Integrating Biophysical and Economic Values of Wetlands: Recent Advances in Ecosystem Service Valuation

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Background/Problem Statement

- Complex systems
- Big problems, "wicked" problems (Lambert et al. 2011)
- Importance of getting the numbers (about) right – it's impossible to manage what we do not value (Sukhdev 2008)

"**Some problems are so complex that you have to be highly intelligent and well informed just to be undecided about them**." --Laurence J. Peter, Peter's Almanac (Peter 1982)

Transdisciplinary Research

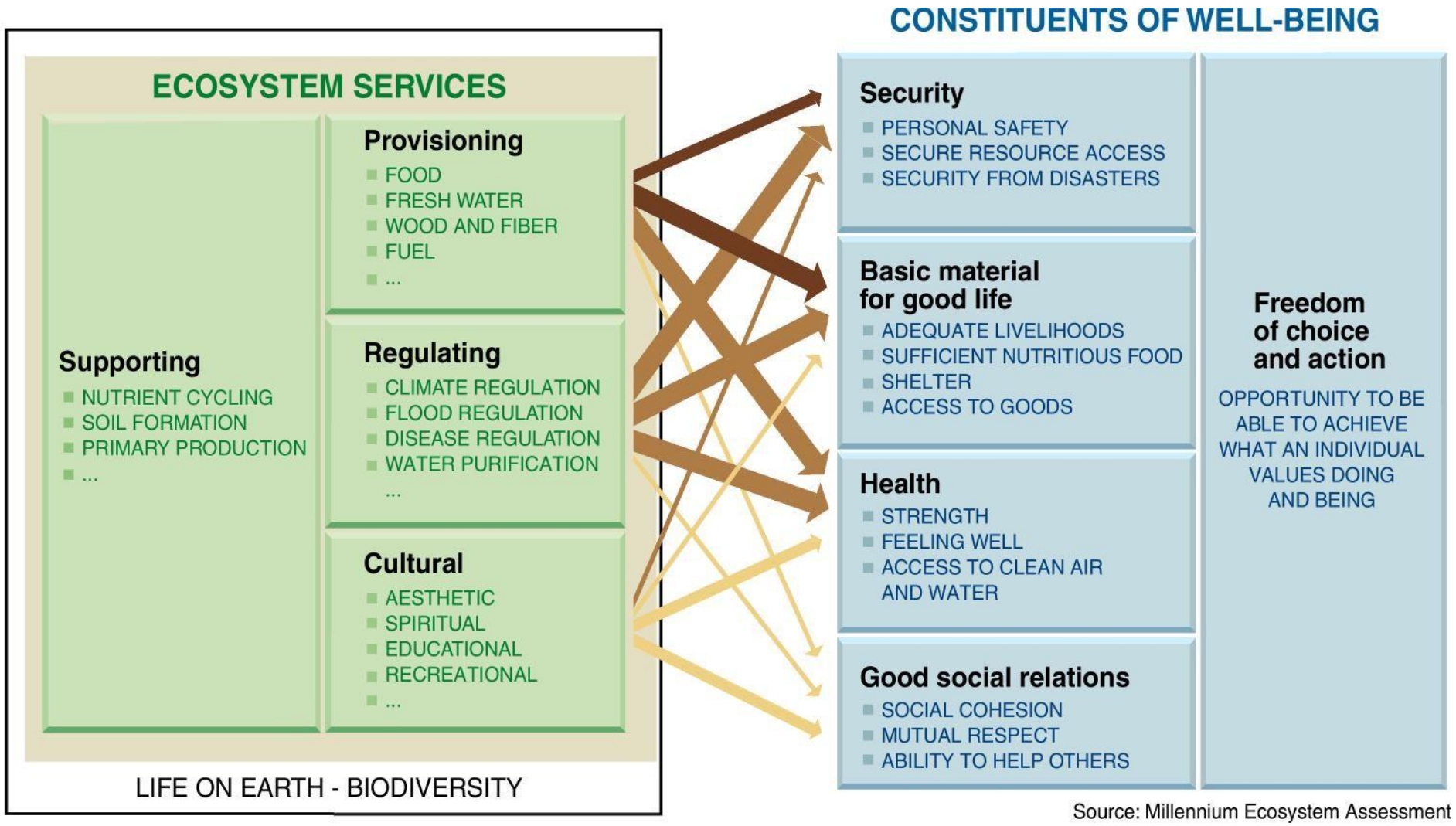
- Need inter- and/or trans-disciplinary approach
  - Multidicsiplinarity: Researchers from different disciplines separately address a problem and then combine results
  - Interdisciplinarity: From the start, researchers jointly address the problem and work to reduce disciplinary boundaries and reduce language barrier (e.g., Bingham et al. 1995)
  - Transdisciplinarity: Researchers jointly develop and use a shared conceptual framework that synthesizes and extends discipline-specific theories, concepts and methods; Create new models and language (Stokols et al. 2008)
    - Let the problem determine the tools used rather than the tools determine the problem studied

