**NASA DEVELOP National Program**

Mobile County Health Department

**Fall 2015**

**Short Title: Coastal Texas Water Resources II**

**Subtitle:** Using NASA Earth Observations to Assess the Health of the Laguna Madre through Land Cover Mapping and Thermal Analysis

**VPS Title:** Tapping Groundwater Resources—Literally! A Hypersaline Laguna Madre

**Project Team & Partners**

**Project Team:**

Elaina Gonsoroski (Project Lead), egonsoroski@gmail.com

Vishal Arya

Jennifer Boyd

**Advisors & Mentors:**

Joe Spruce (NASA Stennis Space Center)

Bernard Eichold, M.D., Dr.PH (Mobile County Health Department)

**Past or Other Contributors:**

Georgina Crepps

Tyler Lynn

Rodrigo Pereira da Silva

Ryan Schick

**Partner Organizations:**

National Park Service (NPS) (End-User), POC: Joe Meiman

Texas A&M University-Corpus Christi (End-User), POC: Dr. Dorina Murgulet

**Project Details**

**Applied Sciences National Application Addressed:** Water Resources

**Study Area:** Laguna Madre, Padre Island National Seashore, Texas; Kenedy County, TX

**Study Period:** July 1986 – September 2015

**Earth Observation & Parameter:**

Landsat 5, Thematic Mapper (TM) – Land cover, thermal bands

**Ancillary Datasets Utilized:**

* Texas A&M University-Corpus Christi – *In situ* and historic water temperature and salinity data
* USGS National Landcover Dataset (NLCD) – Soil data
* Southern Regional Climate Center – *In situ* precipitation data
* USDA National Resources Conservation Service (NRCS) – Geologic formations and soil data

**Models Utilized:**

* Clark Labs TerrSet Land Change Modeler for ArcGIS/IDRISI Land Change Modeler – Predicting honey mesquite tree expansion
* PRISM Climate Group – Precipitation data

**Software Utilized:**

ERDAS IMAGINE – Land classification of Landsat imagery

ArcGIS – Raster analysis of Landsat 5, auxiliary data, as well as map creation

dnppy – Open source Python scripts for converting Landsat imagery to TOA reflectance and surface temperature

TerrSet – Land modeling and forecasting of mesquite tree expansion

**Project Overview**

**80-100 Word Objectives Overview:**

The National Park Service (NPS) manages natural resources along the Laguna Madre, which is located within Padre Island National Seashore, Texas. This location is one of only six hypersaline lagoons in the world—however this may not have always been the case. To address NPS concerns, this project will utilize NASA Earth observations (EO), *in situ* data, and different models, to see if the proliferation of honey mesquite trees (*Prosopis glandulosa*), and their ability to tap into groundwater resources via a well-developed taproot system, has obstructed freshwater inflow to the lagoon. If this is indeed what has led the lagoon to become hypersaline, these findings will allow for changes in future land management decisions.

**Abstract:**

This project was conducted to aid the National Park Service (NPS) in assessing the historical hydrology of the Laguna Madre located within Padre Island National Seashore. While the lagoon is now hypersaline, there is historical evidence indicating this was not always the case. It is hypothesized that the proliferation of the honey mesquite tree (*Prosopis glandulosa*) has contributed to the Laguna Madre’s increased salinity by tapping into groundwater, thereby reducing the amount of freshwater flow into the lagoon. The project team partnered with the NPS to analyze the suspected correlation between the occurrence of the mesquite trees and the salinity of the lagoon. NASA Earth observations were used in ArcGIS software and ERDAS IMAGINE to create time series maps and conduct data analyses. Landsat 5 data were used to create Land Use/Land Cover (LULC) maps to analyze the change in mesquite tree coverage compared to various soil types and underlying geology as well as to calculate the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Infrared Index (NDII). Thermal maps of the lagoon were also created using Landsat 5 data to identify thermal anomalies in surface water temperature. These anomalies could indicate possible inflow locations of groundwater to the lagoon. *In situ* and PRISM (Parameter elevation Regression on Independent Slopes Model) precipitation data were used to target months and years for analysis. Through these analyses, the NPS can improve future land management practices.

**Community Concerns:**

* There has been a rapid increase in the native honey mesquite tree population along the Laguna Madre. Their taproots may be depleting the area's groundwater resources, increasing the salinity of the lagoon.
* The observed increased salinity of the lagoon is potentially harming this aquatic ecosystem’s inhabitants—including threatened species of concern, such as seagrasses and sea turtles.
* The increased extent of mesquite trees has occurred on privately-owned land which adds to the complexities of managing native plants, and the interconnectivity between private and public land management.

