“In the long run we are all dead”

Economics, history and long-run ecological change

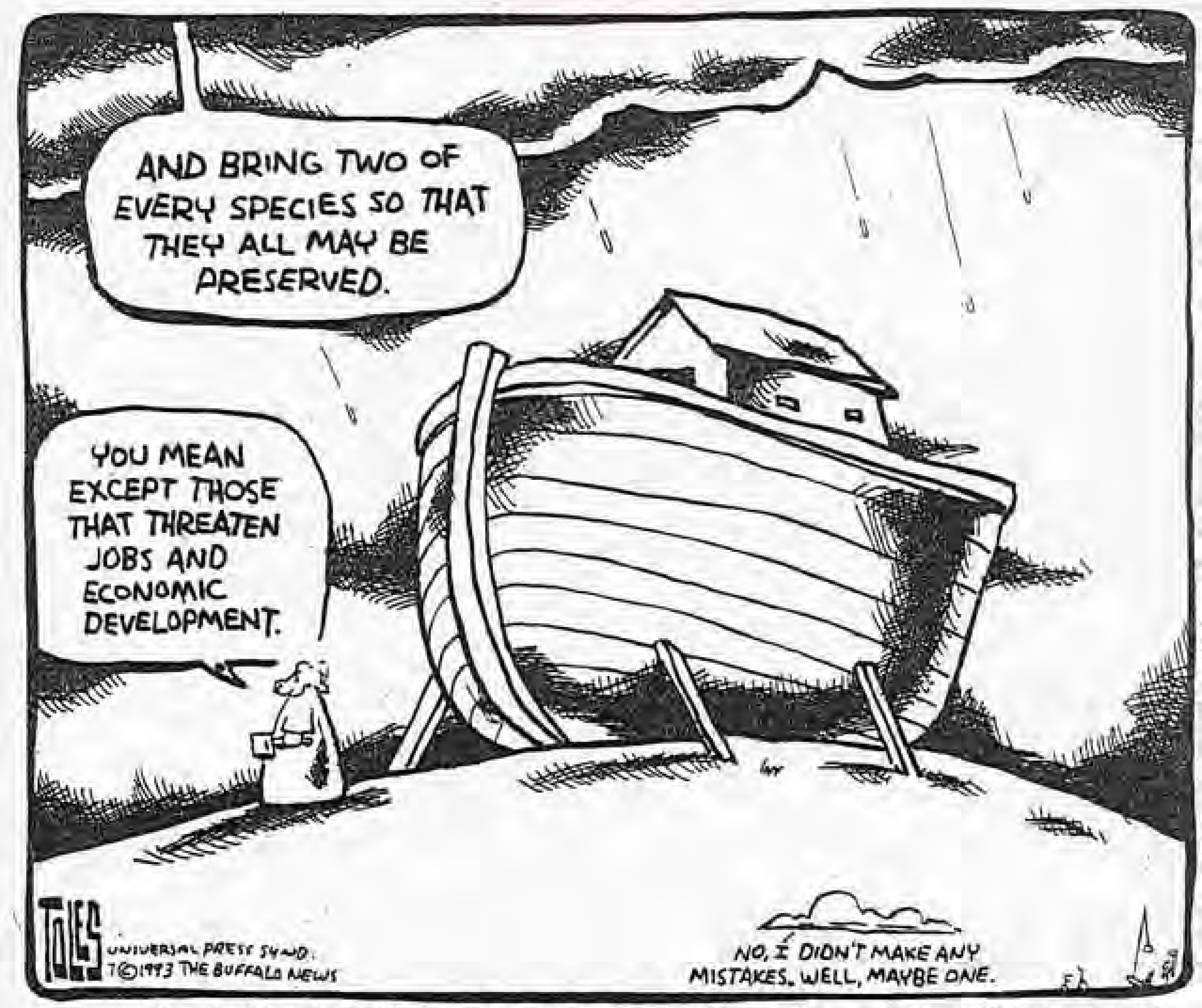
Edward B Barbier
Department of Economics & Finance
University of Wyoming

"The long run is a misleading guide to current affairs. In the long run we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is past the ocean is flat again."

John Maynard Keynes. 1923. *A Tract on Monetary Reform*, Ch. 3.

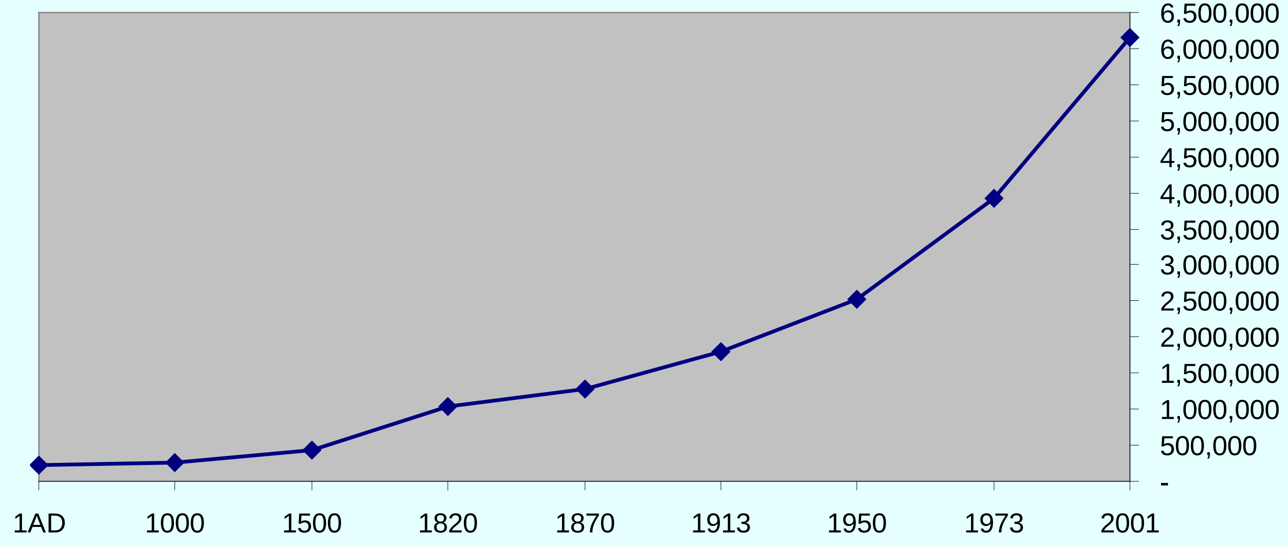
Outline

- Why have economists traditionally been less interested in long-run phenomena, especially long-run ecological change?
- What does history tell us about the importance of long-run environmental change?
- Why have economists become more concerned about long-run ecological change?

