GIS modeling of ecosystem services to evaluate climate-induced impacts

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In the Beginning

TNC and Resiliency – 2011

- Identified need to develop tools for policy makers allowing them to incorporate future SLR into decision making
- Design analyses to assess the potential impacts of SLR on coastal habitats and communities
- Focus on natural habitats and the ecosystem services they provide
- Produce a set of conservation/resiliency indices and ecosystem service models for planning and resource management
- Provide open access to the tools and results through online data portals and visualization applications
Collaboratively Designed

- TNC, local government, planners, resource managers and stakeholder input
- Scoping processes identified four initial questions to address during analyses:
  1. What are the potential impacts of a 1 meter sea level rise to marshes in the study area?
  2. Which communities are potentially most at risk to hurricane storm surge, and how might sea-level rise increase that risk?
  3. Which communities might be most or least resilient to these future changes?
  4. How might SLR impacts and future marsh habitat distribution inform land acquisition and habitat conservation planning?

- Incorporate ecosystem service models to quantify ($) potential impacts
Conservation and Resiliency Analyses

- Series of inter-connected analyses to assess SLR and storm surge impacts which include:
  1. Marsh Viability
  2. Community Risk
  3. Community Resiliency
  4. Marsh Conservation and Management

- Ecosystem Services Modeling – Natural Capital Project (NATCAP) InVest Models
  - Carbon Storage / Sequestration
  - Fisheries
  - Coastal Protection
  - Biodiversity
The Puzzle

Conservation and Resiliency Assessment Framework

Present and Future Scenarios

**HABITAT**
- Identify and map coastal habitats that benefit human communities

**COMMUNITY**
- Identify risk of SLR and Storm Surge on coastal communities

**CONSERVATION**
- Identify conservation and management options

**INDICATORS**
- Marsh gain, loss and persistence (VIABILITY)
- Ecological Indicators (RISK)
- Socioeconomic Indicators (RESILIENCY)
- Future Marsh Priority Areas (MANAGEMENT)

**ECOSYSTEM SERVICES**

- SLAMM (Sea Level Affecting Marshes Model)
- ADCIRC (Advanced Circulation Model)

Existing Management Areas
**Spatial Model Inputs – SLR and SS Scenarios**

- Sea-Level Affecting Marsh Model (SLAMM)
- ADvanced CIRCulation Model (ADCIRC)
Marsh Viability Analyses

1. Extract salt marsh land cover classes from SLAMM scenarios
2. Delineate individual marsh complexes
3. Map advancement zones and calculate change in distribution
4. Classify marsh loss/gain/persistence to illustrate potential marsh viability

Marsh Viability Index
Marsh and Block Group scales
Community Risk Analysis

1. Calculate % area of Block Group Inundated and create raster maps
2. Social Vulnerability Index (SoVI)
3. Classify block groups by % of area inundated
4. Classify Block Group by SoVI index
5. Community Risk Index

Corpus Christi Bay, Texas
Community Resiliency Analysis

Community Resilience Index
Block Group scales

http://SLRportal.org
Marsh Conservation and Management

- Future Marsh Advancement
- Existing marsh footprint
- Existing Marsh management

Long-Term Marsh Management
Ecosystem Services

TNC Texas and Ecosystem Services

- Identified need to incorporate ecosystem services into conservation and restoration

- Healthy and intact ecosystems provide valuable services to society but most lack a formal market for evaluation of their services

- Ecosystem services are the benefits provided by nature to society. Examples include:
  - Carbon sequestration
  - Coastal protection
  - Habitat for fish and wildlife
  - Water filtration
  - Recreation – and more…

[Diagram showing habitat services with corresponding benefits]
TNC and the Natural Capital Project

TNC partnered with organizations and scientists from around the country to develop ecosystem service models

- Stanford University
- University of Minnesota
- World Wildlife Fund
- And collaborators..

InVest Models

- GIS - Spatial models to evaluate a range of ecosystem services
- Open access and user friendly
- Scenario-based (future impacts)
Fisheries Model — Galveston Bay Region, Texas

- **Species**
  - Blue Crab
  - Southern Flounder
  - Brown Shrimp
  - Red Drum

- **Marsh Edge**

- **Marsh Volume**
Carbon Sequestration – Galveston Bay region, Texas
The Complete Picture

Toolkit for Planning and Management

http://SLRportal.org
Sea-Level Rise
Research and Scenarios for a Changing Coast

Coastal Resilience
Decision Support Tool

http://maps.coastalresilience.org/gulfmex/

www.sealevelrise.org
www.slrportal.org
Valuing nature

The Nature Conservancy
Investing in our Future — Nature’s Way

Questions????

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