Mapping Ecosystem Services of the Coastal Environment

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2008: Using Science for Decision Making in Dynamic Systems

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Ecosystem services: **definition**

“The benefits people obtain from ecosystems”

**Scientific definition:** “conditions and processes through which natural ecosystems, and species that make them up, sustain and fulfill human life” (Daily 1997)
Ecosystem services: classification

“The benefits people obtain from ecosystems”

- Nutrient cycling
- Net primary production
- Pollination & seed dispersal
- Habitat
- Hydrological cycle
- Soil formation

- Gas regulation
- Climate regulation
- Disturbance regulation
- Biological regulation
- Water regulation
- Soil retention
- Waste regulation
- Nutrient regulation

- Supportive
- Regulating

- Recreation
- Aesthetic
- Science & education
- Spiritual & holistic

- Water supply
- Food
- Raw materials
- Genetic resources
- Medicinal resources
- Ornamental resources

Source: Millennium Ecosystem Assessment 2005
Ecosystem services: framework

GOVERNANCE

ECOSYSTEM-BASED MANAGEMENT

Ecosystem Services

Provision

Flow

Benefit

VALUE

Monetary  Non-monetary

Modified from: Turner et al., 2008
Ecosystem services: \textit{aspects for mapping}

**SOCIAL – ECOLOGICAL SYSTEM**

**Natural infrastructure**

- Biophysical infrastructure
  - Components
  - Structure
  - Function
- Efficiency/productivity
- Health
- Resilience
- Spatial dynamics \((\text{of provisioning})\)
- …

**Interaction**

- Threats
  - Natural drivers
  - Human drivers
- Intermediate, final joint products
- …

**Ecosystem Services**

**Provision**

**Flow**

**Benefit**

**Well-being**

- Consumed
  - Directly
  - Indirectly
- Realized
  - Objectively
  - Subjectively
- Excludability
- Rivalness
- Marketed/non-marketed
- …
Ecosystem services: services of the coastal zone (1978-2008)

<table>
<thead>
<tr>
<th>Ecosystem Services</th>
<th>Supportive functions and structures</th>
<th>Regulating services</th>
<th>Provisioning services</th>
<th>Cultural services</th>
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<tbody>
<tr>
<td></td>
<td>Nutrient cycling</td>
<td>Water supply</td>
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<td>Net primary production*</td>
<td>Food</td>
<td>Aesthetic</td>
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<td>Pollination &amp; seed dispersal</td>
<td>Raw materials</td>
<td>Science &amp; education*</td>
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<td>Habitat</td>
<td>Genetic resources*</td>
<td>Spiritual &amp; holistic*</td>
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<td>Hydrological cycle*</td>
<td>Ornamental resources*</td>
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<td>Soil formation*</td>
<td>Medicinal resources*</td>
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<td>Soil regulation</td>
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<td>Disturbance regulation</td>
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<td>Biological regulation</td>
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<td>Saltwater</td>
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<td>Data</td>
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<td>Mangrove</td>
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<td>Seagrass</td>
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<td>Oyster reef</td>
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<td>Tidal/floodplain</td>
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<td>Rockery</td>
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<td>Barrier island</td>
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<td>Beach</td>
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<td>Shelf</td>
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</tbody>
</table>

Notes:
- ES classification according to Millennium Ecosystem Assessment 2005; ** ES class new from MEA to Costanza et al. 1997
- Blanks indicate no data available
Ecosystem services: Texas Coastal bend case study
Ecosystem services: provided by wetlands

Wetlands: definition and classification

Definition: “lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water” (Cowardin et al. 1979)

Type of wetlands: marine, estuarine, riverine, lacustrine, palustrine

Characteristics of wetlands: biological, physical, chemical (e.g., species present substrate properties, hydrology, size, shape)

Benefits provided:
• Hydrological services (e.g., water regulation)
• Biogeochemical services (e.g., nutrient regulation)
• Ecological services (e.g., habitat)
Natural infrastructure: “bundle” mapping

<table>
<thead>
<tr>
<th>LULC</th>
<th>Area (ha)</th>
<th>%</th>
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<tbody>
<tr>
<td>Developed</td>
<td>45,639.45</td>
<td>5.4</td>
</tr>
<tr>
<td>Cultivated</td>
<td>276,504.48</td>
<td>32.5</td>
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<tr>
<td>Pasture/hay</td>
<td>81,464.58</td>
<td>9.6</td>
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<tr>
<td>Grassland</td>
<td>37,454.04</td>
<td>4.4</td>
</tr>
<tr>
<td>Forest</td>
<td>24,731.19</td>
<td>2.9</td>
</tr>
<tr>
<td>Scrub/Shrub</td>
<td>115,012.26</td>
<td>13.5</td>
</tr>
<tr>
<td>Palustrine wetland</td>
<td>44,560.44</td>
<td>5.2</td>
</tr>
<tr>
<td>Estuarine wetland</td>
<td>30,158.46</td>
<td>3.5</td>
</tr>
<tr>
<td>Unconsolidated Shore</td>
<td>12,005.73</td>
<td>1.4</td>
</tr>
<tr>
<td>Bare Land</td>
<td>3,769.65</td>
<td>0.4</td>
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<tr>
<td>Water</td>
<td>178,604.28</td>
<td>21.0</td>
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<tr>
<td>Palustrine Aquatic Bed</td>
<td>344.70</td>
<td>0.0</td>
</tr>
<tr>
<td>Estuarine Aquatic Bed</td>
<td>1,059.66</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>851,308.92</td>
<td>100</td>
</tr>
</tbody>
</table>

Data source: NOAA 2005
Natural infrastructure: structure mapping

Cowardin et al. 1979 system:
System
Subsystem (hydro conditions)
Class (veg and substrate)
Subclass (type of)
Modifier (water regime)

Spatial dynamics: in situ, omnidirectional, directional
Ecosystem services: provision example

Natural infrastructure: structure mapping (cont.)

Spatial dynamics: in situ, omnidirectional, directional

Data source: CBBEP 2008
Anthropogenic drivers of state: human footprint
Ecosystem services: benefit example

Service complexity: realized objectively or subjectively?
Ecosystem services: governance

Governance overlap: Federal - State - Local

Legend
- County
- Municipality
- Urbanized area
- Coastal zone

Basin
- 17
- 18
- 19
- 20
- 21
- 22
- HUC
- Bay system

TEXAS

Gulf of Mexico
Ecosystem services: governance

Management units: submerged land
If GOAL = effective, fair and sustainable ecosystem services provision

Challenges:

• Data availability and quality (biophysical and function)
• Models of provisioning → benefits
• Ecosystem services terminology consistency (ontology)
• Dynamic mapping (changes in condition, flow, welfare)

Future research work:

• Identification of “essential infrastructure” of ecosystems
• Implementation of conservation and restoration actions
• Design of “payment for ecosystem services”
Thanks to:

- Contributors: Ali McKenzie, Noel Esquivel, Carlota Santos
- Data providers: CBBEP, BEG, TGLO, TNRIS, NOAA, TCEQ, TPWD, USGS

Thank you

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