Need for Transdisciplinarity

- "…not one 'correct' set of concepts of techniques… need for conceptual pluralism and thinking 'outside the box'" (Farber et al. 2002: 390)
- "Economists and ecologists should work together from the beginning to ensure that the ecological and economic models can be appropriately linked (i.e., the output from ecological modeling is in a form that can be used as an input into economic analysis). This requires that ecosystem impacts be expressed in terms of changes in the ecosystem goods and services that people value." (US NRC 2005: 257)

Challenges of modeling and valuing ecosystem services

- “Ecosystem services” (Ehrlich and Ehrlich 1981)
- Millennium Ecosystem Assessment (2005)
  - Switch focus from ecological processes/function to the services
  - Ecosystem services approach (provisioning, regulating, supporting, and cultural)
  - Ecosystems, ecosystem services, and human well-being linked
  - Provision of ecosystem services is not often factored into important decisions that affect ecosystems
  - Distortions in decision-making damage the provision of ecosystem services making human society and the environment poorer
- We lack practical suggestions for implementing the conceptual ideas for improving ecosystems research
  - Progress largely at conceptual and philosophical level (ecological economics) (Spash 2012)



Source: Millennium Ecosystem Assessment

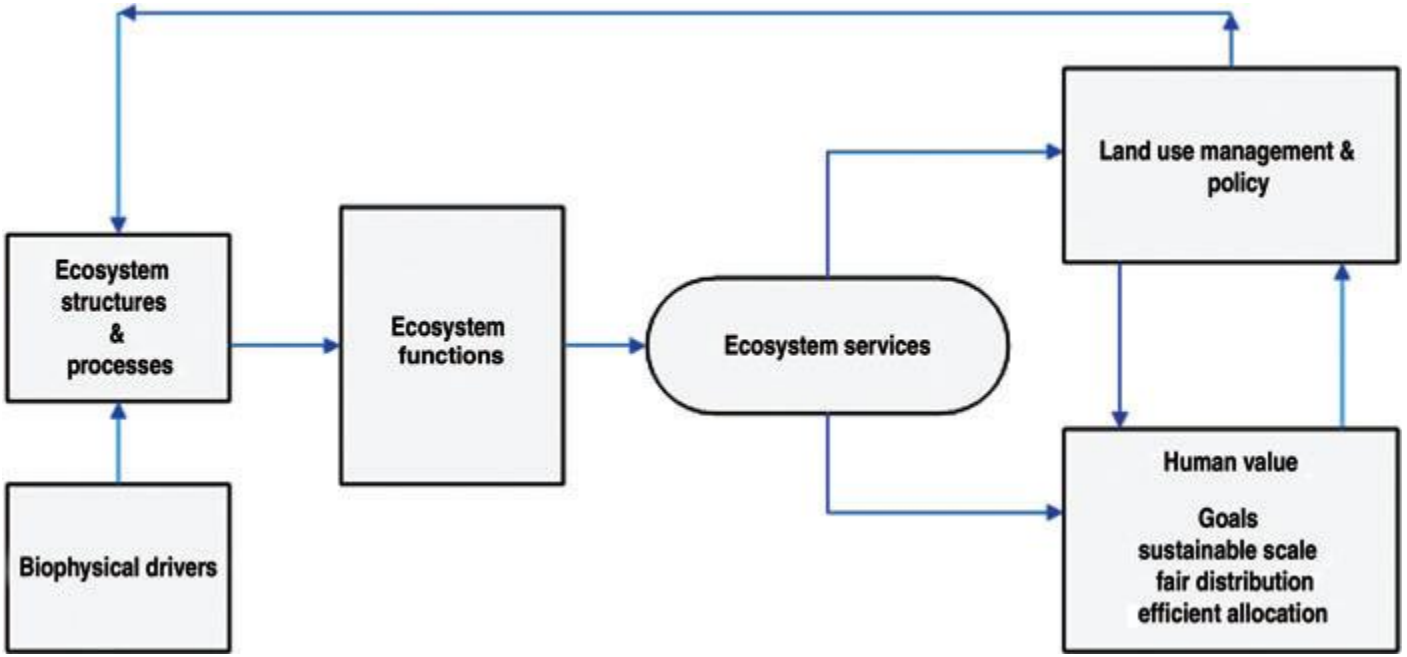
ARROW'S COLOR
Potential for mediation by socioeconomic factors

