Technology, Markets, and Ecosystem Services in Global Ecological Futures

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Millennium Ecosystem Assessment

Goal:

Assess the consequences of ecosystem change for human well-being

• What is the role of ecosystems in meeting development goals?
• How has ecological change affected human well-being?
• What ecological futures are plausible?
Human Wellbeing Increasing, but regional divergence

From Human Development Report 2005
Ecosystem Services:
The benefits people obtain from ecosystems

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<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
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<tbody>
<tr>
<td>Goods produced or provided by ecosystems</td>
<td>Benefits obtained from regulation of ecosystem processes</td>
<td>Non-material benefits obtained from ecosystems</td>
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<tr>
<td>• food</td>
<td>• climate regulation</td>
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<td>• fresh water</td>
<td>• disease regulation</td>
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<td>• fuel wood</td>
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Supporting

Services necessary for production of other ecosystem services.

• Soil formation
• Nutrient cycling
• Primary production
Changes to ecosystems have provided substantial benefits

- Food production more than doubled since 1960
- Food production per capita 40% increase
- Food price halved
- Pulp and paper production 3X increase
- Timber production increased more than 50%

Sources: FAOSTATS, SOFI, Millennium Ecosystem Assessment
Transformation of Earth’s Surface

25% of Earth’s terrestrial surface is *Cultivated*

Source: Millennium Ecosystem Assessment
Year of Peak Fish Harvest

Source: Millennium Ecosystem Assessment and Sea Around Us project
Human caused 6th Mass Extinction?

The distribution of species on earth is becoming more homogenous.

Genetic diversity, population size, range is currently declining for most species.

10–30% of mammal, bird, and amphibian species are currently threatened with extinction.

Source: Millennium Ecosystem Assessment
Estimated Areas of Strong Land Atmosphere Couplings

Land-atmosphere coupling strength (JJA), averaged across AGCMs

(Koster et al 2004)
Agricultural Modification of Water Vapour Flows

(Gordon et al. 2005)
Ecosystem transformation is often a net economic loss to society.

Value from managing ecosystems more sustainably is often higher than value from conversion.

But private benefits are often greater for the converted system.
Alternative Approaches to Environment & Development

- Order from Strength Preservation
- Adapting Mosaic Community Based Management
- Global Orchestration Poverty Alleviation
- Technogarden EcoEfficiency

Axes:
- Devolution
- Global Institutions
- Coordination

Quadrants:
- Reactive
- Ecological Governance
- Proactive
Scenario Storylines

– Global Orchestration: Globally connected society that focuses on global trade and economic liberalization and takes a reactive approach to ecosystem problems but that also takes strong steps to reduce poverty and inequality and to invest in public goods such as infrastructure and education.

– Order from Strength: Regionalized and fragmented world, concerned with security and protection, emphasizing primarily regional markets, paying little attention to public goods, and taking a reactive approach to ecosystem problems.
Scenario Storylines

– **Adapting Mosaic** Regional watershed-scale ecosystems are the focus of political and economic activity. Local institutions are strengthened and local ecosystem management strategies are common; societies develop a strongly proactive approach to the management of ecosystems.

– **TechnoGarden** Globally connected world relying strongly on environmentally sound technology, using highly managed, often engineered, ecosystems to deliver ecosystem services, and taking a proactive approach to the management of ecosystems in an effort to avoid problems.
Alternate Trends Strengthen or Weaken

- Devolution
- Global Institutions
- Coordination

- Today
- 2050

- Reactive
- Proactive

Ecological Governance
Economic Growth

1995
$29 trillion

Global Orchestration
(2050)
$180 trillion
6X
reactive,
globalized,
sustainable development

Order From Strength
(2050)
$94 trillion
3X
reactive,
devolution,
protection

Adapting Mosaic
(2050)
$123 trillion
4X
proactive,
devolution,
bioregionalism

TechnoGarden
(2050)
$149 trillion
5X
proactive,
global,
eco-efficiency

16X
5X
8X
11X

OECD
Asia (without Middle East)
Latin America
Other
% of Ecosystem Services
Declining or Increasing

Order from Strength:

Adapting Mosaic:

Global Orchestration:

Technogarden:
Vulnerability to Ecological Risks

A. Order from Strength
B. Global Orchestration
C. Adapting Mosaic
D. TechnoGarden

Event Size (Number of People Affected)

Footprint Governance Ecol Eng
Ecological Connections
Present Dilemmas

Food

Water

Vs.

Ag. Yield

Fertilizer use

Cost of Low Water Quality

P in Lake
Distant Ecosystem Service Tradeoff
Water Quality vs. Food Provisioning

Basin is 40% USA
Ag. Center
80% corn; ~80% soybeans

Mississippi Basin
Anoxia
Gulf of Mexico
Low Oxygen "Dead Zones" World Wide
Ecosystem Services Exist in Integrated Bundles
Need to Use Integrated Management to Reduce Tradeoffs
SUSTAINABILITY
Is all about learning
How to surf waves of change and persistence?

Nested adaptive cycles provide opportunities for renewal and novelty, within a resilient context.
Ecological Management Approaches

- Experimental management
- Exploratory Alternatives
- Developing
- Frontier
- Resilience Building

- Optimizing Command & Control
- Controllable
- Uncontrollable

- High Uncertainty
- Low Uncertainty
Strategies for Resilience

**Growth**
Storage to allow growth after stress (e.g. root storages)

**Competition**
Resist stress (e.g. thick bark)

**Reorganization:**
Establish new populations (e.g. seed dispersal)

**Crisis**
Triggering crisis (e.g. pyrogenic)
Four Aspects of Resilience Management

Combining different knowledge systems for learning
  e.g. Build local ecological knowledge

Increase ability live with change and uncertainty
  e.g. Nurturing diversity for reorganization and renewal

Practice of adaptive management
  e.g. management integrates monitoring, adaptation and mitigation activities

Navigating larger context
  e.g. Building external practical, social, and scientific networks
Visit the MA Website

www.MAweb.org

Millennium Ecosystem Assessment

Strengthening Capacity to Manage Ecosystems Sustainably for Human Well-Being

News Updates

Millennium Ecosystem Assessment Releases First Report

WASHINGTON, DC, US | SEPTEMBER 23, 2003
The Millennium Ecosystem Assessment (MA), the most extensive study ever of the linkages between the world’s ecosystems and human well-being, today released its first report, Ecosystems and Human Well-being. The 245-page report lays out the approaches, assumptions, processes, and parameters scientists are using in the study. It offers decision-makers a mechanism to identify options that can better achieve core human development and sustainability goals and better understand the
MA Products

Synthesis
- General Synthesis
- Biodiversity
- Desertification
- Business
- Wetlands
- Health
- Board Statement

Technical Volumes
- State and Trends
- Scenarios
- Multi-Scale Assessments
- Responses
We have become as gods

We might as well get good at it.

Stewart Brand