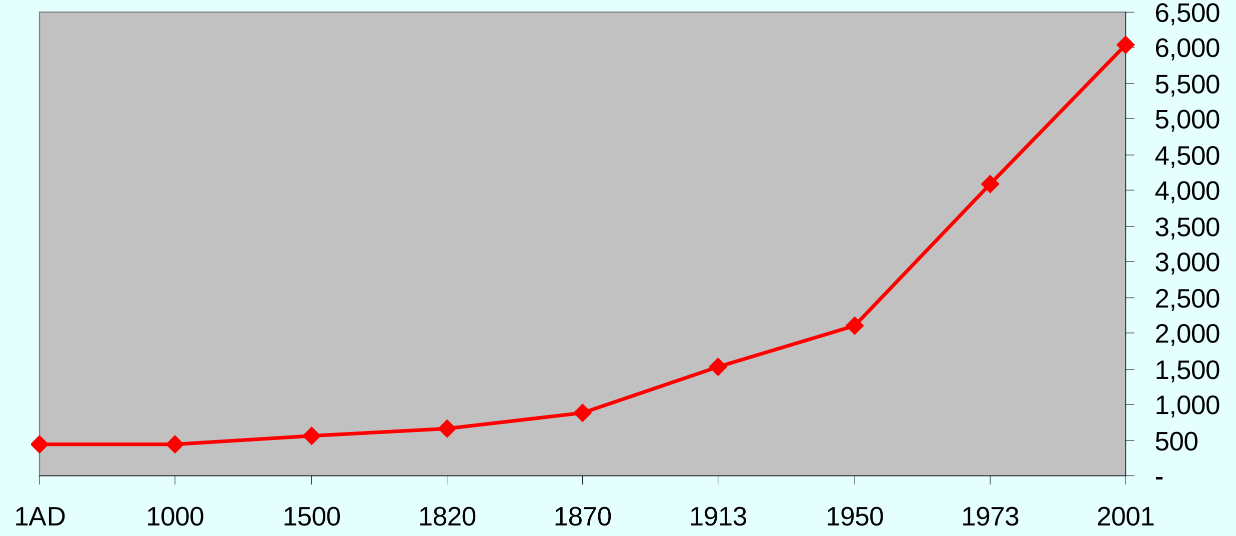

AND BRING TWO OF EVERY SPECIES SO THAT THEY ALL MAY BE PRESERVED.
YOU MEAN EXCEPT THOSE THAT THREATEN JOBS AND ECONOMIC DEVELOPMENT.
TOLES
UNIVERSAL PRESS SYND. 7©1993 THE BUFFALO NEWS
NO, I DIDN'T MAKE ANY MISTAKES. WELL, MAYBE ONE.

If Noah was an economist…

World Population, 1 AD - 2001



World GDP per capita ($1990)



Unending frontiers?

- But the environmental cost has been huge:

  “The early modern near-doubling of human numbers generated new pressures on the natural world….shared long-term historical processes – settlement frontiers, biological invasions, and the world hunt – imposed shattering changes on regional ecosystems around the world. During the early modern period, there was an irresistible, and seemingly irreversible trend towards more intensive human control and use of the land and the natural environment. As this occurred, those intricate local assemblages of vegetation and fauna that had long flourished with far less human intervention lost complexity, lost diversity, lost numerous species, and sometimes were even eradicated completely….These processes once underway, have continued with little restrained or diversion in the nineteenth and twentieth centuries.”

Richards, John F. 2003. *The Unending Frontier: An Environmental History of the Early Modern World.* University of California Press, Berkeley, pp. 617-618.

Why the focus on "frontiers"….?

- The term "frontier" usually refers to an area of unusually abundant natural resources and land relative to labor and capital, and the process of "frontier expansion" or "frontier-based development" refers to finding and exploiting or converting these relative abundant resources for production purposes.
- This perspective is especially important, as it suggests that the process of economic development is not just about allocating scare resources but also about obtaining and exploiting "new frontiers" of natural resources.
- This is particularly the case if the concept of a "frontier" also extends "vertically downwards" to include mineral resources and extractive activities "rather than be horizontally extensive as in the case of land and agriculture."
- When viewed in this way, "frontier resource expansion" has clearly been an important aspect of economic development for most of global history.

Barbier, E.B. 2005. "Natural Resource-Based Economic Development in History." *World Economics* 6(3):103-152.

…because frontier exploitation appears to matter!

- Although historically "frontier expansion" may have been associated with successful resource-based development, this is less likely in the case of most developing countries today.
- The main reason is that the current process of "frontier expansion" in many poor countries has two unique structural features:
  - the key "frontier" activity occurring in these countries is land conversion leading to agricultural expansion
  - this frontier *land* expansion is serving mainly as an outlet for the subsistence and near-subsistence needs of the rural poor.
- Such frontier land expansion does not generate substantial rents, and any resulting agricultural output is consumed mainly locally.
- In the case of frontier resource-extractive activities (e.g. timber harvesting, mining, ranching and commercial plantations) that do yield more significant rents, the rent-seeking behavior associated with these activities will mean that these rents will be re-invested into further exploitation of frontier resources rather than in other sectors of the economy.

