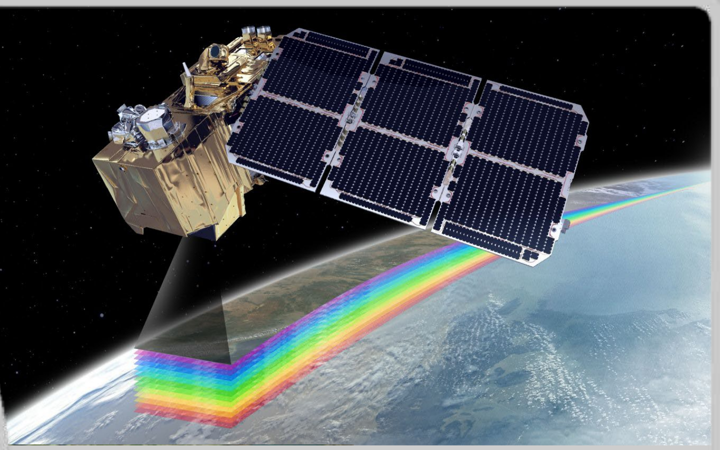
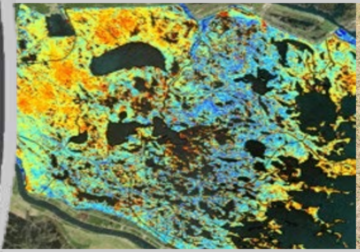
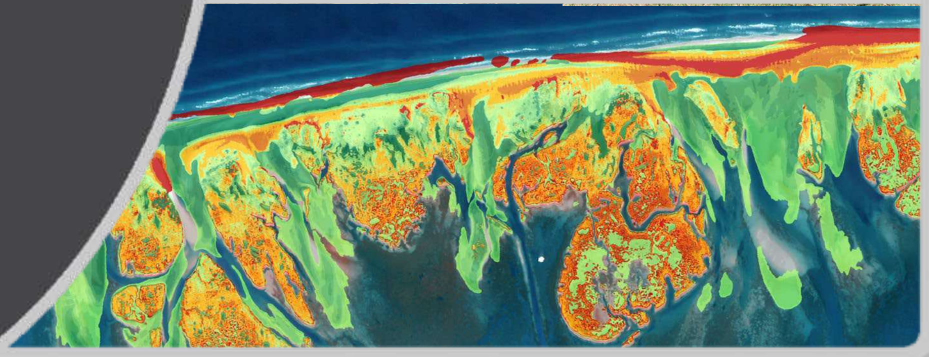
Developing a Remote Sensing Strategy for the USACE Engineering With Nature® (EWN®) Initiative







Molly Reif, Dr. Glenn M. Suir and Christina Saltus

U.S. Army Engineer Research & Development Center
Environmental Laboratory
Vicksburg, MS

January 30, 2023

U.S.ARMY

US Army Corps of Engineers®

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

ERDC Remote Sensing Project Team

Research Geographer & Geospatial Data Analysis Team Lead stationed at the JALBTCX

- Current research focuses on the evaluation and development of spatial analytical methods from airborne and spaceborne remote sensing imagery and lidar for terrestrial and aquatic vegetation and land cover characterization to support USACE civil works projects.
- EWN related research includes lead PI for developing a comprehensive approach to integrate remotely sensed data and methods into the EWN project portfolio.

Research Geographer specializing in remote sensing and GIS application to coastal and wetland environments

- Current research focuses on the integration of spatially explicit approaches into ecological modeling, geospatial tool development, and environmental impacts assessments for habitat mitigation.
- EWN related research includes land change trend assessments to evaluate and quantify the sustainability of sediment beneficial use and nature-based ecosystem restoration activities.

Research Agronomist & Adjunct Professor in school of Geosciences at the University of Louisiana

- Current research focuses on the quantification and evaluation of wetland structure and function, assessing episodic impacts, and using novel remote sensing techniques to guide critical ecosystem restoration and adaptive management.
- EWN related research includes integration of remote sensing technology to improve project efficiencies and quantify environmental benefits of natural and nature-based features.

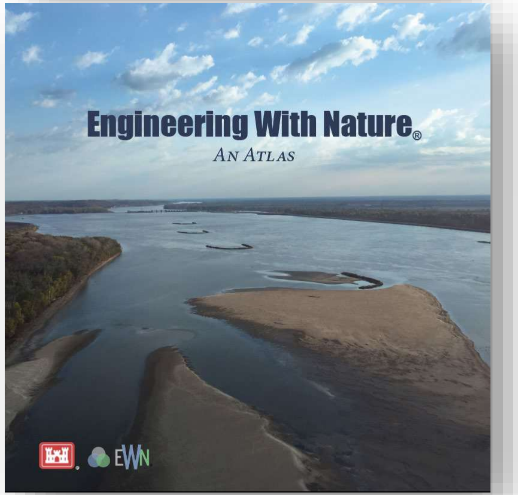
Engineering With Nature®

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaboration.

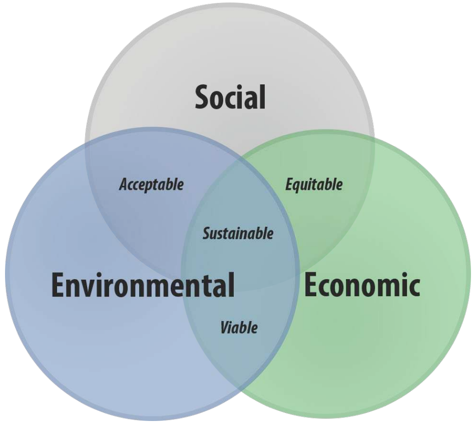
Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners

www.engineeringwithnature.org



Triple-win outcomes are achieved throughout EWN by systematically integrating social, environmental, and economic considerations at every phase of a project. The results are innovative and resilient solutions that are more socially acceptable, viable and equitable, and, ultimately, more sustainable.



A rendering of a horizontal levee design that achieves storm and flood risk reduction while increasing habitat value.

The EWN® Approach: Innovation in Practice

Policy development

- Engagement with policymakers
- USACE policy/procedure development

Engagement, partnering, and teaming

- Within USACE, e.g., EWN Proving Grounds
- With other organizations inside and outside government

Research

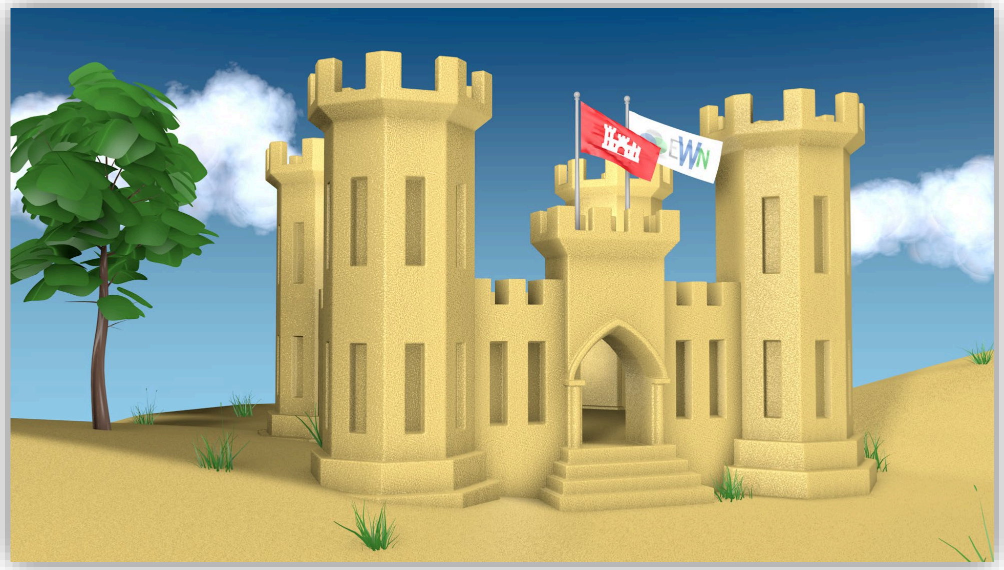
- Innovations in practice
- Taking the “long view”
- Establishing future targets and conditions
- Tools for delivery

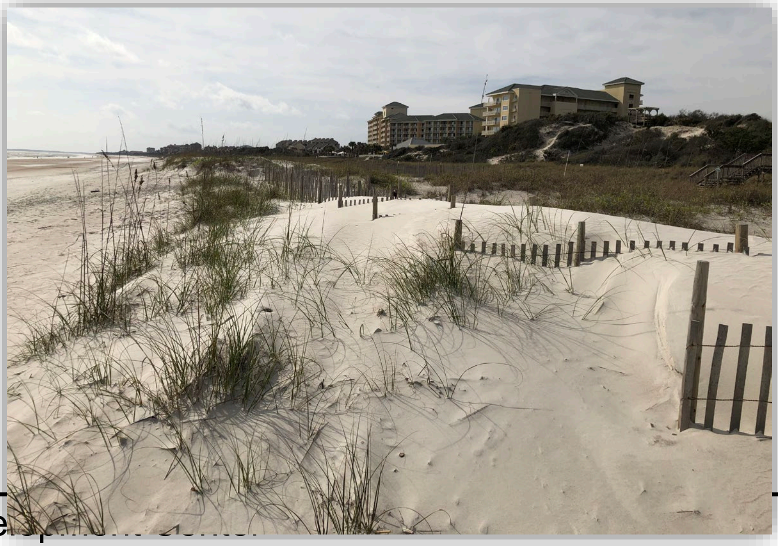
On-the-ground projects and demos

- Across the spectrum of applications and project development (i.e., from planning to operations)

Strategic communications

- Individual research papers
- Visionary products, e.g., EWN Atlas
- Education, e.g., academic curricula, training





EWN® Research and Development

Encompasses diverse landscapes, geographies, challenges, and techniques

- In 2022, 35 new projects were funded
- The research portfolio explores nature-based solutions for multiple natural hazards and challenges:
  - Sediment management, flood risk, coastal storms, drought, wildfire, and habitat health

Collaboration is integral to the success of EWN projects and for robust research. The following partners have active research projects to expand the study of natural infrastructure across geographies and disciplines while capitalizing on the complimentary expertise of each partner. Learn more about their contributions through the Network for EWN.

