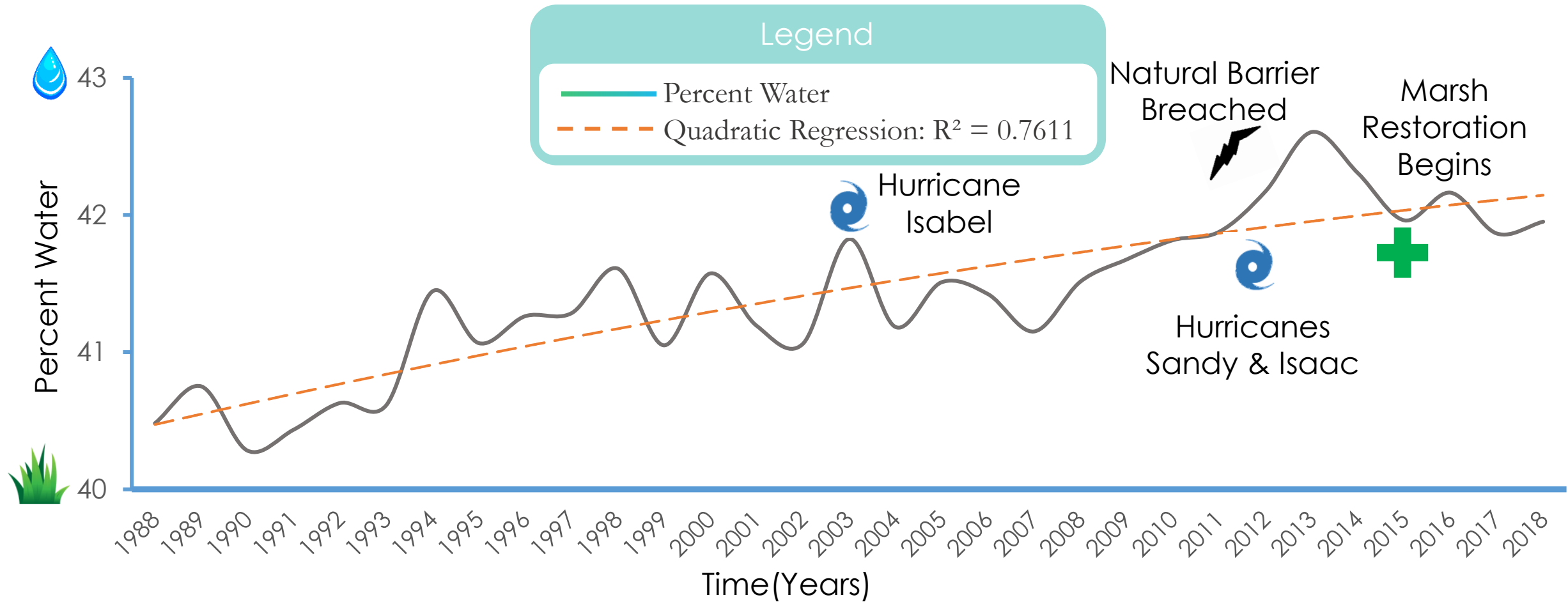
COASTAL LAND LOSS TIME-SERIES MAPS