Economic implications

- The outcome is that whether one is talking about exploitation of “horizontal” or “vertical” frontiers, and whether the exploitation is the basis for commercial or subsistence activity, the frontier economy will remain a largely isolated enclave within the larger developing economy.
- The resulting land expansion and resource exploitation becomes symptomatic of a pattern of economy-wide resource-based development that:
  - generates little additional economic rents
  - what rents are generated are not reinvested in more productive and dynamic sectors, such as manufacturing.
- This would suggest that low and middle-income countries that have experienced persistent expansion of agricultural land and other natural resource “reserves” over the long term are likely to have performed less well than countries that have been less reliant on frontier conversion.
- For evidence and documentation, see:

  Barbier, E.B. 2005. *Natural Resources and Economics Development*. Cambridge University Press, Cambridge and New York.

Terrestrial ecosystems

Human expansion

1
Exploration
Surveying
Small-scale extraction

2
Large-scale extraction
Transportation networks

3
Agricultural conversion
Permanent settlements

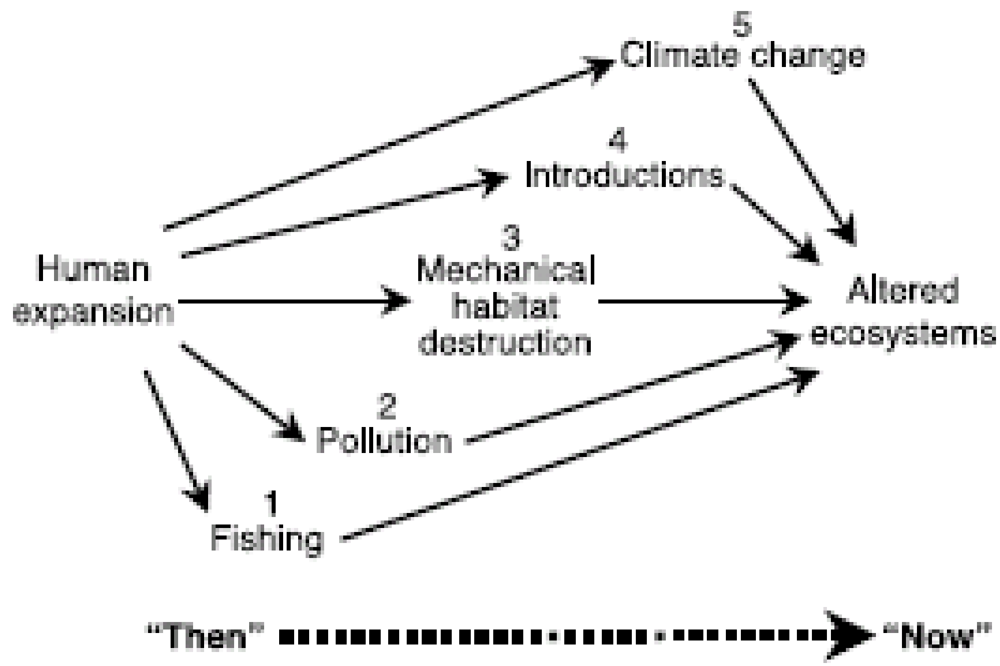
4
Modernization
Urbanization

Low → High

Altered ecosystems
Population density
Economic activity/development
Pollution/resource-intensity

Coastal ecosystems

Fig. 3. Historical sequence of human disturbances affecting coastal ecosystems. Fishing (step 1) always preceded other human disturbance in all cases examined. This is the basis for our hypothesis of the primacy of overfishing in the deterioration of coastal ecosystems worldwide. Subsequent steps 2 through 5 have not been observed in every example and may vary in order.



Jackson, J. et al. 2001. "Historical over-fishing and the recent collapse of coastal ecosystems." *Science* 293:629-638.

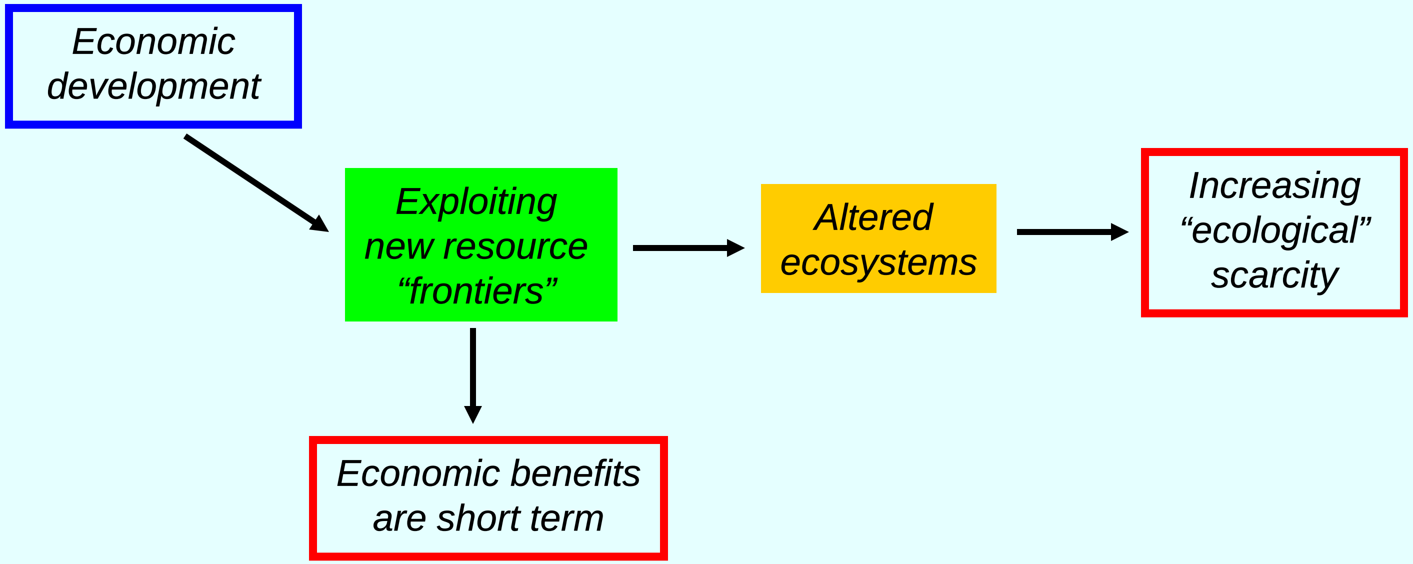
Marine ecosystems

"A dramatic depletion of large predators triggered fisheries to target species of lower trophic levels in a process called 'fishing down marine food webs' (Pauly et al. 1998). More recently, fisheries exploitation has spread from coastal areas to the open ocean and a general decline in fish biomass has been reported; as a consequence, many marine species are of serious conservation concern."