UNIVERSITY OF GEORGIA Institute for Resilient Infrastructure Systems

UF UNIVERSITY of FLORIDA

The UNIVERSITY of OKLAHOMA

ASU Arizona State University

THE WATER INSTITUTE OF THE GULF

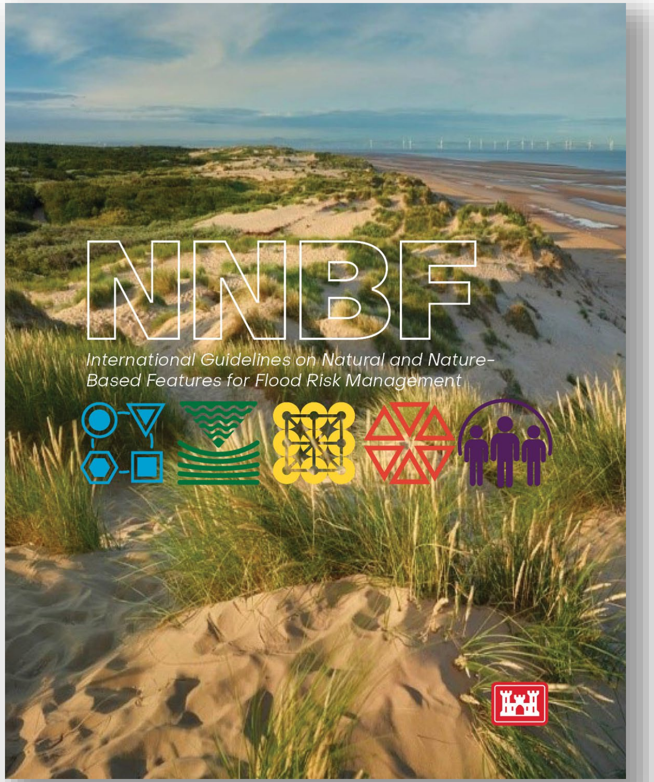
https://ewn.erdc.dren.mil/?page_id=9601

Engineering With Nature® Atlases & Guidelines

<u>Volume 1</u>
56 Projects,
27 USACE

<u>Volume 2</u>
62 Projects,
23 USACE

NNBF Guidelines

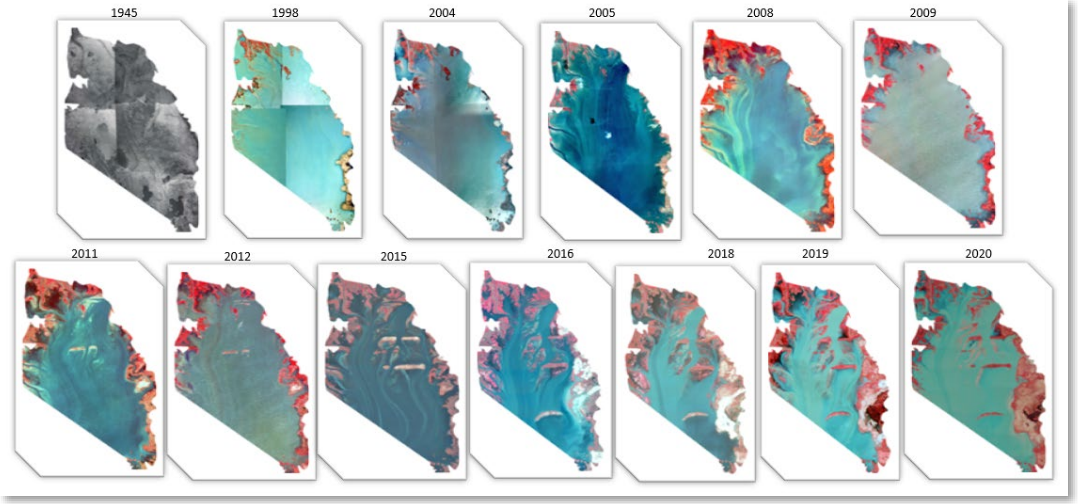


"The mission of US Army Corps of Engineers is to deliver vital public and military engineering services; partnering in peace and war to strengthen our nation's security, energize the economy and reduce risks from disasters. Engineering With Nature supports this mission which is why it will always be an important initiative for the Corps." LTG Scott A. Spellman, 55th Chief of Engineers, Commanding General, USACE

www.engineeringwithnature.org

Project Background

- **Problem**
  - Increasing number/variety of EWN projects seek ways to efficiently quantify project performance
  - Without a targeted approach, use of remotely sensed data/methods could be misaligned with project needs
  - Site access constraints limit traditional surveys; thus, data may not accurately reflect project benefits



West Bay, Louisiana Sediment Diversion, 1945–2020

- **Need**
  - Additional technical aids and tools to advance the practice and implementation of EWN projects

- **Opportunity**
  - Policy expansion surrounding climate change to incorporate more natured based solutions

https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Roadmap.pdf

Project Goals & Impact

- **Overall Objective**

  Improve the integration of remote sensing technology into the EWN project life cycle to enhance effectiveness and quantification of environmental benefits

- **Goals**

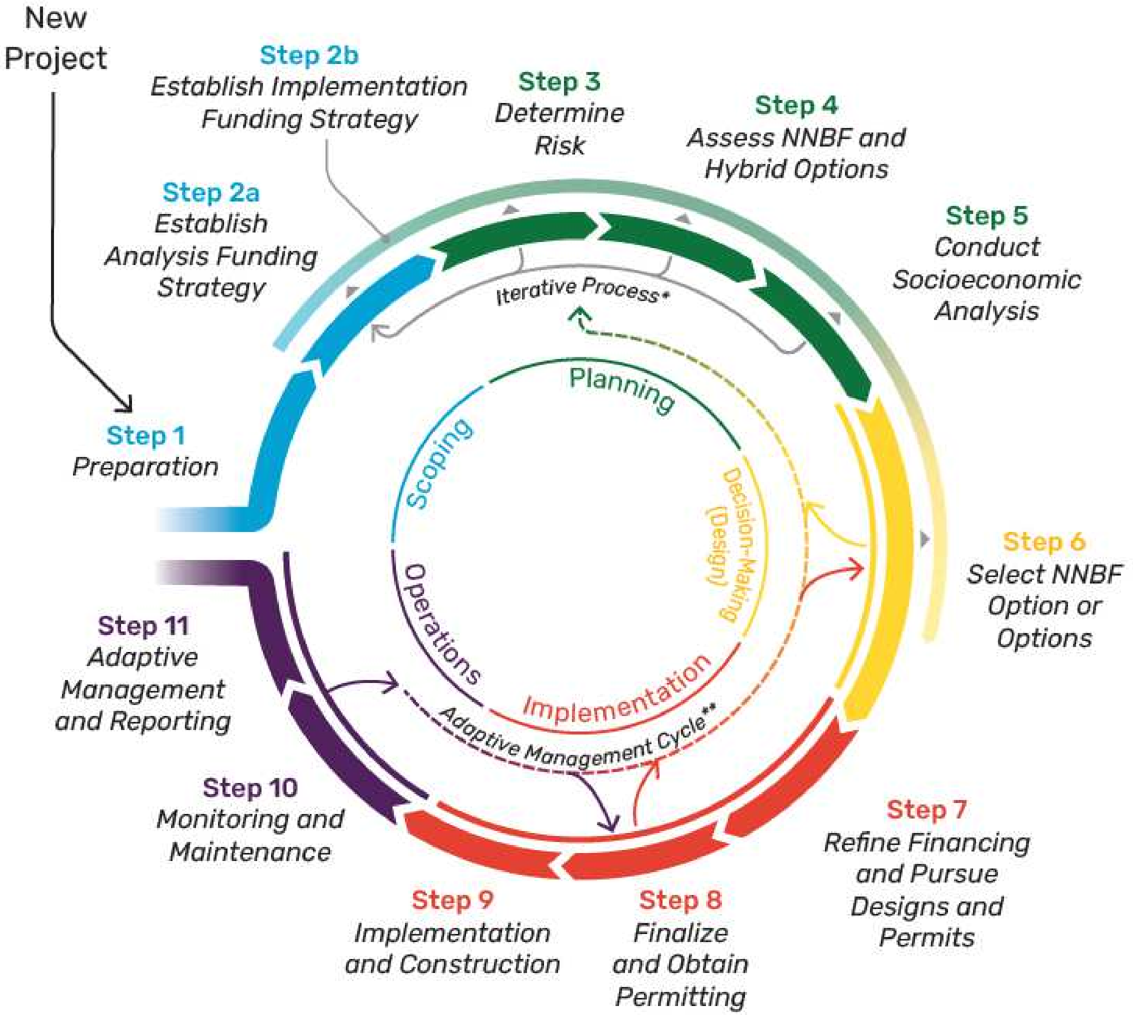
  Establish a remote sensing strategy or roadmap specific to EWN, resulting in greater efficiencies across a project life cycle to enable:

  1. Quantification of project progress
  2. Examination of environmental conditions pre- and post- project phase
  3. Tracking and evaluation of project milestones
  4. Project option comparisons across locations and scales

https://hdl.handle.net/11681/45241

Strategic Alignment with EWN

- **Project Framework - Phases**
  - 5 phases of a project: (1) Scoping, (2) Planning, (3) Decision-Making, (4) Implementation, and (5) Operations
  - Phases provide a general guide for integrating nature-based features into the broader and multidimensional project approach



- Geospatial data is often used ad-hoc
- Is there a targeted approach to benefit the project development process?

https://hdl.handle.net/11681/41946

Strategic Alignment with EWN

- Remote sensing data applications can be used throughout the EWN project lifecycle
- Alignment of geospatial methods with EWN project phases to enable practitioners:
  - ✓ **Scoping/Planning**: baseline conditions & extent of issues
  - ✓ **Decision-Making:** project alternatives & model inputs
  - ✓ **Implementation/Operations:** impact & benefits quantification

Project Phase	Remote Sensing Applications
Scoping	- Characterizing the extent of the issue - Mapping area of interest - Assessing system processes - Defining baseline conditions
Planning	- Hazard and vulnerability assessments - Ecosystem and habitat analyses - Assessing risks and environmental impacts - Establishing project performance criteria - Communicating with stakeholders
Decision Making	- Serving as essential information and input for models - Performing engineering, ecological, social, and economic assessments - Evaluating project alternatives - Completing cost-benefit analyses - Involving the community and stakeholders in plan selection
Implementation	- Finalizing project designs - Generating as-built specifications - Assessing potential environmental impacts - Establishing construction timelines and milestones
Operations	- Quantifying project performance - Assessing project indicators, target values, and triggers - Developing monitoring reports - Identifying adaptive management needs

https://hdl.handle.net/11681/45241

Strategic Alignment with EWN

- **Project Framework - Types**
  - 10 distinct project types
  - Metrics varying by project type used to assess project performance & environmental benefits

Project Category	Benefits
-Beaches and Dunes	-Aesthetics
-Environmental Enhancement of Infrastructure	-Beach nourishment
-Islands	-Bird habitat
-Levee Setbacks and Floodplains	-Fish habitat
-Reefs	-Invertebrate habitat
-Riverine Systems	-Island restoration
-Unique Projects	-Mammal habitat
-Use of Vegetation and Natural Materials	-Recreation
-Wetlands	-Reptile habitat
-Other	-Shore protection
	-Vegetated habitat

https://hdl.handle.net/11681/45241

- Geospatial data can be used without consideration for suitability
- Is there a way to better link spatially-derived metrics to specific project performance?

