Wetland Restoration and Floodplain Management

Making the Case for Integration

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Wetlands & Floodplains

Approximately 80% of wetlands are located in floodplains.
Wetlands & Climate Change
Change in Precipitation in the United States, 1901–2014

*Alaska data start in 1925.


For more information, visit U.S. EPA’s "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.
State Wetland Program Engagement in Wetland-Flood/Hazard Mitigation Integration Efforts

- States engaged in formal integration (25 states)
- States engaged in informal integration (4 states)
- Developing integrative activities (1 states)
- No integration reported (10 states)
- Unknown/No data available (10 states)

- Link to Individual State Summaries (http://www.aswm.org/wetland-programs/state-wetland-programs)
Clockwise from top left: Landscaping plan for stormwater wetland in Blue Heron Park; elevation of typical stone faced headwall; cross section through stormwater wetland shows landscaping and vegetation details | Images courtesy of NYC DEP
ESV: A Decision-Making Tool
Functions, Goods, Services, Benefits...What??

Source: Earth Economics
Ecosystem Benefit Valuation Process

1. Identify the Context
2. Define the Boundaries
3. Identify Stakeholders
4. Develop Functional Analysis & Baseline
5. Perform an Ecosystem Benefit Valuation
6. Develop a Trade-off Analysis
7. Communicate Results
ECOSYSTEM BENEFIT VALUATION METHODS

- Market Based
  - Market price method
  - Productivity method
- Revealed Preference
  - Avoided cost
  - Substitution/Replacement
  - Travel cost
  - Hedonic pricing
- Stated Preference
  - Contingent valuation
  - Conjoint Analysis
- Benefit Transfer
Study: The Value of Wetlands in Protecting Southeast Louisiana from Hurricane Storm Surges (by, Edward B. Barbier, Ionnis Y. Georgiou, Brian Enchelmeyer, and Denise J. Reed), 2013.

Objective: To estimate the storm protection benefits of wetlands to southeastern Louisiana.

Valuation Method Used: Damage Cost Avoided
Southeast Louisiana

Results of hurricane storm surge simulations were combined with an economic analysis of the expected damage to residential properties from storm surge floods across 312 potentially affected sub-planning units across 15 Southeastern Louisiana parishes.
# Southeast Louisiana Study Findings

## Estimated storm surge impacts & marginal values of changes in wetland continuity ($W_L$) and roughness ($W_R$)

<table>
<thead>
<tr>
<th>Estimated wetland impacts on attenuating maximum storm surge levels</th>
<th>Estimated marginal values of wetlands in terms of avoiding damages to residential property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in storm surge</td>
<td>Marginal value</td>
</tr>
<tr>
<td>1% change in $W_L$ per segment</td>
<td>- 8.4% to – 11.2%</td>
</tr>
<tr>
<td>1% change in $W_R$ per segment</td>
<td>- 15.4% to – 28.1%</td>
</tr>
<tr>
<td>9.4 to 12.6 km change in $W_A$</td>
<td>- 1m</td>
</tr>
</tbody>
</table>

*Each segment has an average length of 6km*
**Study:** Economic Valuation Of Wetland Ecosystem Services In Delaware (prepared for the DDNREC by Industrial Economics, Inc.), 2011.

**Objective:**
To analyze the value of the changes in ecosystem services that would happen as a result of continued trends in wetland loss in Delaware, i.e., the “net loss.”

**Valuation Methods Used:**
Avoided/Damage Costs & Replacement/Substitution Costs
Delaware: continued

Process:

- DNREC developed enhanced NWI+ maps to establish a baseline scenario
- They created a future scenario by applying data on historic trends
- They used the InVEST model to estimate values in relation to spatial attributes
Delaware Findings

- **Inland Flood Control:** Resulted in increased flood heights (variable across Red Clay Creek).
  - Economic value: $720 - $21,200 in present value ($57 - $1,690 annualized)

- **Coastal Storm Protection:** Resulted in increased flood heights (variable across the landscape statewide) damaging residential units.
  - Economic value: $47,600 - $301,000 in present value ($3,790 – $23,900 annualized)