- Low
- Medium
- High

ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being

- Weak
- Medium
- Strong

Ecosystem Services Valuation Framework



Liu et al. 2010 (adapted from de Groot et al. 2002)

Goal-Value Connection

- Anthropogenic, monetary valuation
  - Not arguing to force all values into single economic indicator, but for recognition of multiple values and pluralistic discussion
- Three broad goals (Liu et al. 2010):
  1. Ecological sustainability
  2. Equity (within current generation and between current/future generations)
  3. Efficiency, as constrained by (1) and (2)
- Insufficiency of (3) → insufficiency of neoclassical economics, need for transdisciplinary approach

Valuation Approaches

- Monitizing assessment (Farber et al. 2002)
  - Revealed-preference (e.g., market, travel cost, production, hedonic)
  - Stated-preference (e.g., contingent valuation, conjoint choice)
  - Cost-based (e.g., replacement, avoidance) ← strong role of ecologists
  - Benefit transfer
- Non-monetizing assessment (US EPA 2009)
  - Civic valuation (e.g., citizen juries; discourse-based; deliberative democracy [Howarth & Wilson 2006; Wilson and Howarth 2002])
  - Biophysical ranking methods ← Emergy?
  - Ecosystem benefit indicators
  - Measures of attitudes and preferences
  - Decision science (e.g., multiple criteria analysis)
  - Subjective happiness metrics (Welsch & Kuhling 2009)

Major Challenges of Ecosystem Service Valuation

- Ecology: quantities/qualities of ecosystem services
  - Ecological production function (quantity/quality of services)
  - How are services produced, changed?
- Economics: values of ecosystem services
  - Appropriate and reliable methods
  - Total or marginal values
  - Apply value (as WTA or WTP) to the change using a suitable method
  - Example: Coastal wetlands as breeding and nursery grounds for fish
    - Production function approach: estimate increased fishery productivity due to wetlands
    - Value of fishery productivity: for commercial fishery it is the change in profit plus consumer surplus with increased productivity
    - Question: If the prices of fish or associated profits are low, does that mean that wetlands aren't valuable?

Major Challenges of Ecosystem Service Valuation, cont'd

- Linking ecology and economics
  - Analytically difficult to link economic and ecological processes
    - Ecologists focus on changes to structure, processes
    - Complexity – limits of science
  - Need accurate estimates of ecological responses of ecosystem services to anthropogenic changes
  - Economic studies typically use highly simplified ecological models
- Ecosystems produce multiple ecosystem services
  - Services are closely interconnected
  - Interconnections make it difficult to analyze one service in isolation
- Policy choices may involve tradeoff among services
  - Limits application of single-service study
  - Danger of mistaking single service value for the value of the entire ecosystem
- A complete accounting would be "correct" but virtually impossible with current (or near-term) methods

Specific Recommendations

1. Biophysical realism of ecosystem service models
2. Assess trade-offs of ecosystem services under competing policies
3. Consider off-site effects (of political decisions)
4. Include comprehensive stakeholder involvement to ensure feasibility of management options