- Remotely sensed data used to detect and quantify system and feature structure and function at a multitude of scales
  - ✓ Performance indicators such as habitat type, acreage, and biodiversity

Technical Approach

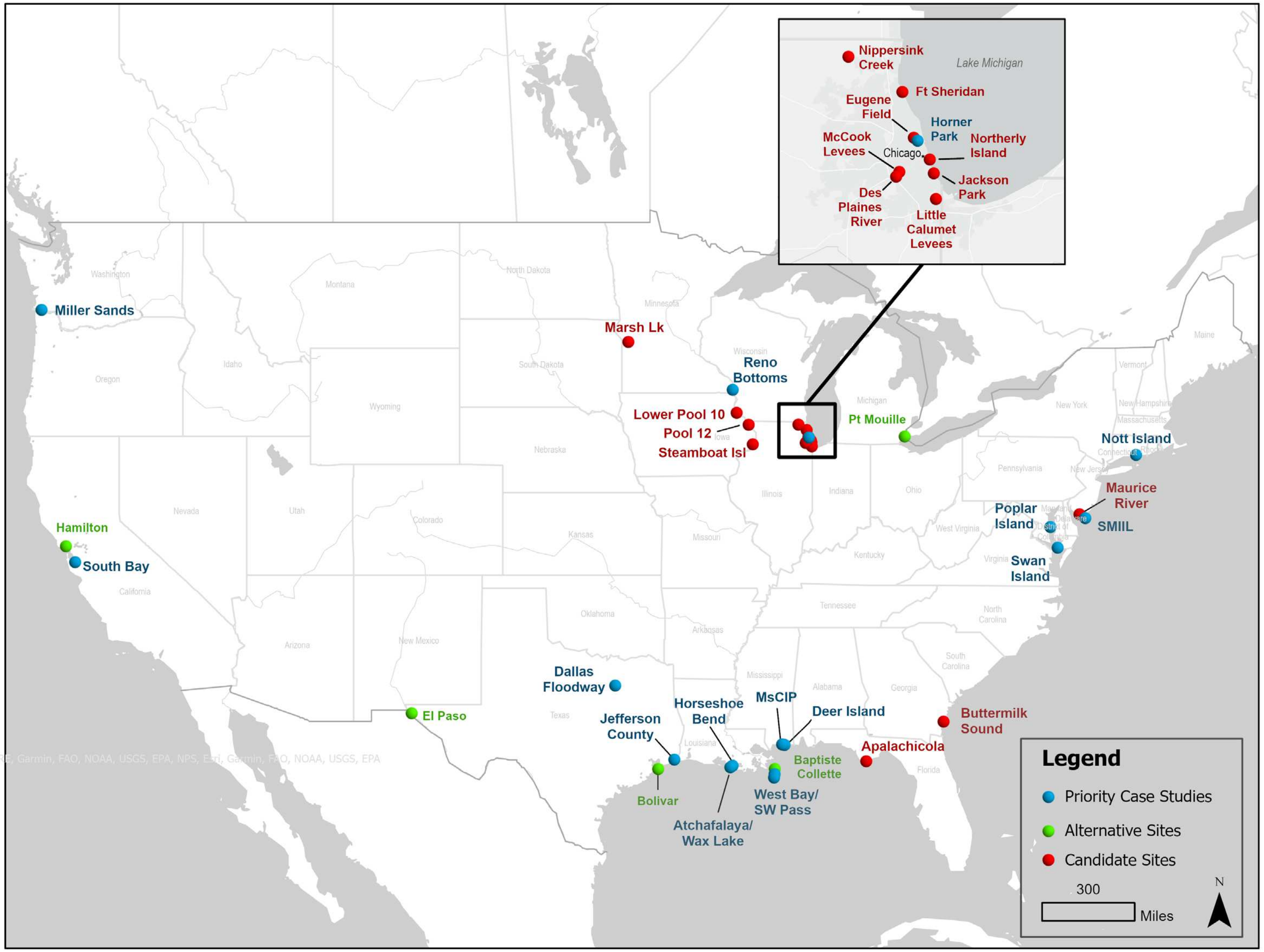
Metric Review
- Spatial metric review
- Technical Note - roadmap for remote sensing strategy

Data-Rich Case Studies
- Inventory and prioritize case studies
- Document workflows for metrics and methods

GIS Software Tool(s)
- Demonstrate metrics and methods for case studies
- Develop tools and user-guides

Remote sensing strategy report for EWN

Case Study Inventory

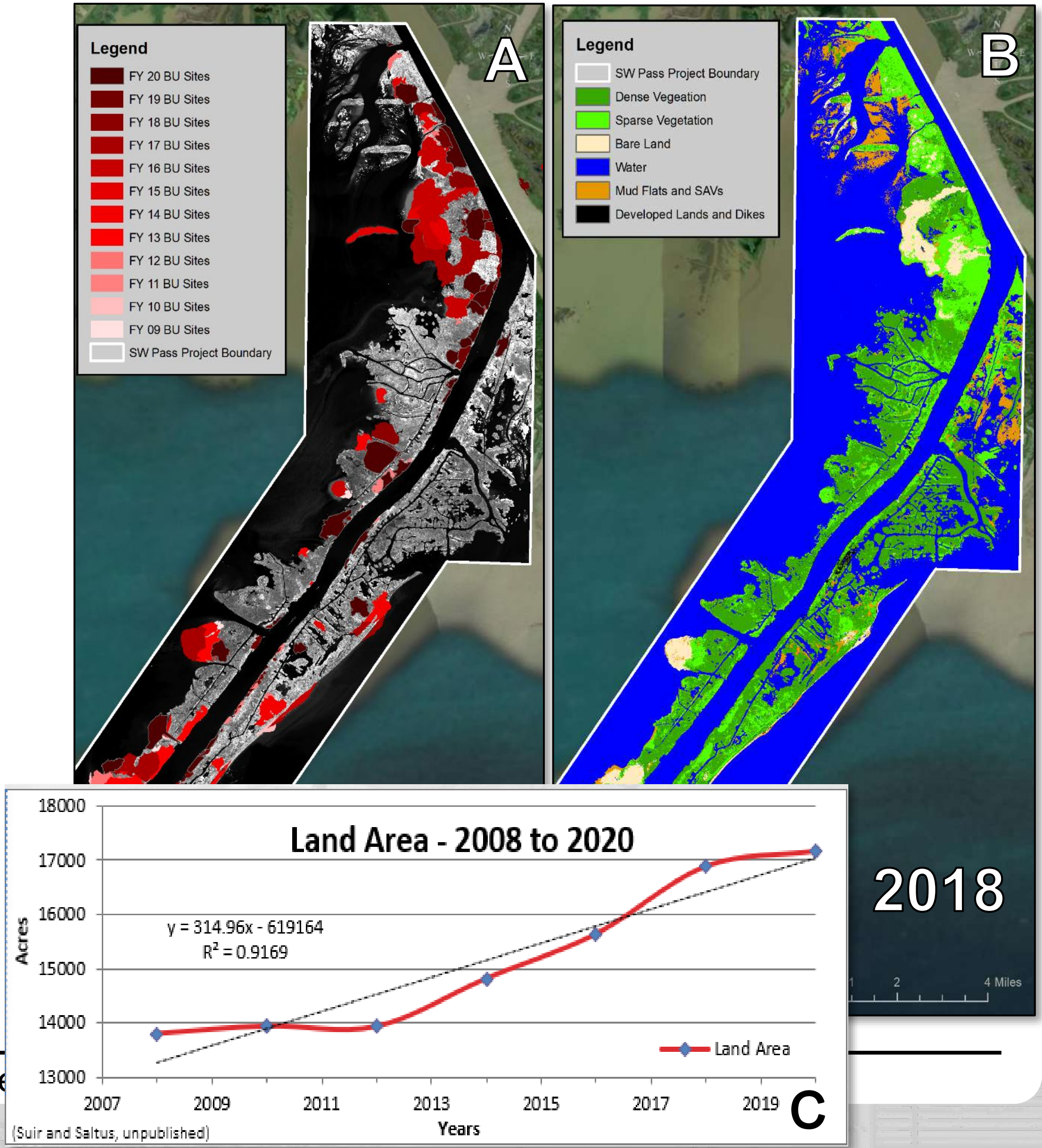


- Roughly 40 candidate sites (case studies) and data descriptions compiled into a database
- Studies recommended by District POCs, PIs, and EWN Practice Leads and canvassing
- Represent a variety of project types and phases
- 14 Priority case studies selected based upon:
  - Remotely sensed and field data availability for leveraging
  - Geographic variability (coastal and inland)
  - Spatial metric diversity
  - EWN project type and phase variety

Coastal Case Study Example

- Southwest Pass, MS River
  - **Project Types:** Use of Vegetation and Natural Materials; Wetlands; Environmental Enhancement of Infrastructure; Riverine Systems; Islands

Project Phase	Remote Sensing Application
Scoping	BUDM footprint extents (A)
Planning	Quantification of material placed 6,770 ac. (A)
Decision Making	Wetland classification (B)
Implementation	Biannual classification and habitat pattern analysis (B, C)
Operations	Land gain benefits and quantification, 3,300 ac. (C)