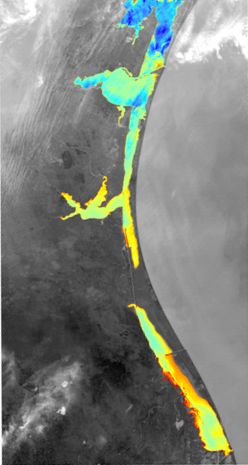
**Current Management Practices & Policies**:

The Laguna Madre is managed by the federal government as it is part of Padre Island National Seashore. However, a large amount of the land surrounding the lagoon is privately owned. As a result, managing the health and water quality of this hypersaline aquatic ecosystem has become increasingly complex and difficult. Currently, the NPS collects *in situ* data from limited locations to monitor different water properties of the Laguna Madre, such as temperature, pH, turbidity, and salinity.

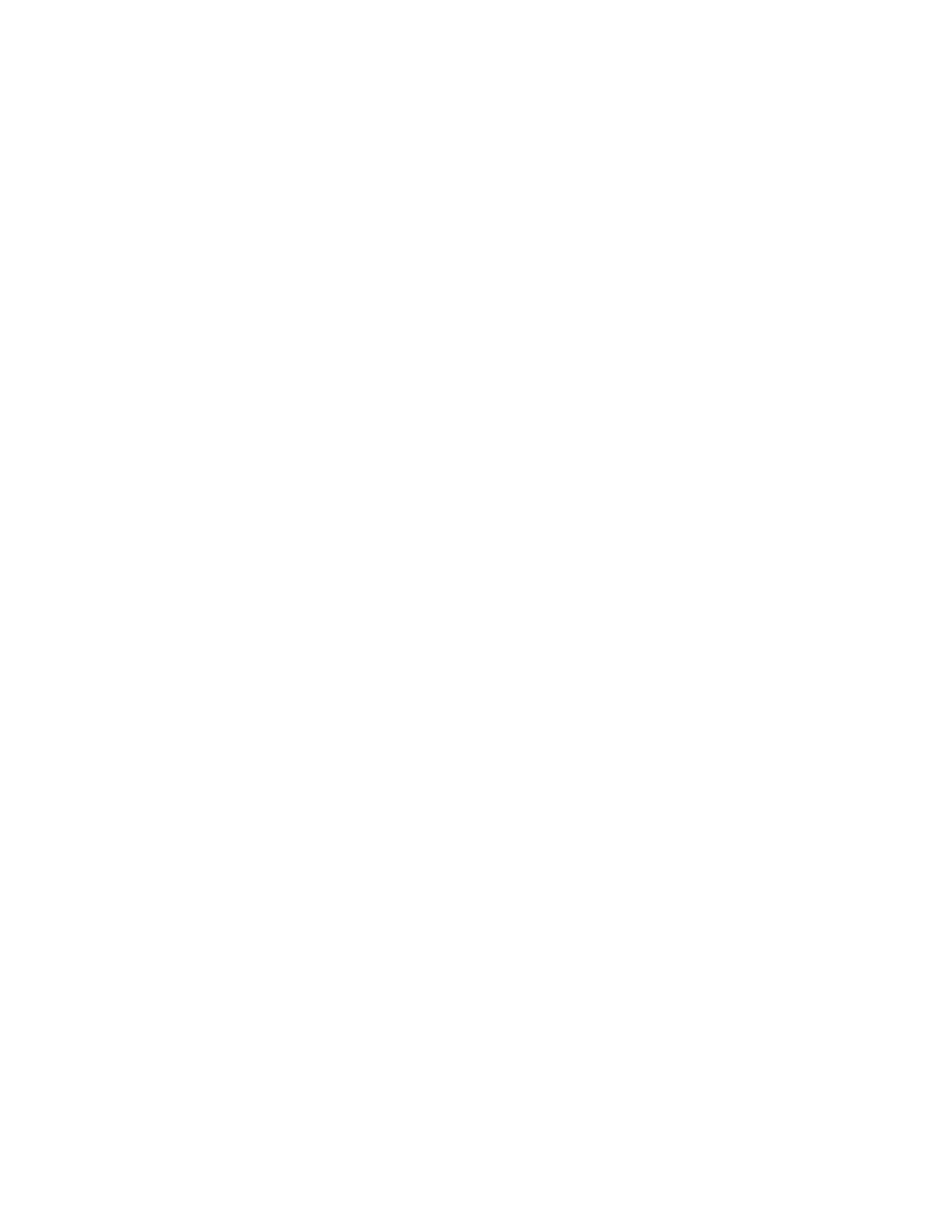
**Decision Support Tools & Benefits:**

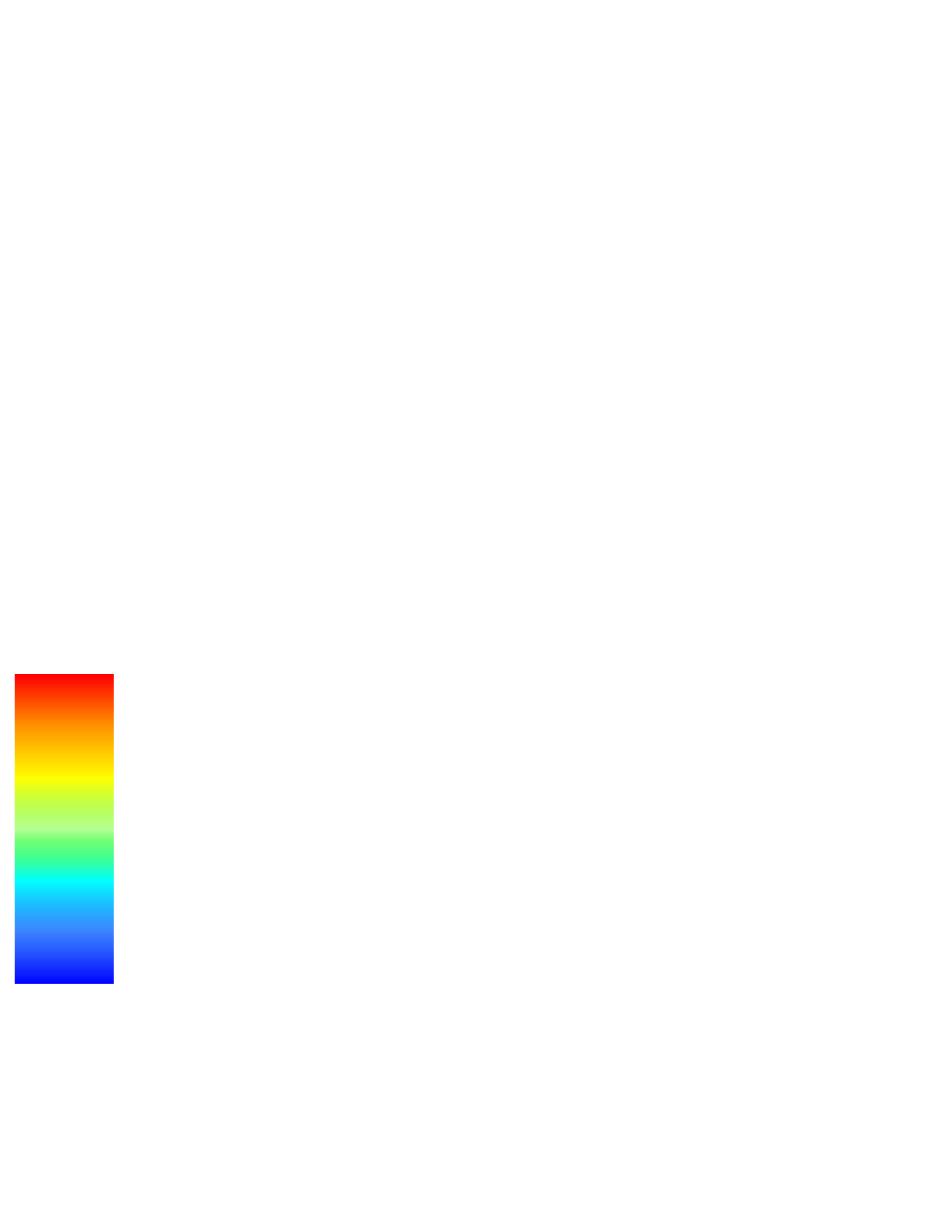
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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| LULC Map Time Series | Landsat 5 TM | Determining whether changes in land management are needed if recorded increases in mesquite trees correlates with decreases in groundwater and increases in lagoon salinity |
| Mesquite Tree Extent Prediction Maps | Landsat 5 TM | Determining whether changes in land management are needed if increases in mesquite trees are predicted as well as correlated with decreases in groundwater and increases in lagoon salinity |
| Mesquite Tree Occurrence Map with Soil Type/ Underlying Geology | Landsat 5 TM | Identifying whether soil type and the underlying geology (1) can be identified as a factor in mesquite tree location and (2) can be used as a predictor of tree occurrence for future land management decisions |
| Thermal Maps of Lagoon | Landsat 5 TM | Identifying changes in groundwater flow into the lagoon to assess the need for changes in land management practices |

**Project Imagery**

**Caption:** Band 6 from Landsat 5 TM visualizes the thermal properties of the Laguna Madre in November 1986. Blue represents cooler regions and red, warmer.

**Image:** LagunaMadre\_Thermal





**Software Release Requirements**

What category do the tools your project is creating fall within?

Category V