Morato, T. et al. 2006. "Fishing down the deep." *Fish and Fisheries* 7:23-33.

Pauly, D. et al. 1998. "Fishing down marine food webs." *Science* 279:860-863.

The overall economic implications…



Barbier, E.B. 1989. *Economics, Natural Resource Scarcity and Development: Conventional and Alternative Views.* Earthscan Publications, London.

Barbier, E.B. et al. 1994. *Paradise Lost? The Ecological Economics of Biodiversity.* Earhscan Publications, London

Why are economists interested?

- The costs of increasing ecological scarcity, in terms of loss of valuable ecosystem "services", are more evident today.
- There is increasing concern, among the public and (some) policymakers, that these losses are mounting, not diminishing.
  - Processes of "frontier expansion" are more rapid than ever.
  - The risks of catastrophic events seem to be rising.
- Interdisciplinary cooperation: Economists are working more closely with ecologists and other natural scientists to estimate and document these losses and their implications for human welfare.
- The key concept in this dialogue: *ecosystem services*

What are ecosystem services?

- Broadly defined, “ecosystem services are the benefits people obtain from ecosystems” (Millennium Ecosystem Assessment 2003, p. 53).
- Such benefits are typically described in the following manner: “Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life….In addition to the production of goods, ecosystem system services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well.” (G. Daily, ed. 1997. *Nature’s Services*, Island Press, Washington DC, p. 3).
- Thus in the current literature the term “ecosystem services” lumps together a variety of “benefits”, which in economics would normally be classified under three different categories:
  - (i) “goods” (e.g. products obtained from ecosystems, such as resource harvests, water and genetic material),
  - (ii) “services” (e.g. recreational and tourism benefits or certain ecological regulatory functions, such as water purification, climate regulation, erosion control, etc.), and
  - (iii) cultural benefits (e.g., spiritual and religious, heritage, etc.).

The challenge for economics

- As a recent US NAS report has emphasized, "the fundamental challenge of valuing ecosystem services lies in 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" (Heal et al. 2005, p. 2).
- Moreover, it has been increasingly recognized by economists and ecologists that the greatest "challenge" they face is in valuing the ecosystem services provided by a certain class of key ecosystem functions – *regulatory and habitat functions*.

Heal, G. et al. 2005. *Valuing Ecosystem Services: Toward Better Environmental Decision Making*. Washington DC: The National Academies Press.

Examples of Services Provided by Ecosystem Regulatory and Habitat Functions

Ecosystem Functions	Ecosystem Processes and Components	Economic Services (Benefits)
Regulatory Functions		
•Gas regulation	Role of ecosystems in biogeochemical processes	Ultraviolet-B protection Maintenance of air quality Influence of climate
•Climate regulation	Influence of land cover and biologically mediated processes	Maintenance of temperature, precipitation
•Disturbance prevention	Influence of system structure on dampening environmental disturbance	Storm protection Flood mitigation
•Water regulation	Role of land cover in regulating runoff and river discharge	Drainage and natural irrigation Flood mitigation
•Soil retention	Role of vegetation root matrix and soil biota in soil structure	Maintenance of arable land Prevention of damage from erosion and siltation
•Soil formation	Weathering of rock, organic matter accumulation	Maintenance of productivity on arable land
•Nutrient regulation	Role of biota in storage and recycling of nutrients	Maintenance of productive ecosystems
•Waste treatment	Removal or breakdown of nutrients and compounds	Pollution control and detoxification
Habitat Functions		
•Niche and refuge	Suitable living space for wild plants and animals	Maintenance of biodiversity Maintenance of beneficial species
•Nursery and breeding	Suitable reproductive habitat and nursery grounds	Maintenance of biodiversity Maintenance of beneficial species

Special measurement issues

- Natural ecosystems and their services fall in the special category of "nonrenewable resources with renewable service flows".
  - Natural ecosystems do not increase but are depletable (converted).
  - Ecological services of intact systems are "non-depletable" flows.
- Most benefits arising from the regulatory and habitat functions of ecosystems are non-marketed.
  - Require explicit methods to measure their social value.
  - Failure to measure these values means that ecosystems are "underpriced" in development decisions that convert ecosystems.
- Uncertainty over future values
  - Benefits of ecosystem services could be larger in the future.
- The need to consider future values is further exacerbated by irreversible conversion.

Coastal protection service of mangroves

- Mangrove wetlands, which are found along sheltered tropical and subtropical shores and estuaries, are particularly valuable in minimizing damage to property and loss of human life by acting as a barrier against tropical storms, such as typhoons, cyclones, hurricanes, and tsunamis.
- Mangroves protect coastal area from wind and trap sediment in their roots, as well as absorb the energy and slow the hydrological flow of storm surges.
- Preliminary evidence from the Indian Ocean countries most severely affected by the Tsunami Disaster suggests that those coastal areas that had dense and healthy mangrove forests and other substantial vegetative cover suffered fewer losses and less damage to property than those areas in which mangroves had been degraded or converted to other land use.

Unhurt mangrove forest behind the two washed villages by the 26 Dec 2004 Tsunami at Praphat Beach of Ranong, Thailand (9^o 22.476'N, 98^o 23.861E).

The badly damaged *Avicennia* forest at Ban Nam Khem, Phang Nga, Thailand (8^o 52.082’N, 98^o 16.583’E).

Thick and strong prop roots of *Rhizophora* buffered the tidal waves; behind the zone, all trees appear intact at Ban Nam Khem, Phang Nga, Thailand (8^{o} 52.006'N, 98^{o} 16.710'E).