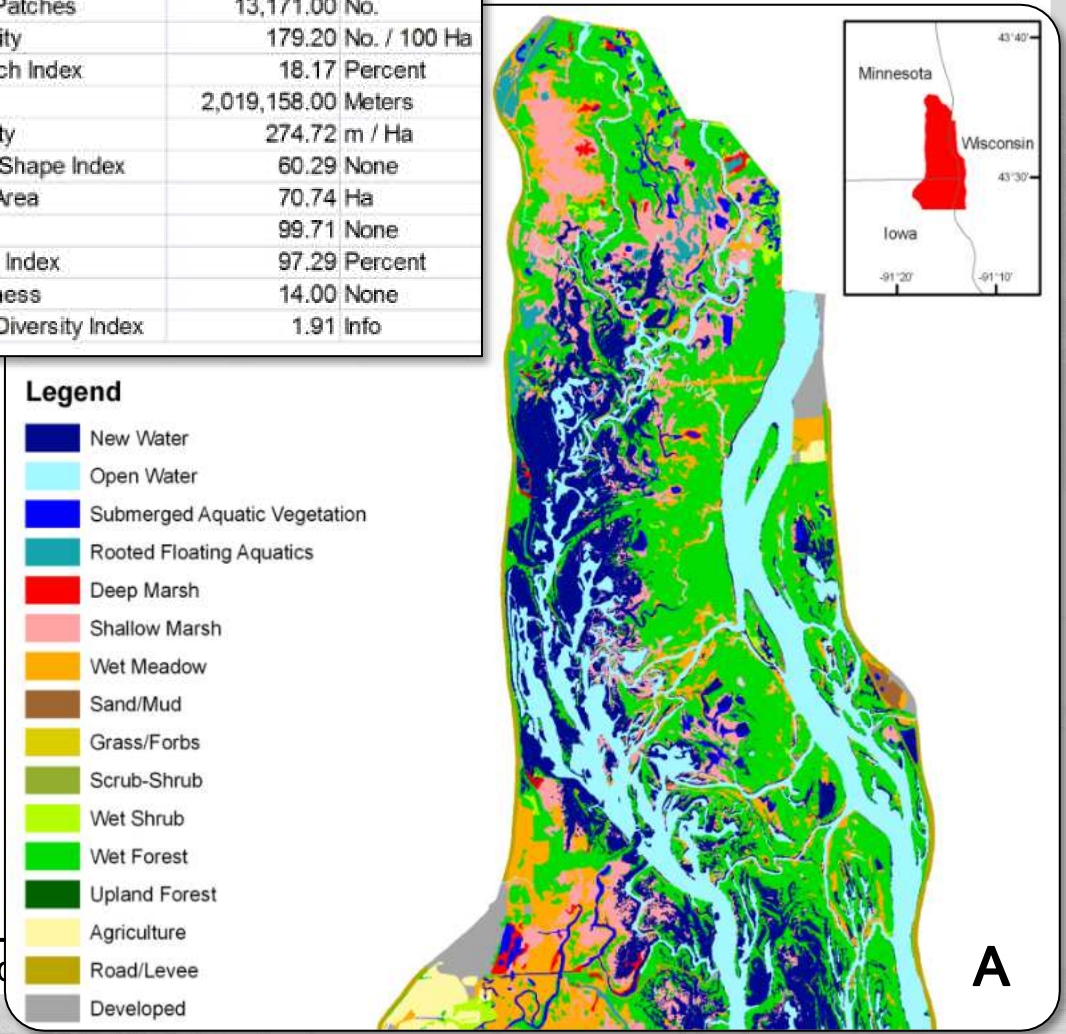


Inland Case Study Example

- Reno Bottoms Habitat Rehabilitation and Enhancement Project, MN
  - **Project Types:** Levee Setbacks and Floodplains; Riverine System; Use of Vegetation and Natural Materials; Environmental Enhancement of Infrastructure

B

METRIC	ADJUSTED VALUE	UNITS
Total Area	7,349.96	Ha
Number of Patches	13,171.00	No.
Patch Density	179.20	No. / 100 Ha
Largest Patch Index	18.17	Percent
Total Edge	2,019,158.00	Meters
Edge Density	274.72	m / Ha
Landscape Shape Index	60.29	None
Total Core Area	70.74	Ha
Cohesion	99.71	None
Aggregation Index	97.29	Percent
Patch Richness	14.00	None
Shannon's Diversity Index	1.91	Info



Project Phase	Remote Sensing Application
Scoping/Planning	Baseline land cover classification (A)
Decision Making	Modeled floodplain habitat impacts from alternative scenario river level changes (A, B)
Decision Making	Landscape metrics quantification (B)

ATCHAFALAYA BIG ISLAND MINING

PROJECT SUMMARY:

- Atchafalaya River Navigation Channel
- 12,000,000 m^3 Dredged Annually
- Project Area:
  - Big Island, Atchafalaya River Delta
  - 3,400 acres
- Estimated Cost: ~$7 M
- Status: Completed 1998
- Project Benefit: 1,560 Acres (20 Yrs)

PROJECT TYPE:

- **WETLAND CREATION**
  - BU of Dredged Material
- **HYDROLOGIC RESTORATION**
  - Create Distributary Channels
  - Reestablish Water/Sed Flow

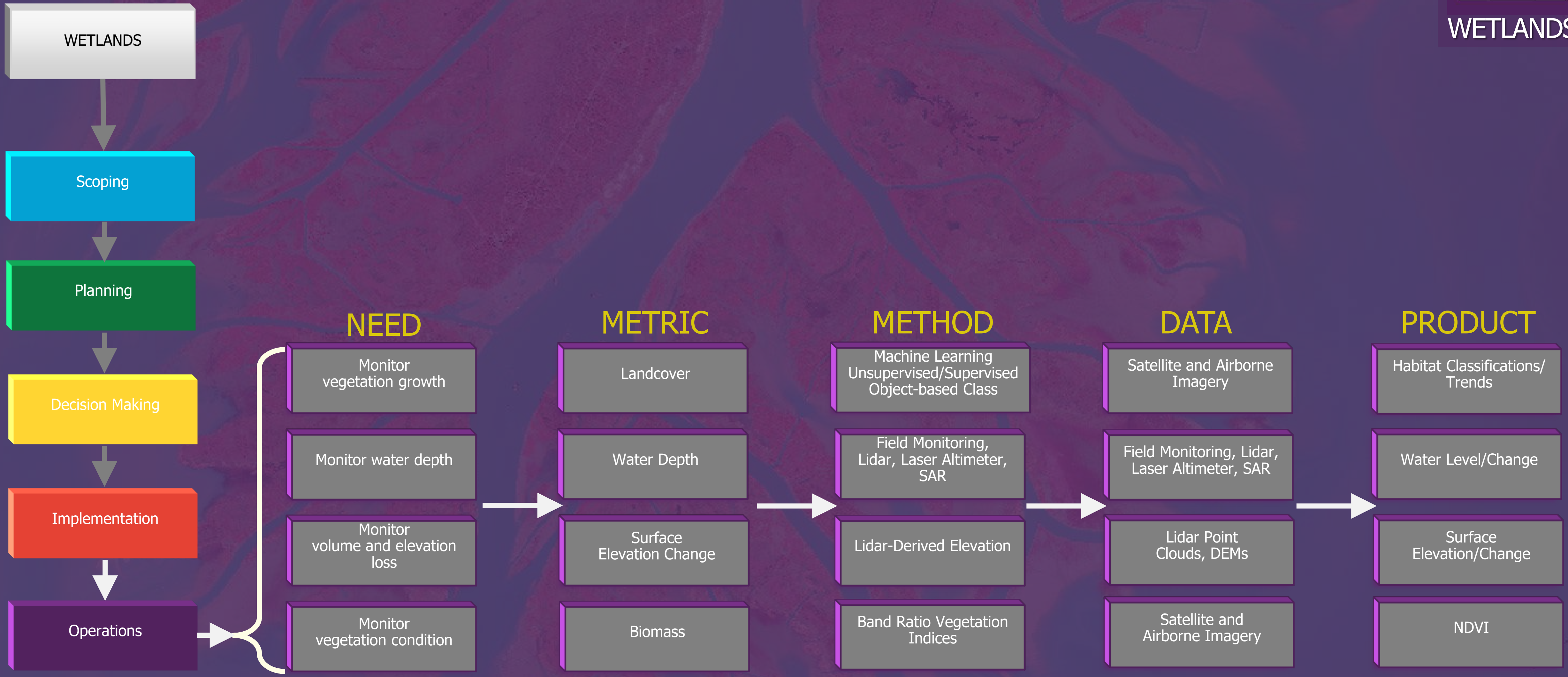
PROJECT PHASE:

- **OPERATIONS**
  - Wetland Monitoring
  - Quantification of Performance
  - Compare to Reference/Targets
  - Evaluate Benefits
  - Assess Impacts
  - Adaptive Management

WETLANDS

REMOTE SENSING FLOW CHART

WETLANDS



PROJECT GOALS:

- Sediment delivery, deposition, and retention
- Build for more resistance to storms, tidal influence
- Delta management
- Enhance natural delta building by creating conveyance of sediment to delta lobes

MONITORING NEEDS:

- Elevation change
- Volume loss
- Habitat mapping
- Land area change
- Monitor vegetation growth
- Channel morphology
- Target/Reference Comparison