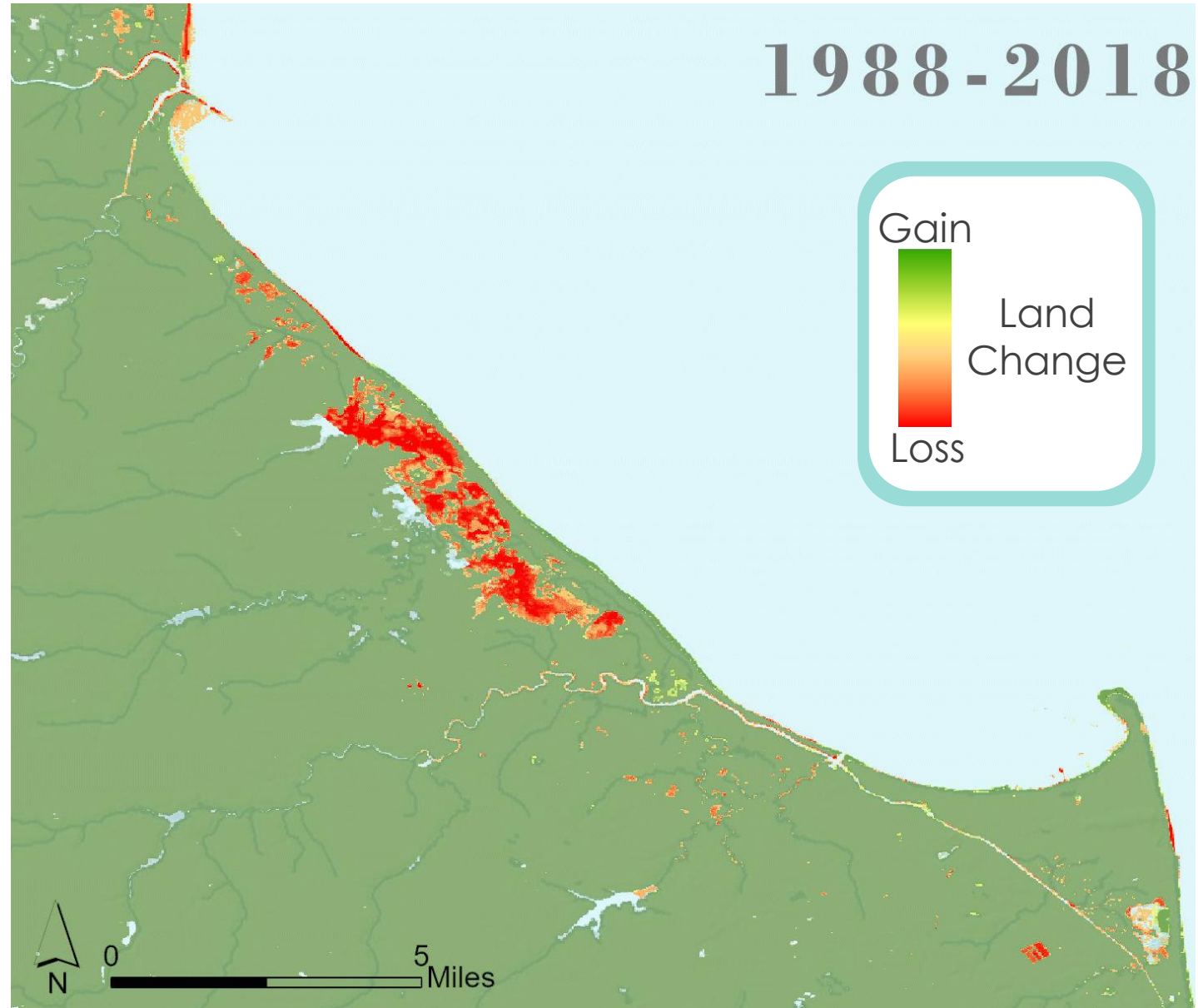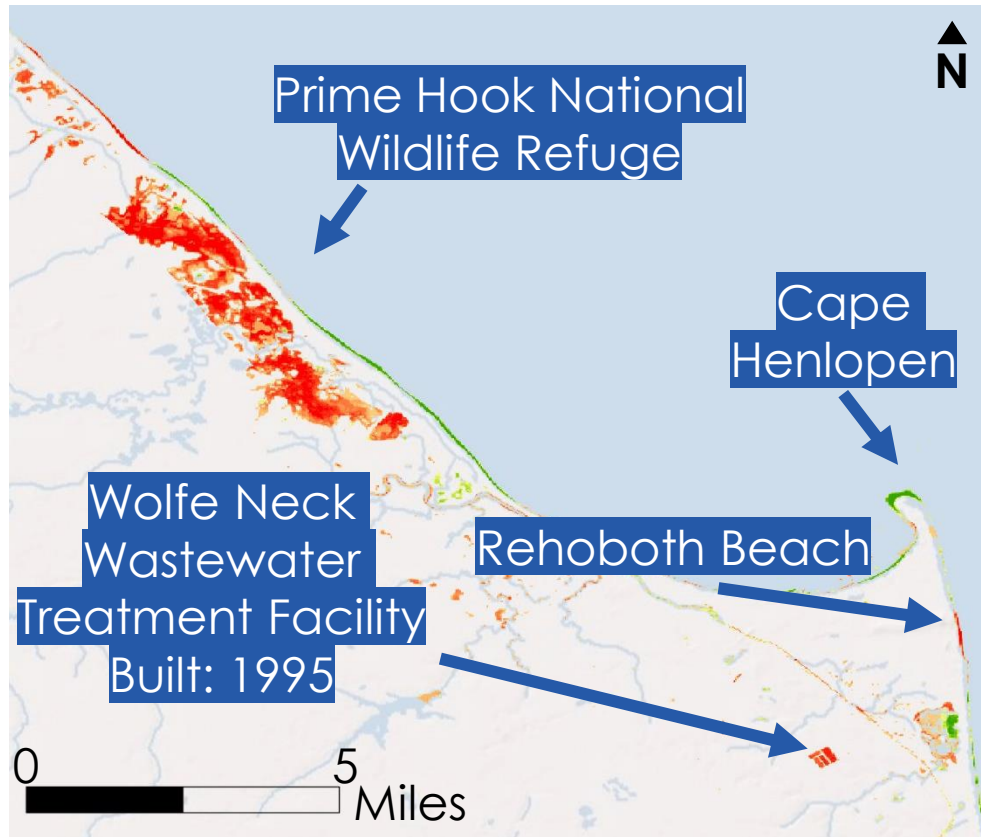
1988-2018