Mangrove Deforestation

- Many mangrove ecosystems throughout the world and particularly in Asian countries are threatened by rapid deforestation.
- At least 35% of the area of mangrove forests has been lost in the past two decades, losses that exceed those for tropical forests and coral reefs.
  - In Asia, 36% of mangrove area has been deforested, at the rate of 1.52% per year.
- Aquaculture accounts for 52% of mangrove loss globally, with shrimp farming alone accounting for 38% of mangrove deforestation.
  - In Asia, aquaculture contributes 58% to mangrove loss with shrimp farming accounting for 41% of total deforestation

Valiela, I. et al. 2001. ‘Mangrove Forests: One of the World’s Threatened Major Tropical Environments.’ *BioScience* 51(10), 807-815.

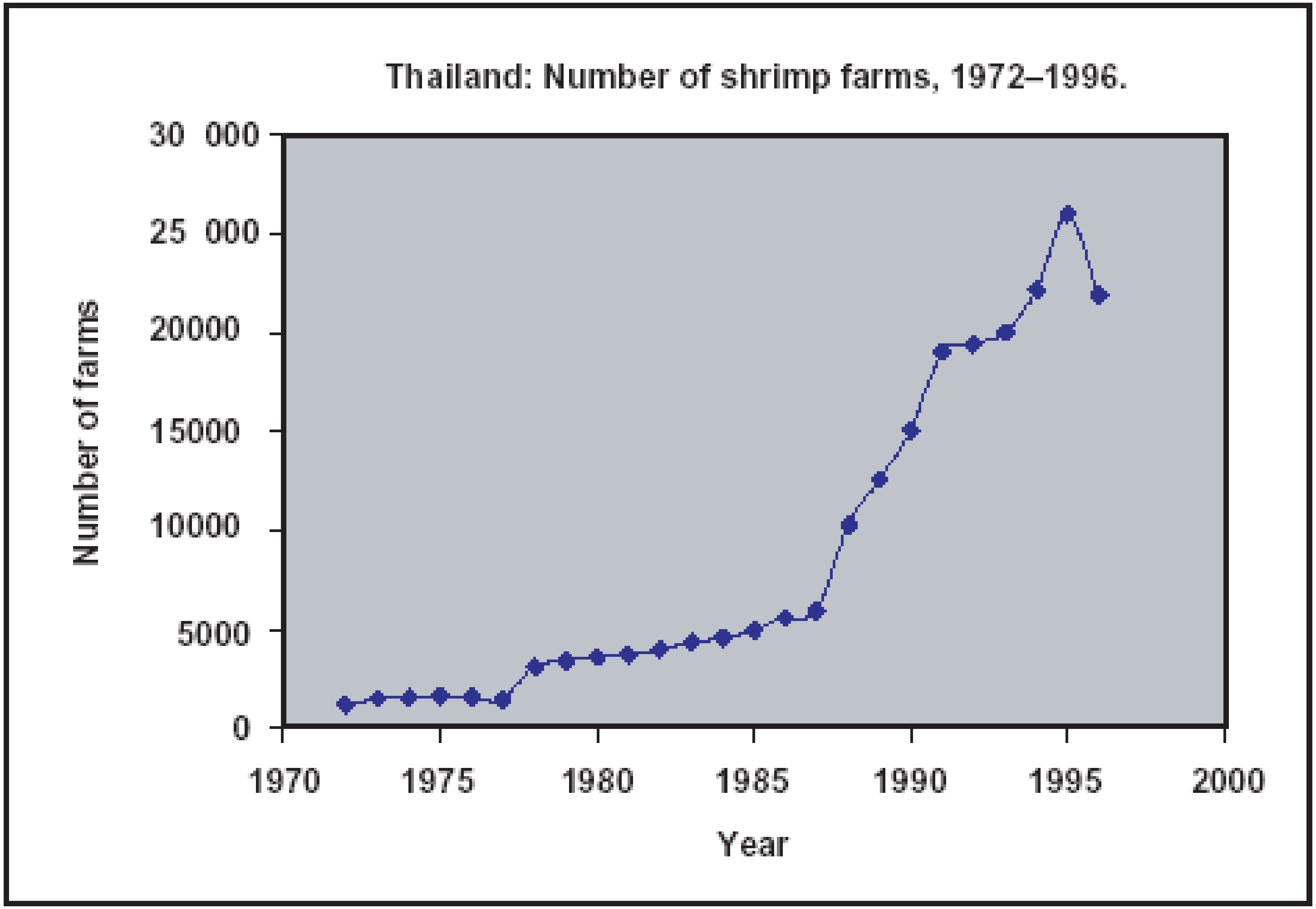
Shrimp farm expansion and mangrove loss in Thailand