WETLANDS 2021

METRICS

WETLANDS

LANDSCAPE

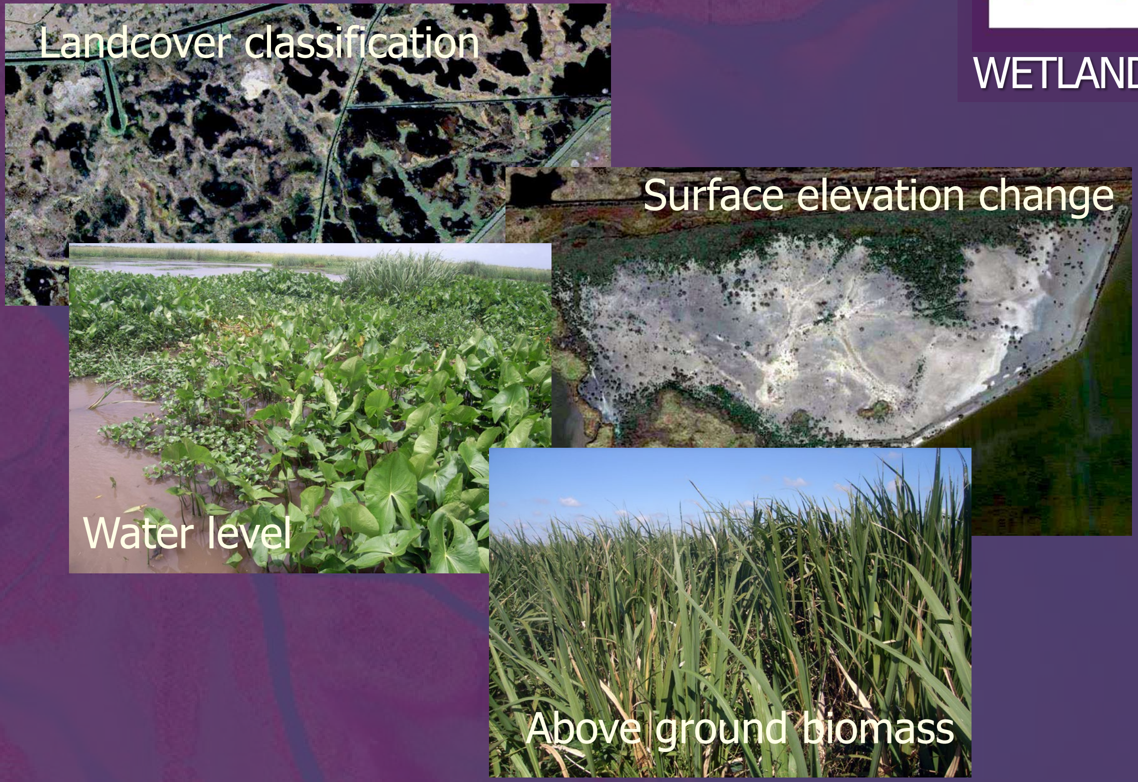
- Areal extent
- Habitat units
- Land/water ratio
- Landcover area
- Landcover change/trends
- Landcover classification
- Landscape configuration

HYDROLOGY

- Hydrologic change
- Navigable paths
- Shoaling
- Water level
- Water quality
- Water residency times
- Wave attenuation

GEOMORPHOLOGY

- Channel changes
- Channel width
- Erosion and accretion rate
- Navigable paths
- Sediment movement
- Sediment transport
- Sediment trapping
- Shoreline change rate
- Shoreline location/position
- Soil type
- Surface elevation changes
- Wetland elevation



VEGETATION

- Above ground biomass
- Biodiversity and richness
- Floristic quality
- Invasive plants
- Marsh edge
- Marsh fragmentation
- Species abundance
- Species biomass
- Species competition
- Species composition
- Species cover
- Species density
- Vegetation biomass estimates
- Vegetation connectivity
- Vegetation density
- Vegetation edge
- Vegetation fragmentation
- Vegetation health
- Vegetation height
- Vegetation interspersion
- Vegetation mortality
- Vegetation presence
- Vegetation performance
- Vegetation recovery
- Vegetation resiliency
- Vegetation shoot density
- Vegetation survival

METHODS

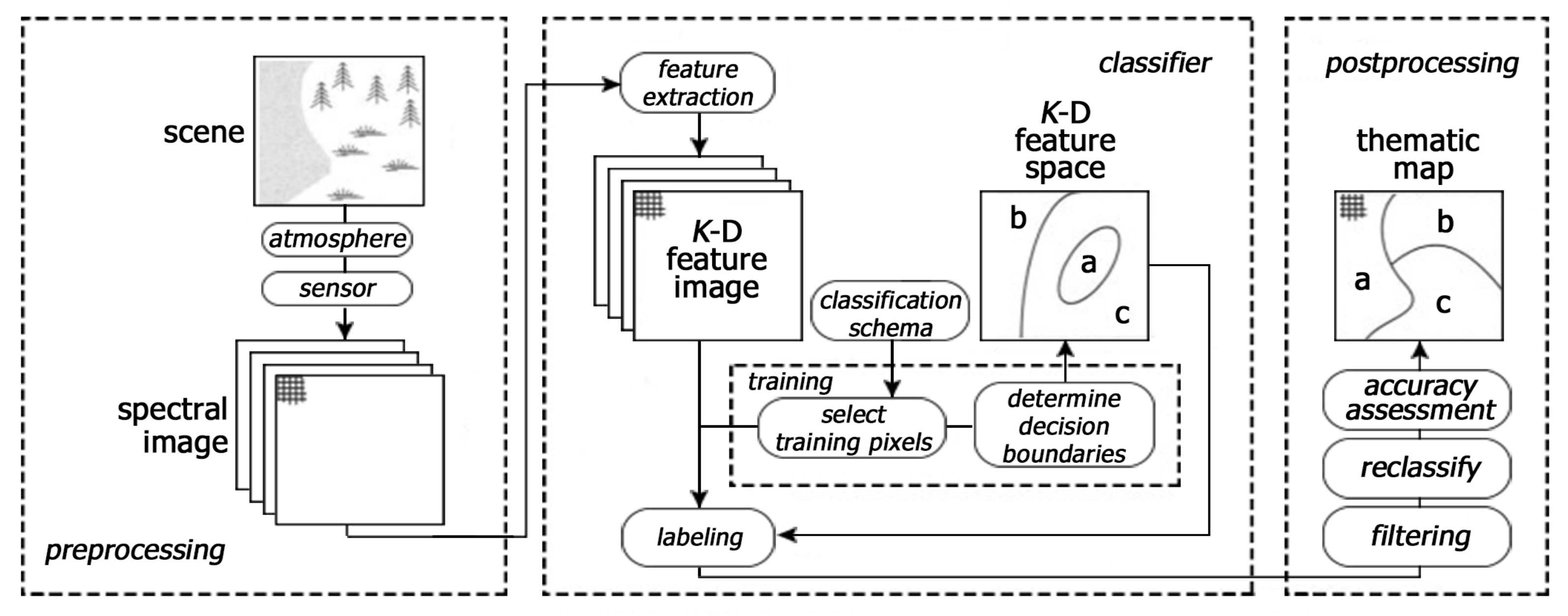
WETLANDS

LANDSCAPE

- *Classification*: The process of sorting or arranging entities into groups or categories; on a map, the process of representing members of a group by the same symbol, usually defined in a legend (ESRI 2022). Common thematic classifications in wetlands are Land Cover, Habitat, and Land-water.

Technique	Characteristics	Schema	Training and Ground Verification Data	Examples
Pixel-based	Each pixel is assumed pure and typically labeled as a single class or feature type	Classes or categories to which image pixels or objects are assigned.	Field collected or measured data used to train classifiers and/or to evaluate the accuracy of remotely sensed or mathematically calculated data.	- Unsupervised (e.g., ISODATA) - Supervised (e.g., Maximum likelihood) - Machine learning (e.g., Random forests)
Object-based	Geographical objects, instead of individual pixels, are considered the basic unit			- Image segmentation and object-based image analysis techniques

Li et al., 2014



Schowengerdt 2006

METHODS

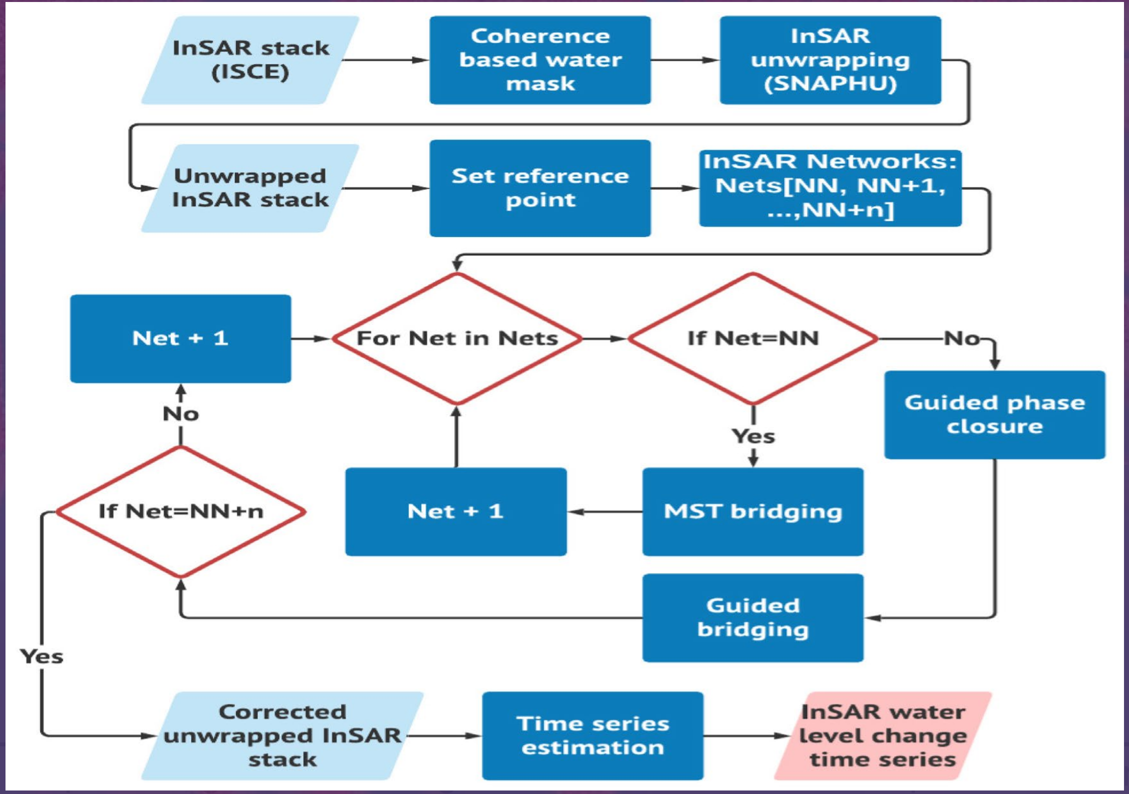
WETLANDS

HYDROLOGY

- *Water Depth*: Height of the water surface above the soil surface (in a wetland) or above an established datum plane (as "stage" in a river).

Technique	Description	Ground Verification Data
Synthetic Aperture Radar	Uses double-bounce scattering of the radar pulses between the water surface and emergent vegetation to provide spatially extensive water level and changes in wetland environments.	Field collected or measured water depths used to evaluate the accuracy of remotely sensed or mathematically calculated data.

SAR water level change time-series processing workflow.