- **Water Purification:** 1.2% increase in nitrogen, 0.9% increase in phosphorous and 1.3% increase in sediment delivered to waterways
  - Economic value (based on municipal water treatment costs): $9,670,000 in present value ($770,000 annualized)
Available Tools

A COMPARATIVE ANALYSIS OF ECOSYSTEM SERVICE VALUATION DECISION SUPPORT TOOLS FOR WETLAND RESTORATION

Prepared for the Association of State Wetland Managers
By Mark Healy and Dr. Silvia Secchi
Southern Illinois University

InVEST
Integrated Valuation of Ecosystem Services and Tradeoffs

Description
- Collection of models intended for the valuation and mapping of terrestrial, wetland, and aquatic ecosystem services
- Developed to facilitate incorporation of natural capital into development and conservation decision-making

Target Users
Governments, non-profits, international lending institutions, corporations

Ecosystem Service Models
- carbon
- coastal blue carbon
- coastal protection
- habitat quality
- habitat risk assessment
- recreation
- scenic quality
- sediment retention
- water purification

Background/Methodology
The suite of models is offered to accomplish Natural Capital Project’s threefold resolution to: (1) provide evidence for the viability of incorporating natural capital into decision-making, (2) offer replicable methods or tools (i.e., InVEST) for widespread use, and (3) disseminate the methodology and capacity building.

The ecosystem service models may be applied individually or in an integrated manner to quantify the value of ecosystem services in economic and biophysical units. InVEST is able to conduct static and dynamic assessments and is useful for the analysis of tradeoffs in forecasted development and land-use change scenarios.

Development Outlook
InVEST 1.0.0 (Beta) offers 6 ecosystem service models. Today, version 3.0.0 offers 15 functional models, some of which have been continually refined and updated. Initially, InVEST models were developed to work with ArcGIS software. Currently, nearly all models are offered in standalone configurations for Windows operating environments. Many supporting tools aimed at simplify user application have been developed and are currently offered under an experimental platform.

References and Additional Resources
Web Page: http://www.naturalcapitalproject.org/invest/
Multimedia:
- NOVA article: http://www.npr.org/2014/02/07/301003125/the-power-of-wetlands
- Stanford University Online Course, Intro to the Natural Capital Project Approach: http://noia131.classroom.stanford.edu

General Information
Collaborator(s):
- Natural Capital Project
- Stanford University
- The Nature Conservancy
- World Wildlife Fund

Version: 3.2.0 (2016)

Availability: Free and open-source
Interface: Desktop application
Python application program interface (API) is facilitated but optional (API documentation)

Analysis scale: Local to Global
The appropriate scale is largely contingent on the resolution of user-supplied data. Use of analytic and ecosystem service(s) addressed. Nevertheless, InVEST maintains the capacity for multi-scale analysis

Analysis type: Quantitative

Data input demand: Moderate to High
Higher (economic valuation) is desired; there is variation between existing models (see matrix)

Valuation units: Monetary/Nonmonetary

Cartographic output: Yes

Tool requirements:
- Internet connection is needed to run external models.
- GIS software is required to view results (as well as pre-processing if needed)
- “The Coastal Protection” toolkit requires ArcGIS.

Time requirements: Low to High
There is variation between existing models, many models may require considerable time for data preparation, yet most models require a short time to run if data is readily available

Skill requirements: Moderate to High
- moderate to advanced scientific expertise
- GIS proficiency
- Sampling proficiency (optional)

User support: High
NetGal offers thorough training, forums, and various training programs

Cost: Low to High
Cost is related to the person-hours allocated to the assessment
Best Practice Recommendations

• Include Threshold Effects
• Consider Bundling Benefits
• Avoid Double Counting
• Account for Diverse Values
• Plan for Monitoring & Adaptive Management
• Provide a High & Low Range of Values
• Clearly and Transparently Communicate Assumptions, Uncertainties and Findings
Summary – Use a Watershed Approach
QUESTIONS/DISCUSSION

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