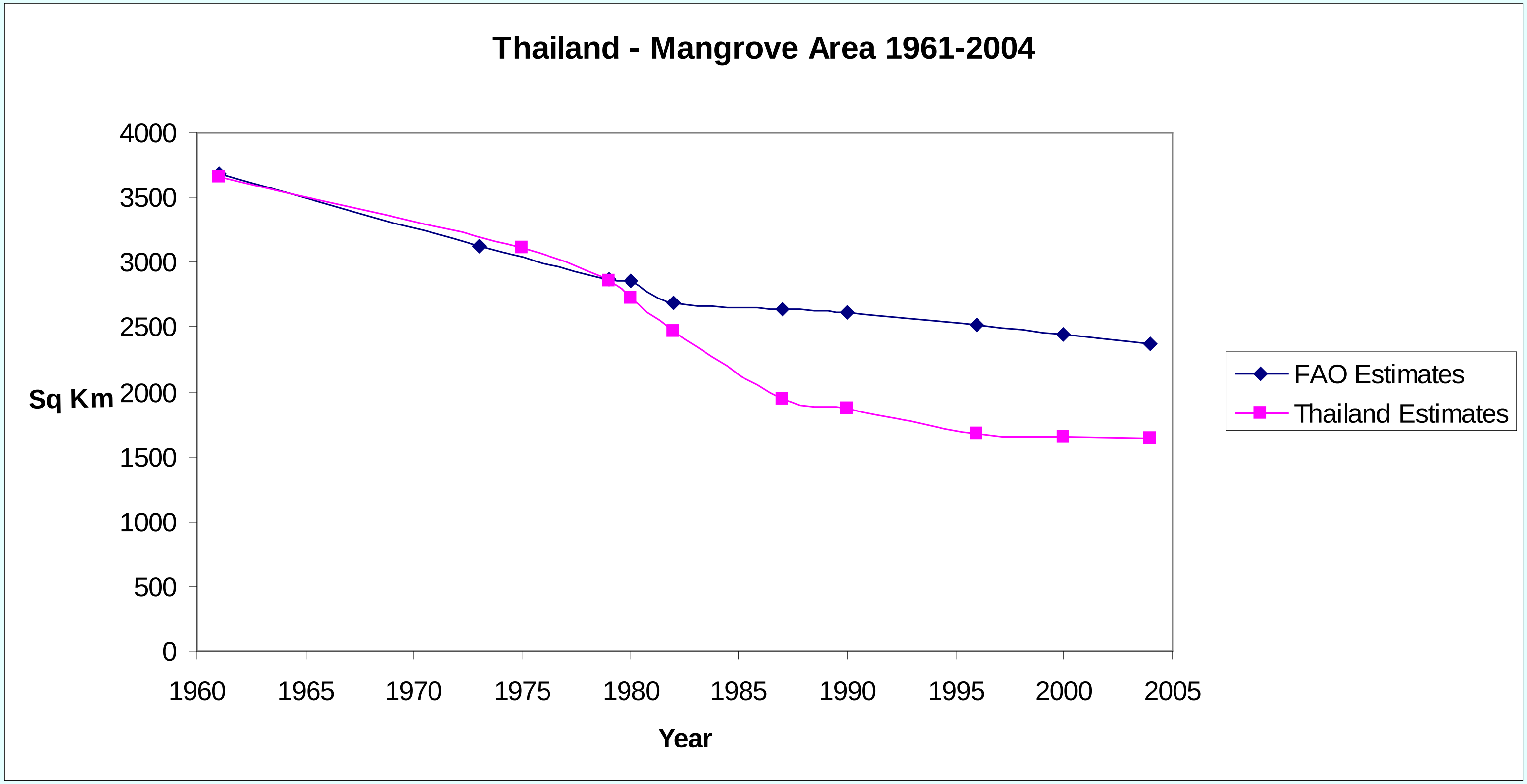
- Mangrove deforestation has been prevalent in Thailand, one of the countries worst affected by the Tsunami Disaster.
- Over 1961-96, Thailand has lost around 2,050 km^2 of mangrove forests, or about 56% of the original area, mainly due to shrimp aquaculture and other coastal developments.
- Estimates of the amount of mangrove conversion due to shrimp farming vary, but recent studies suggest that up to 50-65% of Thailand's mangroves have been lost to shrimp farm conversion since 1975.
- Shrimp farming is highly profitable and important economically:
  - Since the late 1990s, the total value of export earnings for shrimp in Thailand has been around US$ 1 billion to US$ 2 billion annually.
  - Thailand has been the world's largest producer of cultured shrimp since 1991.

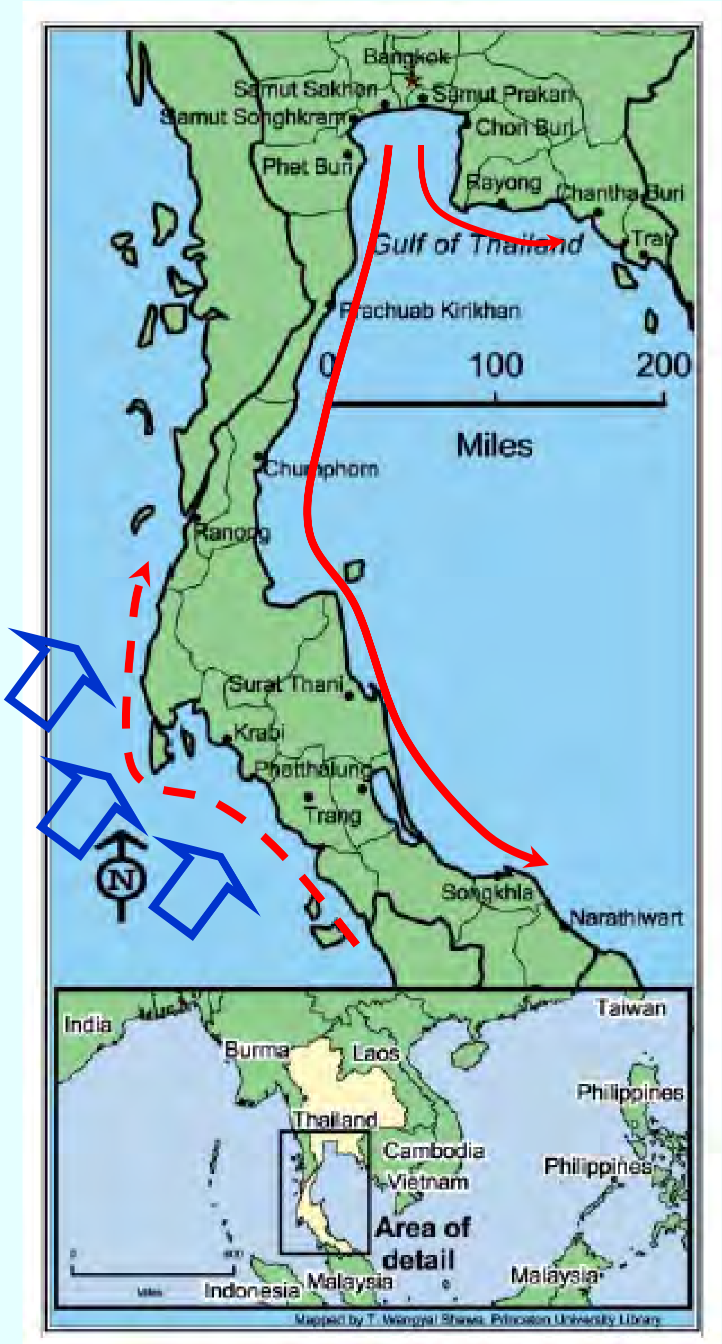
Barbier, E.B and S. Sathirathai, ed. 2004. *Shrimp Farm Expansion and Mangrove Loss in Thailand.* Edward Elgar, London.