Oliver-Cabrera et al., 2021

METHODS

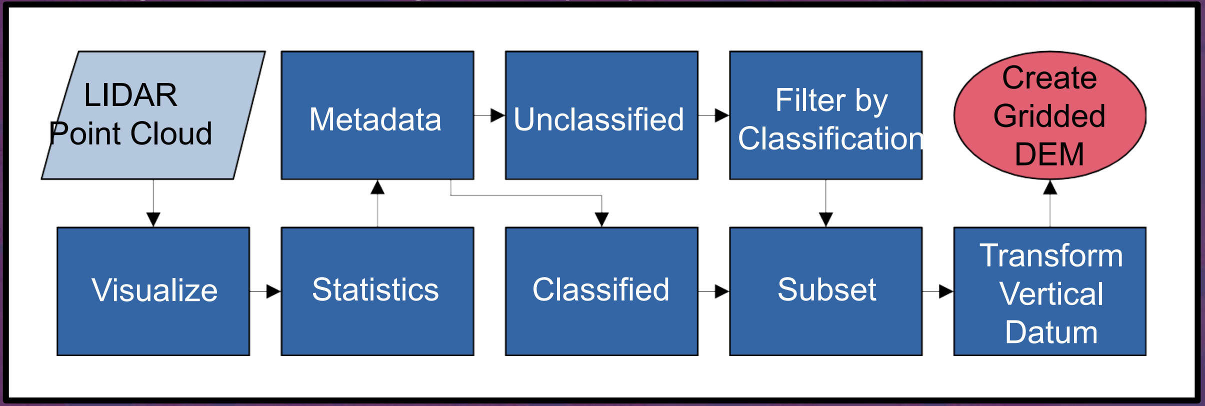
WETLANDS

GEOMORPHOLOGY

- *Elevation*: The vertical distance of a point or object above or below a reference surface or datum (generally mean sea level in coastal systems). Elevation generally refers to the vertical height of land.

Technique	Description	Ground Verification Data
Lidar-derived Digital Elevation Model	Representation of the Earth's topographic surface (bare ground), excluding surface objects (e.g., trees, buildings, etc.). Often derived from high-resolution light detection and ranging data.	Field collected or measured elevation data, usually via DGPS or elevation tables, used to evaluate the accuracy of remotely sensed or mathematically calculated data.

Processing workflow for creating elevation (DEM) from LIDAR data.



METHODS

WETLANDS

VEGETATION

- *Biomass*: The total amount of organic matter in a defined area; usually refers to vegetation and is often reported as total, above- or below-ground biomass.

Technique	Description	Ground Verification Data
Normalized Difference Vegetation Index (NDVI)	NDVI quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).	Field collected or measured vegetation data, usually via plant survey, used to evaluate the accuracy of remotely sensed or mathematically calculated data.

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

EOS Data Analytics, 2022

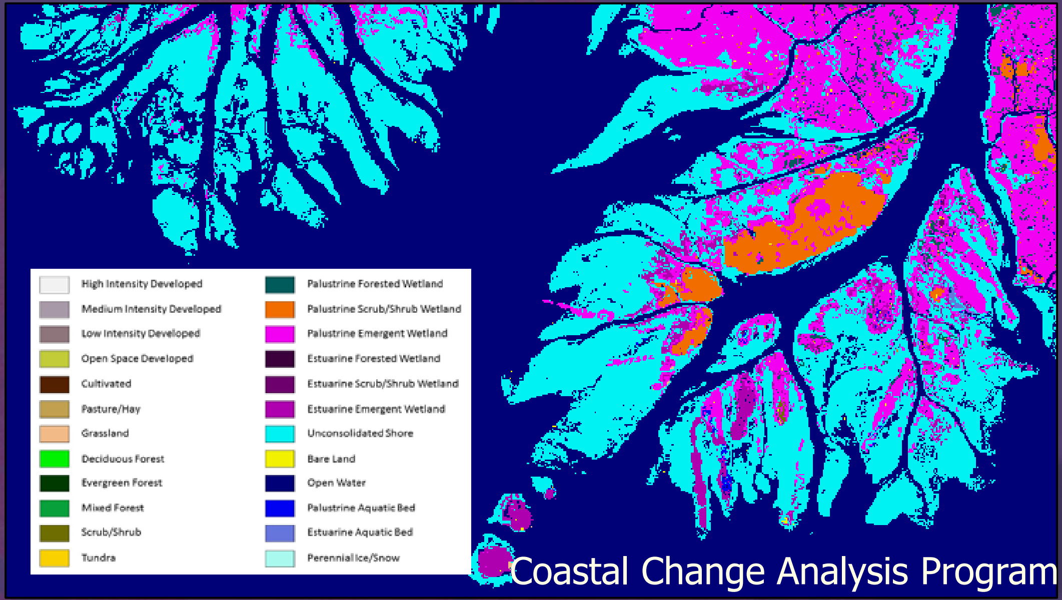
SOURCE DATA

WETLANDS

LANDCOVER CLASSIFICATION

- *Existing Data Products*: National and Regional landcover data created using standard classification systems and maintained by governmental agencies or commercial organizations. Although these data can be used as is, transformation is often required to generate value added products that satisfy project needs.

Coverage	Land Cover Data
NATIONAL	Esri Land Cover 10m
	Global Land Survey (GLS)
	Climate Change Initiative (CCI) Land Cover V2
	OSM Land Use Data
	USGS – Global Land Cover Characterization (GLCC)
	GlobeLand30
	UN FAO Global Land Cover Network (GLC-SHARE)
	Land Cover Type Yearly L3 Global 0.05Deg CMG
	Sentinel-2 10m Land Cover Time Series
	National Landcover Dataset (NLCD)
	LandFire Vegetation Cover
	USFWS National Wetlands Inventory (NWI)
REGIONAL	Vegetation Types in Coastal Louisiana 1968-2021
	Louisiana Vegetation Maps 1956, 1978, 1988
	NOAA C-CAP Regional Land Cover Data



Coastal Change Analysis Program

- *Input Data*: Required to derive new landcover classification data. Input data are typically pre-processed, used in conjunction with ancillary data (field or other remotely collected data), and appropriate techniques (visual interpretation) or methods (e.g., parametric, supervised, pre-pixel, object-based image analysis) to generate landcover data.

Platform	Data
Satellite imagery	MAXAR WorldView, Planet SkySat
Airborne imagery	NAIP, NASA AVIRIS, JALBTCX
Airborne video	UAS

MAXAR WorldView2

SOURCE DATA

WETLANDS

WATER LEVEL

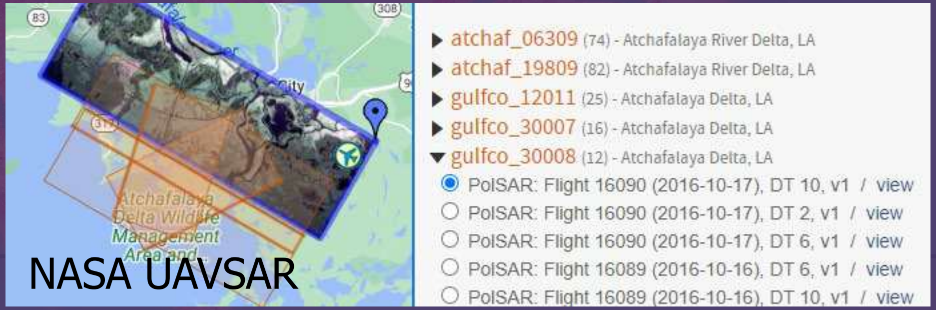
- *Existing Data Products*: National and Regional water level data collected and/or created using monitoring stations and maintained by governmental agencies or commercial organizations. Although these data can be used as is, transformation is often required to generate value added products that satisfy project needs.

Coverage	Hydrologic Data
NATIONAL	NOAA National Water Level Observation Network
	NOAA National Data Buoy Center Data
	USGS National Water Information System
	USACE Stage and Hydrologic Data
REGIONAL	Louisiana Coastwide Reference Monitoring System
	Louisiana CPRA Monitoring Stations

USGS National Water Information System

- *Input Data*: Required to derive new water level data. Input data are typically pre-processed, used in conjunction with ancillary data (i.e., monitoring station data), and appropriate methods (e.g., radar interferometry) to generate water level data.

Platform	Data
Air-borne systems	UAVSAR, UAS lidar
Space-borne systems	NASA ICESat-2 L3A



NASA UAVSAR

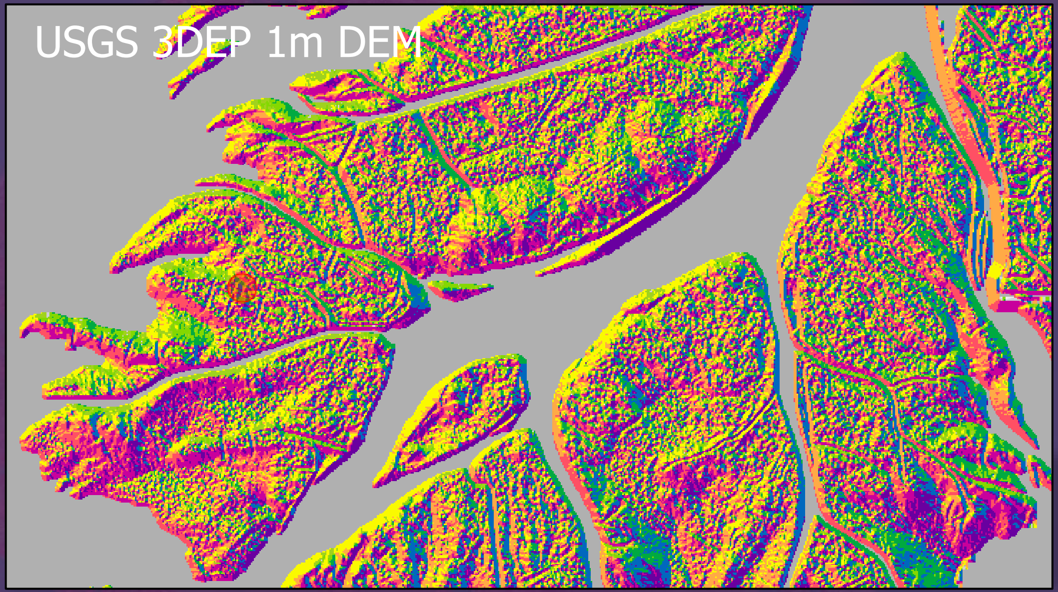
SOURCE DATA

WETLANDS

SURFACE ELEVATION CHANGE

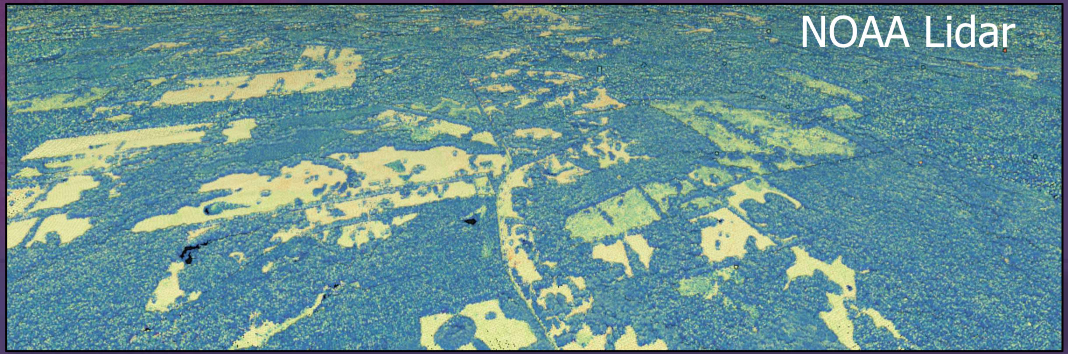
- *Existing Data Products*: National and Regional elevation data created using standardized methods and maintained by governmental agencies. Although these data can be used as is, transformation is often required to generate value added products that satisfy project needs.

