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**What is DEVELOP?**

NASA Applied Sciences’ program that **collaborates** with decision makers to conduct environmental research projects using **NASA Earth observations**.

**DEVELOP bridges the gap between NASA Earth Science and society**, building capacity in both its participants and end-user organizations to better prepare them to handle the environmental challenges that face society.

**DEVELOP is a dual-capacity building program:**

**Partners & Participants**
Objectives

- Apply NASA Earth observations in Mobile and Baldwin Counties to investigate:
  - Marsh extent
  - Marsh condition
  - Urban development
Community Concerns

- Pollution
- Trash Dumping
- Water Quality
- Turbidity
- Marsh Extent
- Urbanization
- Ecological Diversity
- Economic Cost
The study area included Mobile and Baldwin Counties, located in Coastal Alabama.

- Study Period: Jan 1987-May 2016
- Forecast models and maps through 2030
NASA Satellites and Sensors Used

Landsat 5 - TM

Landsat 7 – ETM+

Landsat 8 - OLI

AQUA - MODIS

TERRA - MODIS
Methodology: Marsh Extent Analysis

- Landsat's 5, 7 and 8 images from 1987-2016, once every 5 years
- Stack of 4 images each year (12 band composite)
- Calculated reflectance at the top of the atmosphere
  - Segmented Images
- Used segments to create training samples
Methodology: Marsh Extent Analysis

- Applied Preexisting Land Cover Map
- Masked out everything but the marshes
- Calculated area of marshes for each year

Image Credit: Mobile Bay Eco Forecasting II Team
Reference: Ellis et. al. 2009, NASA ROSES GOMI project
Results: Marsh Extent

- Marsh extent increasingly changed from 1987 to 2001
- Between 2001 and 2006, extent has dropped significantly
- Conservation efforts &/or natural regeneration

Image Credit: Mobile Bay Eco Forecasting II Team
Reference: Preexisting Land Cover Maps from NASA ROSES GOMI
Methodology: Urban Development

Methods and Software

- Normalized Difference Impervious Surface Index (NDISI) (Xu 2010)
- NOAA Impervious Surface Analysis Tool (ISAT)
- Top of atmosphere reflectance

Data

- 2015 Landsat 8 Images
- NOAA Coastal Change Analysis Program (C-CAP) (2001-2011)
- National Land Cover Databases (NLCD 2001-2011)
- ISAT: C-CAP, NLCD, and HUC-12 watershed shapefiles to estimate risk, percent imperviousness, and impervious surface area

NDISI Formula:

\[
\text{TIR} - \frac{\text{VIS} + \text{NIR} + \text{SWIR}}{3} \\
\text{TIR} + \frac{\text{VIS} + \text{NIR} - \text{SWIR}}{3}
\]

Analysis

- Impervious Surfaces 2015
- Relative Amount
  - High: 1.00
  - Low: 0.16

Image Credit: Mobile Bay Eco Forecasting II Team
Results: Urban Development

- Impervious surfaces increased by over 24% in priority watersheds from 2001-2011
- Addition of 2000+ acres of impervious surfaces 2001-2011
- Average growth of +2.4 percent each year
- Seven watersheds exceed 10% surface imperviousness including four priority watersheds
- Additional eight watersheds fall into 5-10% warning category
- Many of these watersheds contain marshes

Image Credit: Mobile Bay Eco Forecasting II Team
Results: Urban Development

Percent Imperviousness

Average

- 0.00 - 5.00
- 5.01 - 10.00
- 10.01 - 25.00

Impervious Change
Value
- High : 1
- Low : 0

Image Credit: Mobile Bay Eco Forecasting II Team
Reference: NASA ROSES GOMI Project
Datasets

- 8-Day MODIS Composite NDVI Images from the USDA Forest Service ForWarn Dataset from 2000 to 2014

Software and Manipulation

- ArcGIS and model builder
- Microsoft Excel

Analysis

- Maps and excel time series plots displaying the diversity of health trends in the study area
NDVI was selected because it is correlated with chlorophyll content in the leaves of plants.

This detects seasonality in plant types as well as significant change in biodiversity and leaf coverage.

Works by comparing the amount of near infrared light reflected from each pixel to the amount of red light reflected.
Methodology: Marsh Health Trends

- Marsh health trends were generated using the model pictured at left.
- This model created graphs in Microsoft Excel and maps to spatially analyze relative trends.
- Percent maximum was used to account for different plant species.

Image Credit: Mobile Bay Eco Forecasting II Team
Results: Marsh Health

- These differences in vegetation can be seen in the health patterns.
- Trend lines were also drawn, indicating a downward trend in both palustrine and estuarine wetlands, with the palustrine health declining faster than the estuarine.
Other interesting features can be determined from the trends, such as hurricanes, droughts, and harsh winters.

Little Lagoon was hit directly by Hurricane Ivan in 2004 and then a drought two years later in 2006, significantly affecting the health of the area.
Results: Marsh Health

These trends can help to pinpoint areas in need of restoration following significant stressing events.

Image Credit: Mobile Bay Eco Forecasting II Team
Conclusions

- Impervious surface areas are increasing in priority watersheds
- Marsh extent declined during study period but there is evidence of recovery
- Some hurricane impacted marsh still have lower NDVI compared to pre-storm greenness levels
- Health trends seem to be most impacted by weather conditions and urbanization
Error Sources and Uncertainties

- Spatial and temporal resolution
- In situ monitoring
- Ground truth validation
- Atmospheric correction
- Cloud removal
- Processing time

Image Credit: Mobile Bay Eco Forecasting II Team
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