COASTAL LAND LOSS TIME-SERIES MAPS
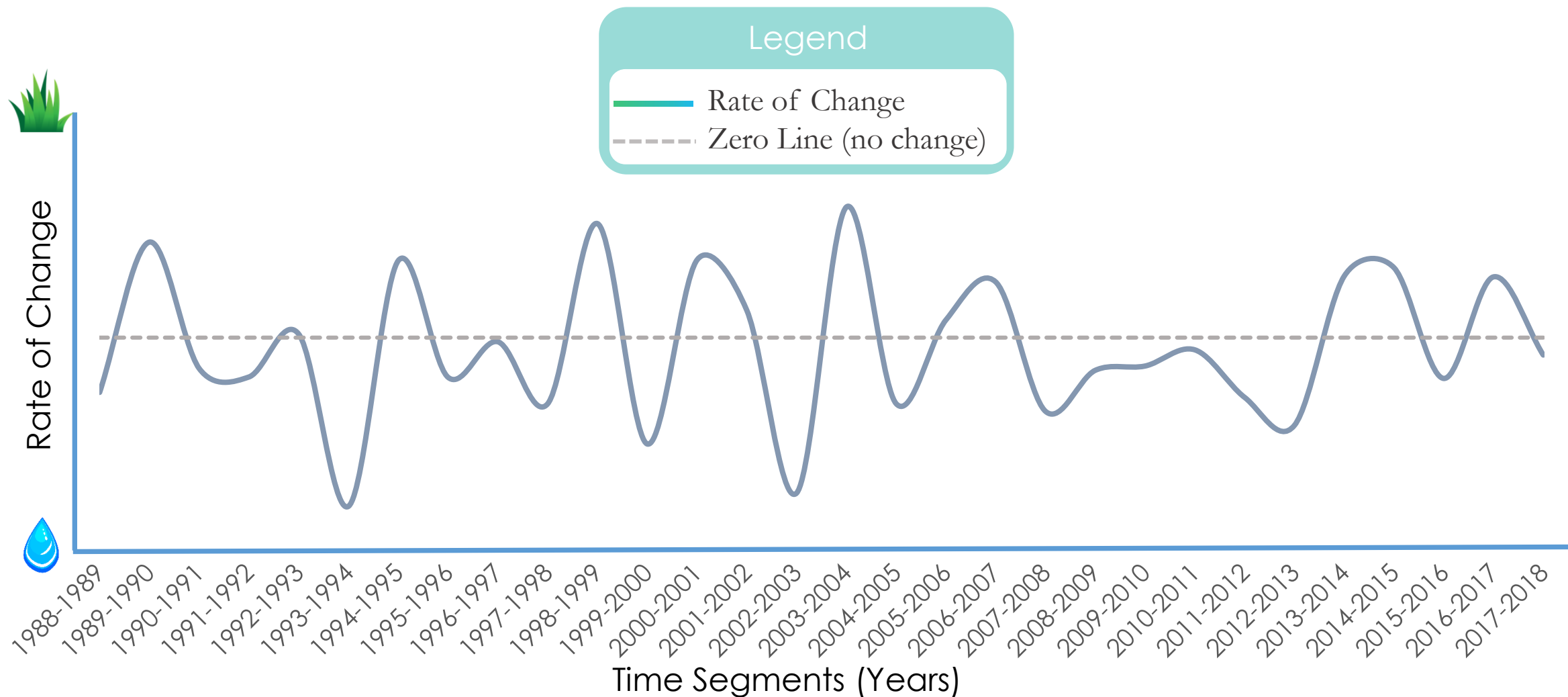
1988-2018

LAND LOSS TREND ANALYSIS

Coastal Land Loss Trends: 1988 - 2018

LAND CHANGE TREND ANALYSIS

## Rate of Coastal Change: 1988 - 2018

LIMITATIONS

Susceptibility Maps:

▸ Susceptibility factor datasets were limited to various time periods and locations (**mismatched**)

▸ No precise scales for coastal susceptibility factor levels found in the literature (possible **source of error**)

Time-Series Maps & Analyses:

▸ State and federal management project locations are based on their **general** location name and start year (**imprecise**)

▸ Classification is an **annual average** (at least two years possibly affected by **cloud-coverage**)

"THE COAST OF DELAWARE" STORY MAP

▸ The story map **features** the **unique geographic circumstances** that put Delaware's coast at risk and the DNREC's **management strategies.**

▸ It also **showcases** the state's coastal **susceptibility**, **time-series maps**, and **trends.**
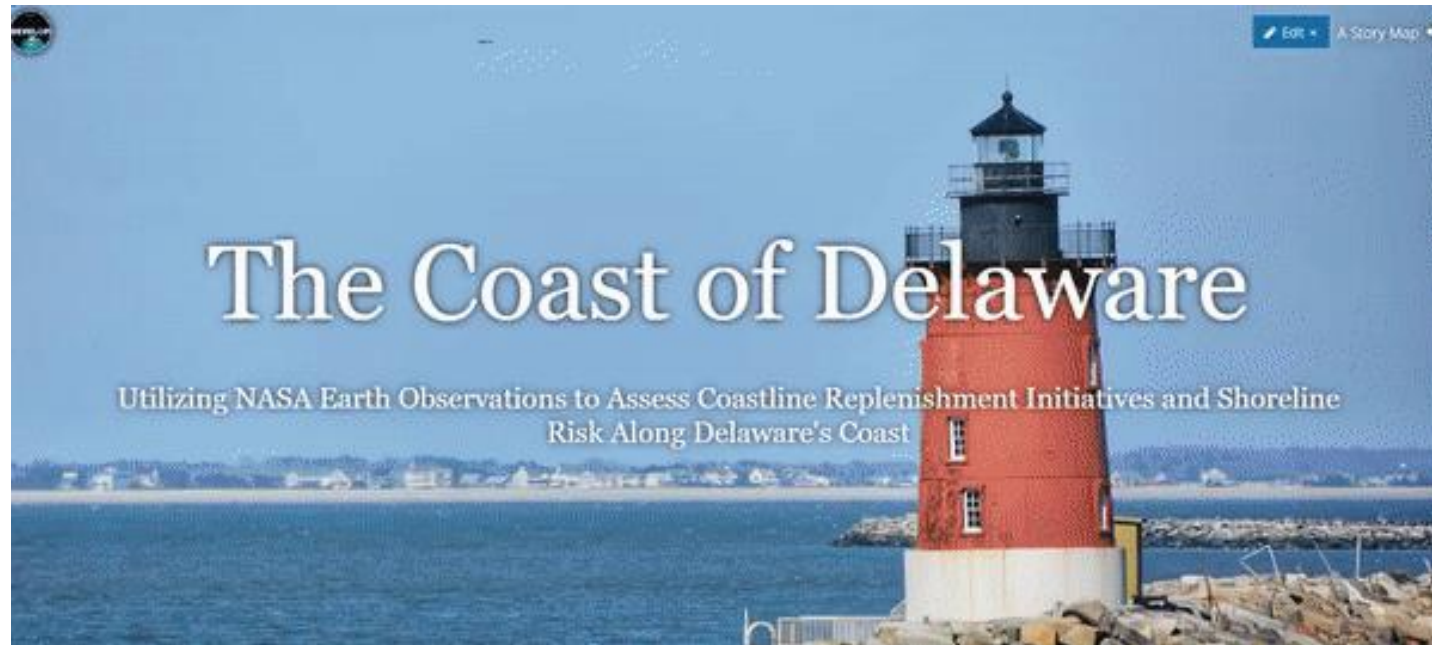
Link here.

CONCLUSIONS

▸ According to NASA Earth Observations, **Delaware's coast has experienced land loss since 1988**.

▸ **Prime Hook** National Wildlife Refuge, **Slaughter** and **Rehoboth** Beaches, and **Assawoman Bay** are the **most susceptible areas** to land loss along Delaware's coast.

▸ **Prime Hook** and **Bombay Hook** National Wildlife Refuges have experienced the **greatest amount of land loss** from 1988-2018.

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