Coverage	Elevation Data
NATIONAL	USGS 3DEP (DEM: 1m, 3m, 10m, 30m)
	NASA Shuttle Radar Topography Mission
	ASTER Global Digital Elevation Model (GDEM)
REGIONAL	NOAA Digital Coast Data
	Barrier Island Comprehensive Monitoring Program



- *Input Data*: Required to derive new elevation data. Input data are typically pre-processed and used in conjunction with ancillary ground control/verification data to generate DEM, DSM, DTM, or other elevation data.

Elevation Data
USGS 3DEP (Lidar, Ifsar)
Louisiana Lidar Project (NOAA, USGS, USACE, DOTD)
JALBTCX Lidar
Louisiana CWPPRA Elevation Survey



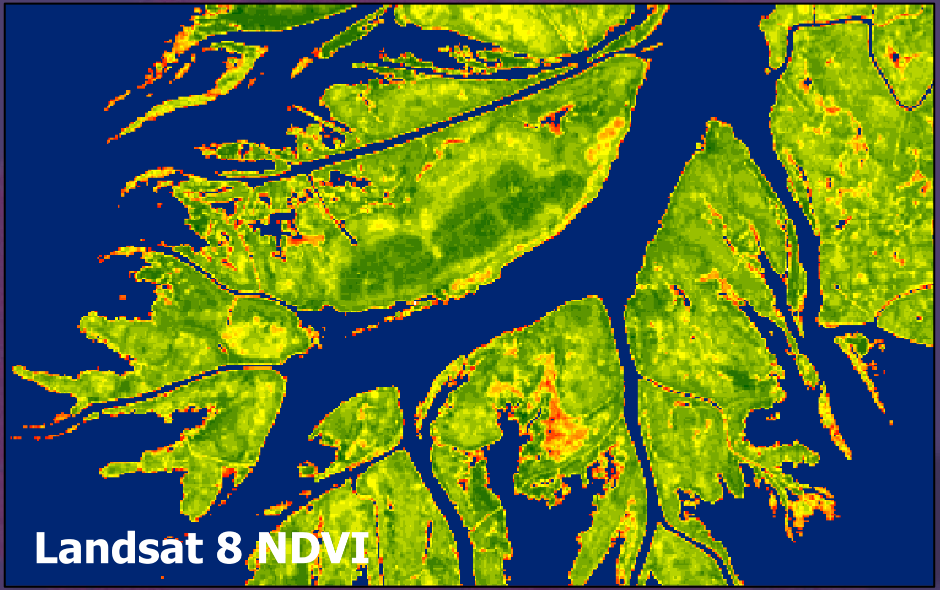
SOURCE DATA

WETLANDS

ABOVEGROUND BIOMASS

- *Existing Data Products*: National and Regional vegetation index data created using standard band ratioing and maintained by governmental agencies or commercial organizations. Although these data can be used as is, transformation is often required to generate value added products that satisfy project needs.

Coverage	Hydrologic Data
NATIONAL	NASA Global Ecosystem Dynamics Investigation (GEDI)
	MODIS Vegetation Index Products
	Landsat NDVI (Google Earth Engine)
	NOAA Advanced Very High Resolution Radiometer
REGIONAL	NAIP Normalized Difference Vegetation Index

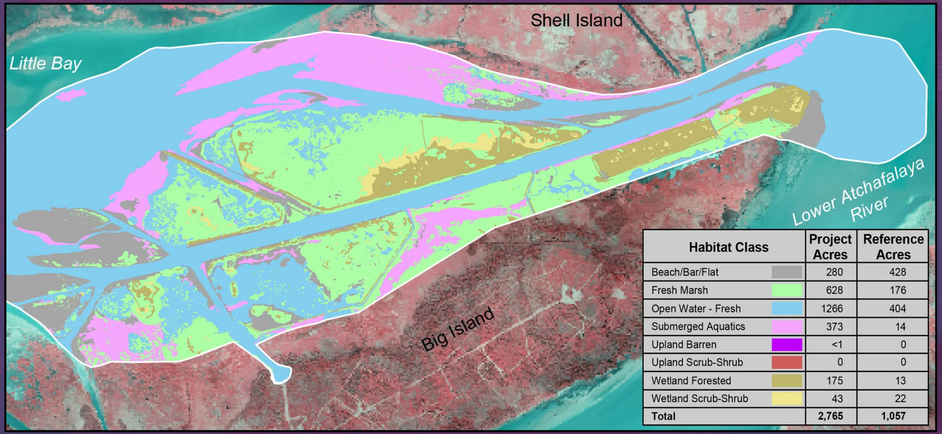


- *Input Data*: Required to derive new vegetation index data. Input data are typically pre-processed and used with appropriate methods (e.g., NDVI) to generate vegetation indices that serve as estimates of aboveground biomass.

Platform	Data
Space-borne systems	MAXAR WorldView, Sentinel 2
Air-borne systems	NASA AVIRIS, JALBTCX, UAS multispectral

VALUE-ADDED PRODUCTS

- Landcover classification

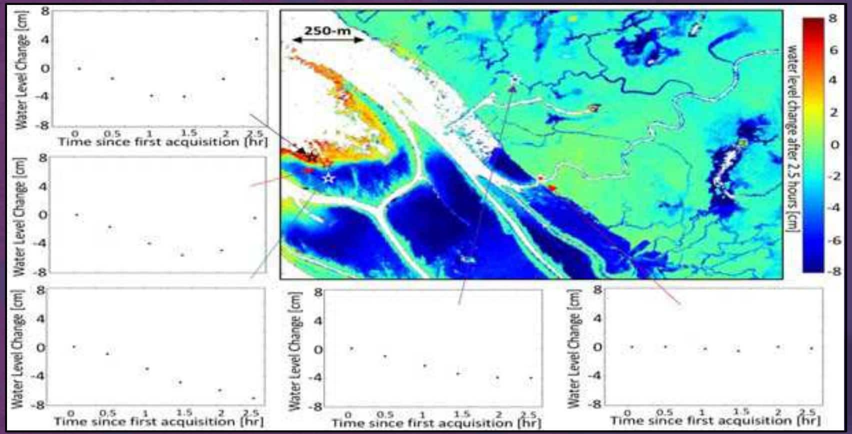


Habitat Class	Project Acres	Reference Acres
Beach/Bar/Flat	280	428
Fresh Marsh	628	176
Open Water - Fresh	1266	404
Submerged Aquatics	373	14
Upland Barren	<1	0
Upland Scrub-Shrub	0	0
Wetland Forested	175	13
Wetland Scrub-Shrub	43	22
Total	2,765	1,057

USGS, 2007?

Habitat Units represent habitat quality (Habitat Suitability Index) and habitat quantity (acres) within a given area at a given point in time (USGS)

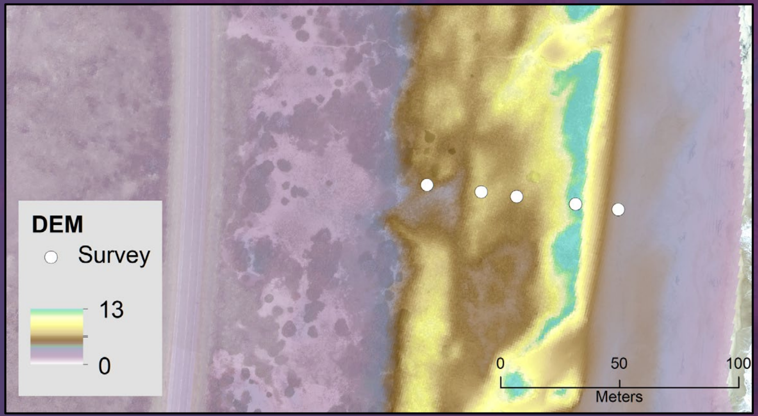
- Water level



Oliver-Cabrera et al., 2021

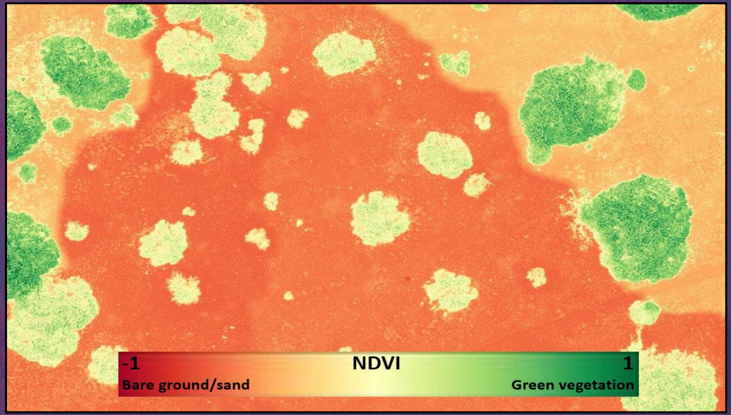
Water level change within wetland from UAVSAR (5mm)

- Surface elevation change



Elevation change using Lidar collected before and after hurricane overwash events