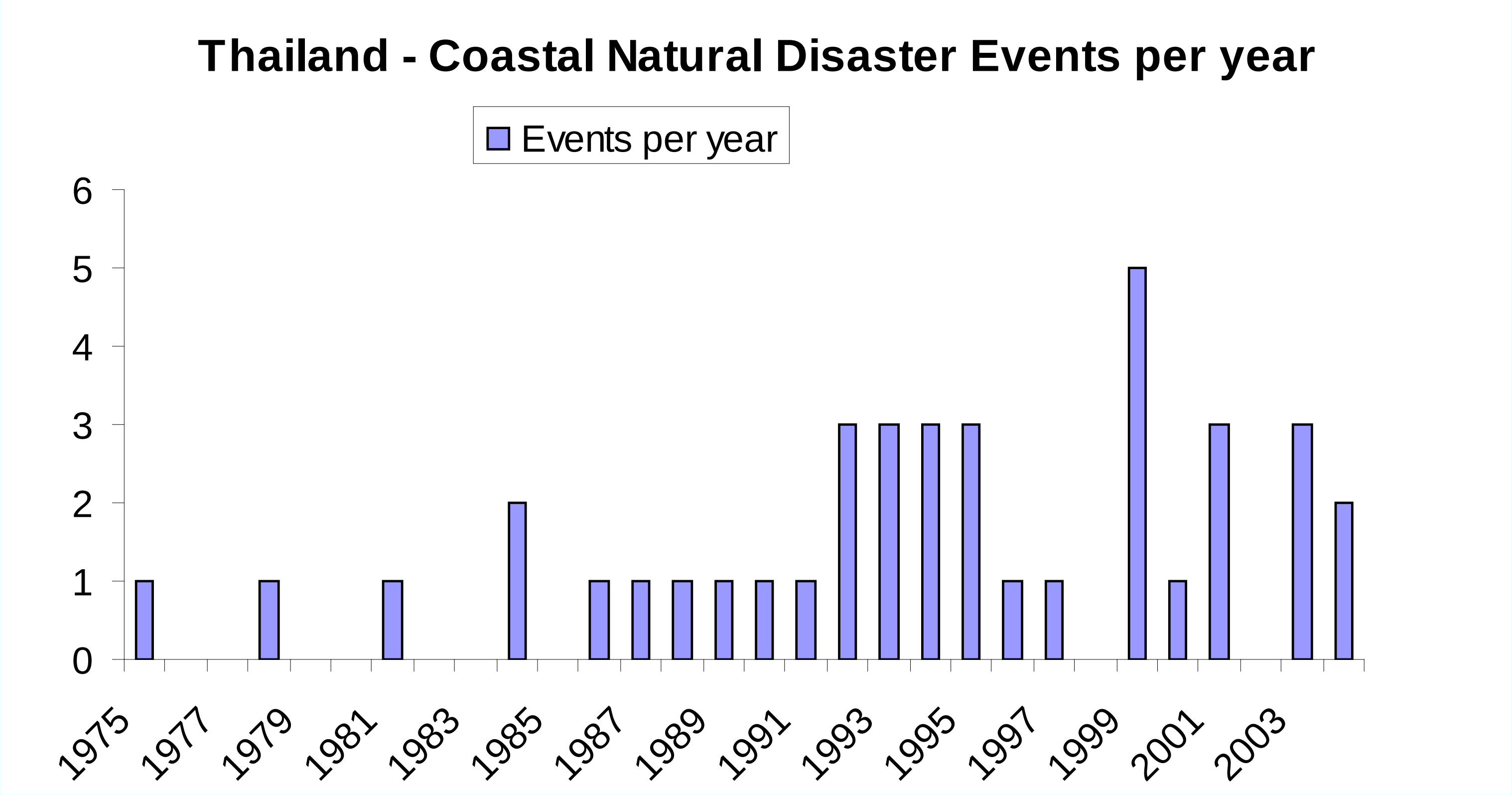
Abandoned shrimp farm and polluted sludge waste discharged from shrimp pond next to mangroves, Southwest coast of Thailand.

