Millennium Ecosystem Assessment
http://www.MAweb.org

Ecosystem Services in the
Millennium Ecosystem Assessment

Steve Carpenter
srcarpen@wisc.edu

Topics for the Talk:

Global change is fast and multifaceted
Organization of the Millennium Ecosystem Assessment (MA)
Ecosystem Services and the Conceptual Framework of MA
Selected Findings of MA
What Can We Do About It?
Key Research Needs for Ecosystem Services

Redrawn from Evans, 1998, Feeding the Ten Billion, Cambridge Univ. Press.

[Graph showing trends in arable area, irrigated area, fertilizer use, and cereal yield over time]
More land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850.

Cultivated Systems in 2000 cover 25% of Earth’s terrestrial surface (Defined as areas where at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture)

Conversion of Land for Human Use

- 5-10% of the area of five biomes was converted between 1950 and 1990
- More than two thirds of the area of two biomes and more than half of the area of four others had been converted by 1990

Water Withdrawals Doubled Between 1960 and 2000

- Intercepted Continental Runoff: 3-6 times as much water in reservoirs as in natural rivers
  (Data from a subset of large reservoirs totaling ~65% of the global total storage)
Since 1960:
- Flows of biologically available nitrogen in terrestrial ecosystems doubled
- Flows of phosphorus tripled

> 50% of all the synthetic nitrogen fertilizer ever used has been used since 1985

>60% of the increase in the atmospheric concentration of CO₂ since 1750 has taken place since 1959

Human-produced Reactive Nitrogen
Humans produce as much biologically available N as all natural pathways and this may grow a further 65% by 2050

Changes in Biogeochemical Cycles

Conditions & Trends: Selected Findings
Nutrient mobilization (N & P) is a global syndrome. Consequences: degradation of freshwater and coastal oceans, harmful algal blooms, human health effects, and others
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Millennium Ecosystem Assessment
• Experts and Review Process
  – Prepared by 1360 experts from 95 countries
  – 80-person independent board of review editors
  – Review comments from 850 experts and governments
• Governance
  – Called for by UN Secretary General in 2000
  – Authorized by governments through 4 global conventions
    (C. on Biodiversity, C. to Combat Desertification, C. on Migratory Species, Ramsar C. on Wetlands)
  – Partnership of UN agencies, conventions, business, non-governmental organizations with a multi-stakeholder board of directors
  – Policy relevant, not policy prescriptive

Millennium Ecosystem Assessment
• Integrated Approach
  – All major sectors considered together
  – Comprehensive analysis of drivers of global change
  – Natural and social sciences, and humanities
  – Driven by questions from policymakers
• Completed in 2005
  – Global reports: Status & Trends, Scenarios, Response Options; plus Subglobal Assessments; Conceptual Framework
  – Synthesis reports (General; for each convention; for business)
  – Summaries for Decision Makers
  – Published free on the internet (http://www.MAweb.org), and in print by Island Press
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Ecosystem Services: Benefits people receive from nature

- Key Connections Involving Ecosystem Services
  - Intact ecosystems provide many benefits
  - Local and global connection

Ecosystem Services are Linked to Human Well-Being

- Human well-being: A holistic concept
  - Intrinsic, safety, security, freedom of choice, social cohesion
  - Life satisfaction and happiness

Key Research Needs for Ecosystem Services

- Integrated assessment
  - Linking services to values
  - Understanding human-ecosystem interactions
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Trends are Clear, But the Future is Not
Trends in Some Key Drivers:

| Constant population of impoverished people | Decline in the proportion of people living in poverty |
| Increasing wealth inequality among countries and among people | More people live in democratic or semi-democratic regimes |
| Only a few percent of people live outside their birth country | By 2007, urban population will equal rural population |
| Increase in fundamentalist religious values in some regions | Increase in post-materialistic values in some regions |
| Increasing frequency of natural disasters that affect >10^6 people | Decreasing frequency of armed conflict |

Kates & Parris, 2003 PNAS 100: 8062-8067;
Sarkees et al., 2003, International Studies Quarterly 47: 49-70
Improvements are possible by 2050

Education:
In the more favorable scenarios, global investment in education is increased to 13% of GDP, vs. 3.5% now.
In 2000, the number of people older than 60 was about the same as the number of people between 0 and 4.
In 2050, the number of people older than 60 will be 3.5 times larger than the number of people between 0 and 4 (UN median projection).
Education of women has strong inverse effect on fertility.
Innovation:

By 2030, the US will have rebuilt half of its built environment.

Source: Arthur C. Nelson, Brookings Institution
http://www.citymayors.com/development/built_environment_usa.html

Innovation:

Potential reductions of greenhouse emissions by 2030:

Source: Intergovernmental Panel on Climate Change, http://www.ipcc.ch/
Fourth Assessment Report, Fig. 4.2
**Imagination**

Example: scenario thinking to break gridlock.

- Arenas for playful, inventive thinking about the future, independent from pressure for formal decisions.
- Positive stories of what the future could be.
- Blunt warnings of dangerous paths.
- Shadow networks linking diverse groups, outside of formal politics.
- Diverse people thinking together about important questions.

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**Key Research Needs for Ecosystem Services**

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**Some Interactions of Ecosystem Services in the MA Scenarios**

Source: Rodriguez et al. (2006)

Interactions of Ecosystem Services

Current Conditions

PROVISIONING
- Food
- Freshwater Supply & Use
- Fuel

REGULATING
- Water, Flood, Drought regulation
- Erosion regulation, Water purification
- Climate regulation

CULTURAL
- Recreation, Ecotourism
- Cultural heritage, Sense of place

Positive interaction (line width indicates the strength of the interaction)

Interactions of Ecosystem Services

Add Corn Biofuel

PROVISIONING
- Food
- Freshwater Supply & Use
- Fuel

REGULATING
- Water, Flood, Drought regulation
- Erosion regulation, Water purification
- Climate regulation

CULTURAL
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Positive interaction (line width indicates the strength of the interaction)

Tradeoffs of Ecosystem Services Are the Norm.

Win-wins are rare.

Decision-makers often increase efficiency of provisioning ecosystem services, and conserve cultural ecosystem services, while degrading regulating ecosystem services.

Regulating ecosystem services are not often quantified in ways useful for decision making.

Economic tools exist to manage the tradeoffs, but data are often insufficient to use these tools.

Dynamics of Ecosystem Services Are Poorly Quantified.

Are some bundles of ecosystem services relatively stable, whereas other combinations of ecosystem services are unstable and transient. Spheres show bundles of ecosystem services that are relatively stable and persistent, separated by combinations of ecosystem services that are unstable and transient. This diagram is for a hypothetical region.
Synthesis of Key Research Needs for Ecosystem Services:

Improve data and models for effects of drivers on ecosystem services:
- Effects of climate, land use change, biodiversity etc.
- Management actions that can change ecosystem services

Improve measures of how ecosystem services affect human well-being

Improve data and models for flows of ecosystem services and tradeoffs among ecosystem services

Learn from existing management – better assessment

Improve monitoring


Summary

Ecosystem services interact closely with human action on ecosystems, and human well-being.

Most of earth’s ecosystem services are degrading, and drivers are likely to intensify for at least a few decades.

Known policies and practices can improve the condition and allocation of ecosystem services.

Provisioning and cultural ecosystem services are apparent to people and often institutions exist to manage them. Regulating ecosystem services are often hidden to the public and lack effective institutions for their management.

Lack of information on interactions and dynamics of ecosystem services is often a barrier to sustainable, equitable management.