- Aboveground biomass

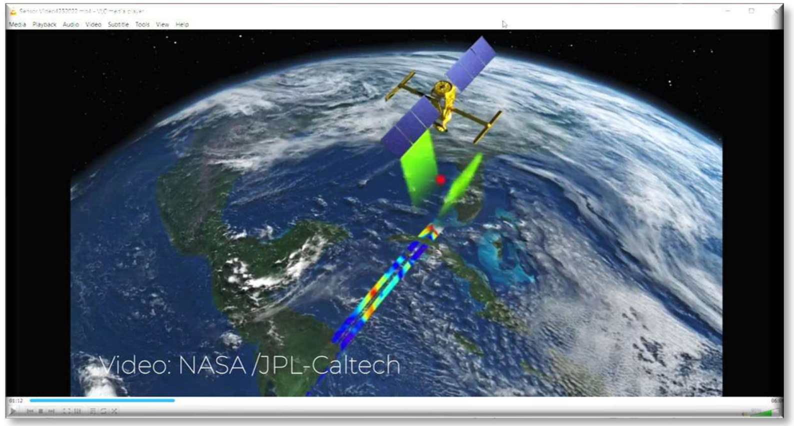


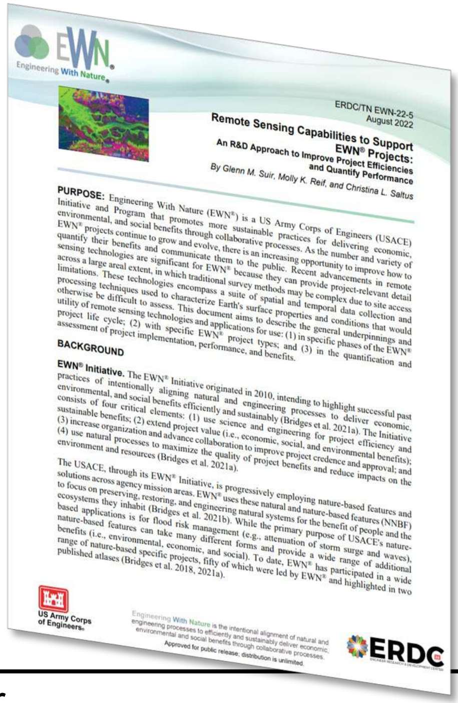
NDVI values as estimates of aboveground biomass of dune vegetation on barrier island

Recent Activities & Products

- EWN Remote Sensing Strategy Video
  - Introduces the research and highlights the value of remote sensing technology to EWN
  - Released May 2022, https://www.erdc.usace.army.mil/Media/Video-Page/videoid/846309/
- ERDC TN EWN-22-5: *Remote Sensing Capabilities to Support EWN® Projects: An R&D Approach to Improve Project Efficiencies and Quantify Performance*
  - Published August 2022, https://hdl.handle.net/11681/45241
- Participated in the Delta-X Applications Workshop, Baton Rouge LA, May 4-5, 2022,

  https://daac.ornl.gov/resources/tutorials/2022_deltax_workshop/index.html
- Compiled and reviewed EWN case study inventory
- Selected priority case studies aligned with EWN project phases and types





EWN Engineering With Nature®

ERDC/TN EWN-22-5
August 2022

Remote Sensing Capabilities to Support EWN® Projects:
An R&D Approach to Improve Project Efficiencies and Quantify Performance

By Glenn M. Suir, Molly K. Reif, and Christina L. Saltus

PURPOSE: Engineering With Nature (EWN®) is a US Army Corps of Engineers (USACE) Initiative and Program that promotes more sustainable practices for delivering economic, environmental, and social benefits through collaborative processes. As the number and variety of EWN® projects continue to grow and evolve, there is an increasing opportunity to improve how to quantify their benefits and communicate them to the public. Recent advancements in remote sensing technologies are significant for EWN® because they can provide project-relevant detail across a large areal extent, in which traditional survey methods may be complex due to site access limitations. These technologies encompass a suite of spatial and temporal data collection and processing techniques used to characterize Earth's surface properties and conditions that would otherwise be difficult to assess. This document aims to describe the general underpinnings and utility of remote sensing technologies and applications for use: (1) in specific phases of the EWN® project life cycle; (2) with specific EWN® project types; and (3) in the quantification and assessment of project implementation, performance, and benefits.

BACKGROUND

EWN® Initiative. The EWN® Initiative originated in 2010, intending to highlight successful past practices of intentionally aligning natural and engineering processes to deliver economic, environmental, and social benefits efficiently and sustainably (Bridges et al. 2021a). The Initiative consists of four critical elements: (1) use science and engineering for project efficiency and sustainable benefits; (2) extend project value (i.e., economic, social, and environmental benefits); (3) increase organization and advance collaboration to improve project credence and approval; and (4) use natural processes to maximize the quality of project benefits and reduce impacts on the environment and resources (Bridges et al. 2021a).

The USACE, through its EWN® Initiative, is progressively employing nature-based features and solutions across agency mission areas. EWN® uses these natural and nature-based features (NNBF) to focus on preserving, restoring, and engineering natural systems for the benefit of people and the ecosystems they inhabit (Bridges et al. 2021b). While the primary purpose of USACE's nature-based applications is for flood risk management (e.g., attenuation of storm surge and waves), nature-based features can take many different forms and provide a wide range of additional benefits (i.e., environmental, economic, and social). To date, EWN® has participated in a wide range of nature-based specific projects, fifty of which were led by EWN® and highlighted in two published atlases (Bridges et al. 2018, 2021a).

US Army Corps of Engineers®

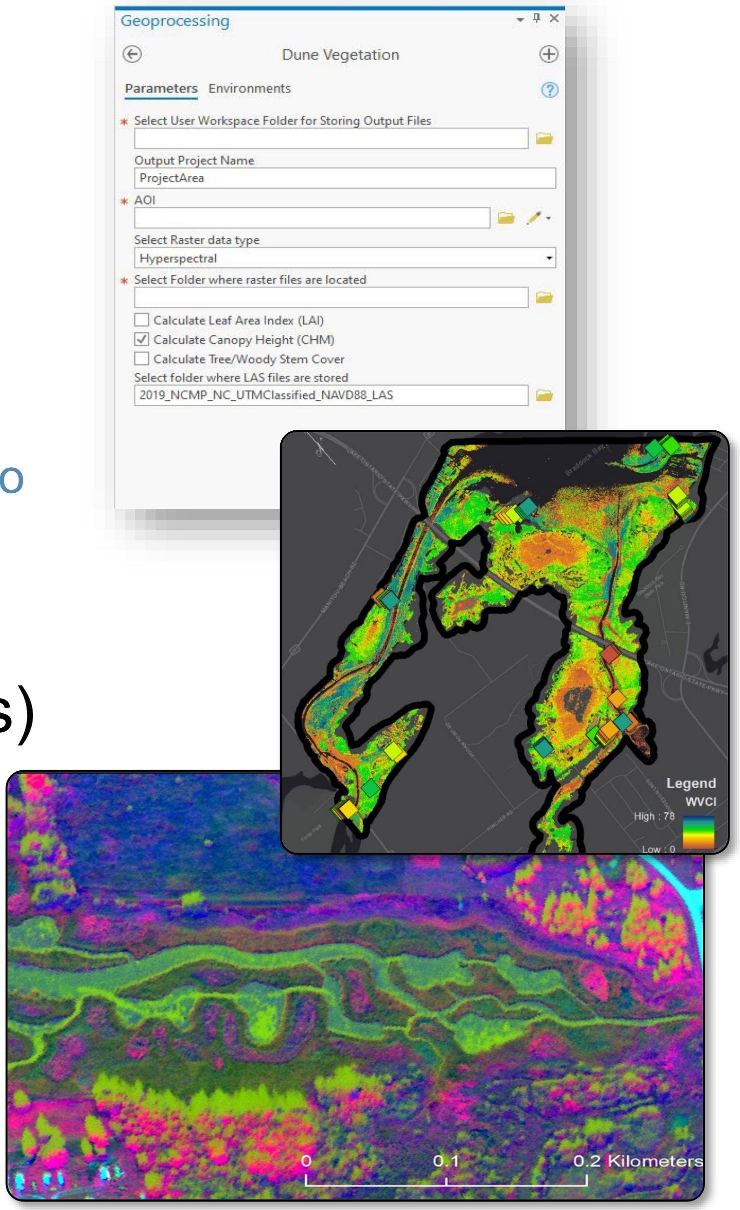
Engineering With Nature is the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Approved for public release; distribution is unlimited.

ERDC

On-going Activities & Products

- Finalize methodological workflows for metric extraction
  - Serving as software toolbox foundation
  - Communicating the methods in a storymap
- Compile priority case study geospatial data into library
  - Focusing on diverse metrics and data sources across the EWN portfolio
  - Using for demonstrating metrics and methods in data-rich case studies
- Develop ESRI ArcGIS toolbox(s) for EWN
- Generate user-guide document and training for toolbox(s) using case study examples
- Author journal paper detailing the remote sensing strategy to support EWN projects



Benefits to EWN

- **Value Statement**

  Innovative remote sensing approaches to quantify project performance, including impacts beyond the project footprint. Applicable to:

  - 100s of projects
  - Vast geographic areas
  - >10s of 1000s acres within the EWN project portfolio
  - >10 project types in all 5 project phases

- **Integration with the EWN Strategic Plan**

  A comprehensive remote sensing approach fits with EWN's vision to assist with:

  1. Demonstrating EWN® project design, implementation, performance, and application
  2. Increasing project forecasting and risk reduction
  3. Improving inter-relationships in system processes
  4. Increasing project efficiencies and resilience
  5. Improving adaptive management

Needs/Opportunities

- **Potential questions for discussion & feedback**
  1. What environmental spatial metrics are we missing that may be relevant to EWN?
  2. How to best quantify benefits from spatial metrics? (gain in wetland acreage etc)
  3. Are there missing spatial metrics related to climate change? (carbon sequestration, blue carbon etc)
  4. What additional remote sensing data sources should we consider specific to NASA assets and relevant to EWN project scales?*

     *We plan to use data from the Delta-X mission in the Louisiana sites
  5. For NASA space missions that are not operational yet, are there test data we could explore?
  6. For the priority case studies, are there collaboration or data leveraging opportunities where NASA JPL could be involved?*

     *This is the last year of the project, but follow-on opportunities may be possible

POCs:
Molly.K.Reif@usace.army.mil
Christina.L.Saltus@usace.army.mil
Glenn.M.Suir@usace.army.mil