Liu et al. 2011

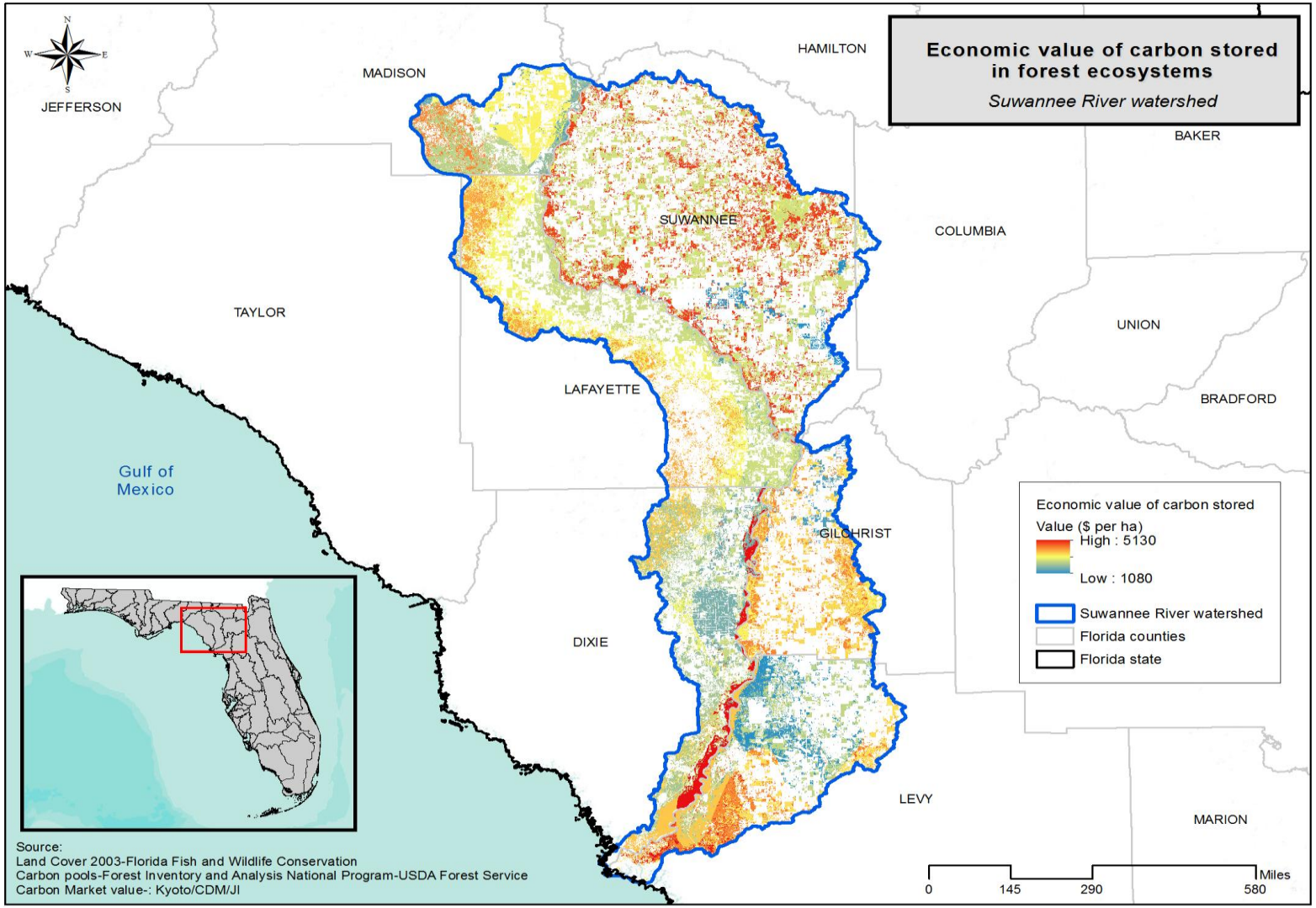
Need for Holistic Approach

- Most effort on valuing recreation benefits (35%) or preferences for water quality change (18%); very little emphasis on most supporting and regulating services (Liu et al. 2010)
- "…fundamental challenge… providing an explicit description and adequate assessment of the links between the structure and functions of natural systems, the benefits (i.e., goods and services) derived by humanity, and their subsequent values" (US NRC 2005: 2)
- Valuation research needs to be more problem- than tool-driven (Hahn 2000)

Recent Advances – Holistic Studies

- Need holistic studies (ecological functions, ecosystem services, social/human welfare, land-use decisions, dynamic feedback) (Turner et al. 2003)
  - Valuing the Arc (http://valuingthearc.org/) – 5-yr study (2007-2011) to assess ecosystem services from Eastern Arc Mountains, Tanzania
  - Natural Capital Project (http://www.naturalcapitalproject.org/) and InVEST
  - MIMES (multiscale intergrated models of ecosystem services) (http://www.uvm.edu/giee/mimes/)
    - Spatially-explicit dynamic modeling, open source
    - E.g., NJ's natural capital worth up to $19.6bn/yr (Liu et al. 2010)

Mapping Ecosystem Services: Suwannee River InVEST example



Note: Integrated Valuation of Environmental Services and Tradeoffs (InVEST) output using FFWCC 2003 Land Cover GIS data at 30m resolution; Assumes $13.60/tCO2e for Certified Emissions Reductions; Includes total carbon stored (Mg/ha), carbon aboveground (Mg/ha), carbon belowground (Mg/ha), carbon soil (Mg/ha), and carbon dead (Mg/ha) from USDA Forest Inventory and Analysis national program data; Source: Delphin, Escobedo, Adams, et al. unpublished.

Recent Advances – Holistic Studies

- PINEMAP (Martin, Peter, Monroe, Adams, et al.; 2011-2016; http://pinemap.org/)
  - Water (WaSSI-C hydrologic process model)
  - Carbon (e.g., FIA data)
  - Timber production (3PG at stand level, SRTS at regional level)
  - Climate (downscaled CC predictions)
  - Life cycle analysis (CORRIM)
  - Bioeconomic model w/ benefit transfer
  - WTA land management

Conclusion / Take home message

- Making strides
- Fertile areas for a coordinated approach