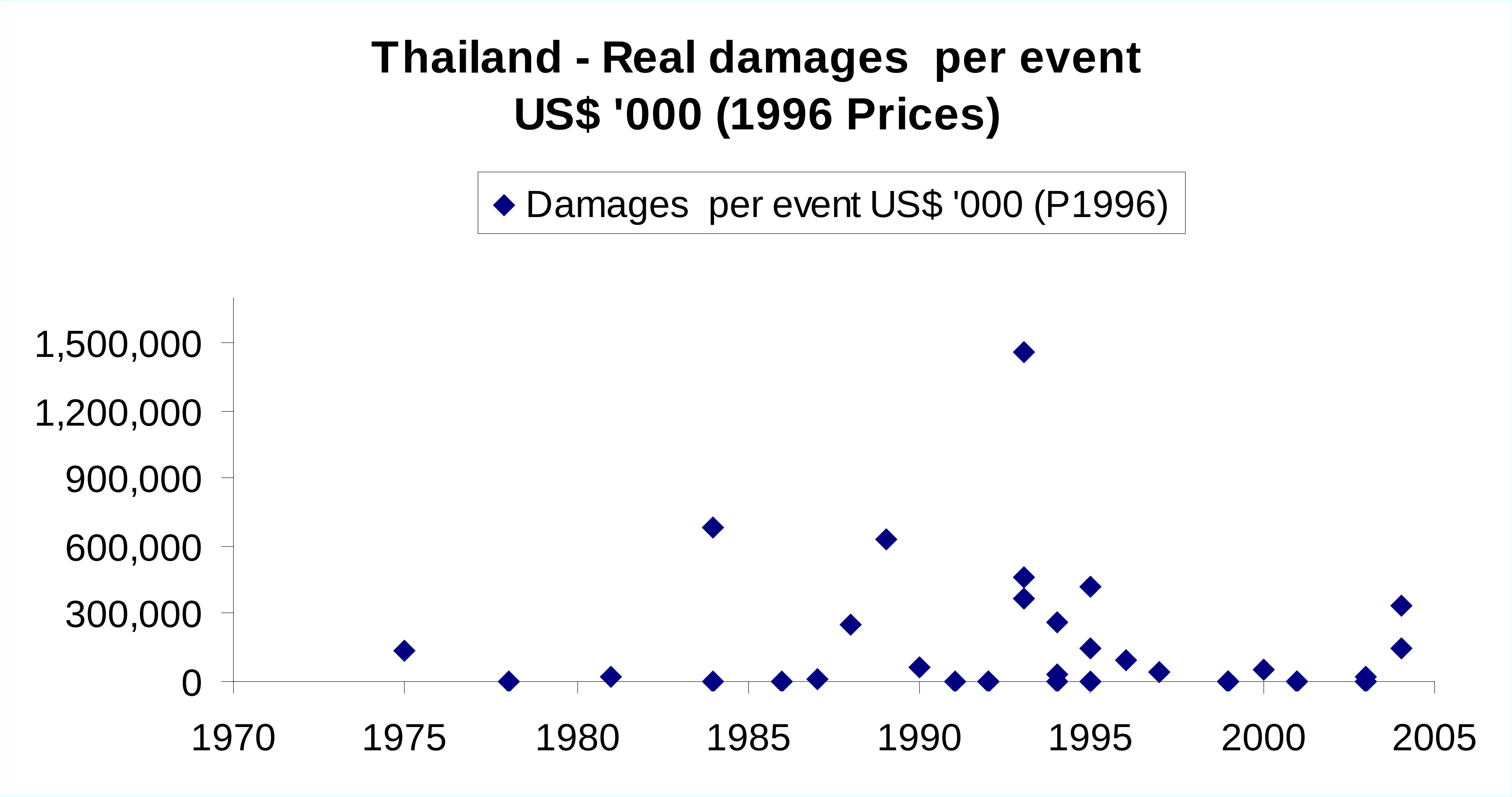
Figure 1. Shrimp farm expansion in Thailand, 1972–1996.




Thailand - Mangrove Area 1961-2004
4000
3500
3000
2500
2000
1500
1000
500
0
Sq Km
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year
FAO Estimates
Thailand Estimates


Bangkok
Samut Sakhon
Samut Prakan
Samut Songhkram
Chon Buri
Phet Buri
Rayong
Chantha Buri
Gulf of Thailand
Trat
Prachuab Kirikhan
0
100
200
Miles
Chumphom
Ranong
Surat Thani
Krabi
Phatthalung
Trang
Songkhla
Narathiwart
N
India
Taiwan
Burma
Laos
Philippines
Thailand
Cambodia
Vietnam
Philippines
Area of detail
Indonesia
Malaysia
Malaysia


Thailand - Coastal Natural Disaster Events per year
Events per year
6
5
4
3
2
1
0
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003



Thailand - Real damages per event
US$ '000 (1996 Prices)
Damages per event US$ '000 (P1996)
1,500,000
1,200,000
900,000
600,000
300,000
0
1970
1975
1980
1985
1990
1995
2000
2005

Valuing protection service: expected damage function

- Values an ecosystem service that reduces the probability and severity of some economic damage by measuring *the reduction in the expected damage resulting from such protection*.
- The essential step to is to estimate how changes in the asset affect the probability of the damaging event occurring.
  - This approach has been used routinely in risk analysis and health economics.
- The EDF approach can be applied, under certain circumstances, to value the protection service of coastal wetlands that also reduce the probability and severity of economic damages from natural storm disasters.
- Two components are critical to implementing the EDF approach to estimating the changes in expected storm damages:
  - the influence of wetland area on the expected incidence of economically damaging natural disaster events, and
  - some measure of the additional economic damage incurred per event.

Barbier, E.B. "Valuing Ecosystem Services as Productive Inputs." *Economic Policy*, forthcoming in January 2007 issue.

Results of the Thailand study

- Analysis for Thailand over 1979-96 shows that a one-km^2 decline in mangrove area increases the expected number of disasters by 0.36%.
  - We cannot reject the hypothesis that over 1979-96 the widespread loss of mangroves in coastal areas of Thailand increased the vulnerability of these areas to more incidences of natural disasters.
- Over 1979-1996 the estimated real economic damages per coastal event per year in Thailand averaged around US$189.9 million (1996 prices).
  - For this period, the marginal effect of a one-km^2 loss of mangrove area is an increase in expected storm damages of about US$585,000 per km^2.
- Over 1996-2004 the estimated real economic damages per coastal event per year in Thailand averaged around US$61.0 million (1996 prices).
  - For this period, the marginal effect of a one-km^2 loss of mangrove area is an increase in expected storm damages of about US$187,898 per km^2.

Comparison of land use values per ha, Thailand, 1996-2004 (US$1996)

Land use	**Net present value ($) per ha (10-15% discount rate)**
1. Shrimp farming:	
Net economic returns	1,078 – 1,220
2. Mangrove replanting and restoration:	
Total cost	8,812 – 9,318
3. Ecosystem goods & services:	
Net income from collected forest products	484 – 584
Habitat-fishery linkage	708 – 987
Storm protection service	8,966 – 10,821
Total	10,158 – 12,392

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Final remarks

- Economists are becoming more interested in ecological change because the economic consequences are becoming less “long term” and more immediate.
- Processes of “frontier-based” development are accelerating; many poor countries have little choice because of the dire poverty, population and development problems they face.
- Industrialized countries have more choices; they should lead the way with resource-conservation development strategies and technologies.
- History tells us that we do not have much time; comparatively few of the world’s major ecosystems remain intact or undisturbed.
- The next 25 years are critical: it is essential that economists, ecologists and natural scientists work together to help analyze the complex economic-ecological problems and formulate solutions.
- Will policy makers listen?