“ECOSYSTEM MANAGEMENT: FOREST AND WATER SYSTEMS”

April 15, 2019

Outline

- The Economics of Forest Management
- Forest Loss and Biodiversity
- Policies for Sustainable Forest Management
- Water: Depletion and Renewal
- Policies for Sustainable Water Management

The economics of forest management

• What economic and ecological principles underlie sustainable management of renewable resources?

• We can view resources simply as inputs into the economic production process or in a broader view, analyze renewable resources in terms of their own internal logic of equilibrium and regeneration.

• Sustainable management of renewable resources involves maintaining the resource's source* and sink* functions in such a way that its quality and availability remain stable over time.

*Source function: the provision of materials for human use

*Sink function: the absorption of waste products from human activity

The economics of forest management

- Economic principles of resource management include profit maximization, efficient resource allocation.

- When we examine forests and water systems in more detail, we see that these economic principles are sometimes consistent with sustainable management

- The ecological principles underlying renewable resource systems are a little mode difficult to express in simple terms. One basic rule derived from ecological principles is that of **maximum sustainable yield:** "no more of the resource should be harvested or withdrawn annually than can be regenerated or replenished by the natural process."

The economics of forest management

- Maximum sustainable yield can be included in an economic analysis and may be consistent with economic goals under some circumstances,
- But we must also consider that most natural systems are characterized by ecological complexity.
- Natural forests usually have a variety of tree species, provide habitat for many animal species as well as fungi and microbial life.
- Human management of natural ecosystems must be a compromise between economic and ecological goals.

The economics of forest management

- Forests are primarily biological systems.
- Natural growth rate is fundamental in forest ecology and provides a link between ecological and economic analyses.
- An important factor in forest management policy is the cumulative nature of forest growth: biomass accumulated years, decades, or even centuries ago will still remain available for use if left undisturbed.

Thus, choices about time of harvesting are important in forest management!

The economics of forest management

- If we measure the volume of standing timber in a forest over time, we obtain a logistic curve.
- The field of population biology identifies a general theory of population change for an organism, such as fisheries or forestry, in the natural environment. Figure 14-1 shows a basic pattern of population change over time characteristic of many species in a natural state.

The economics of forest management

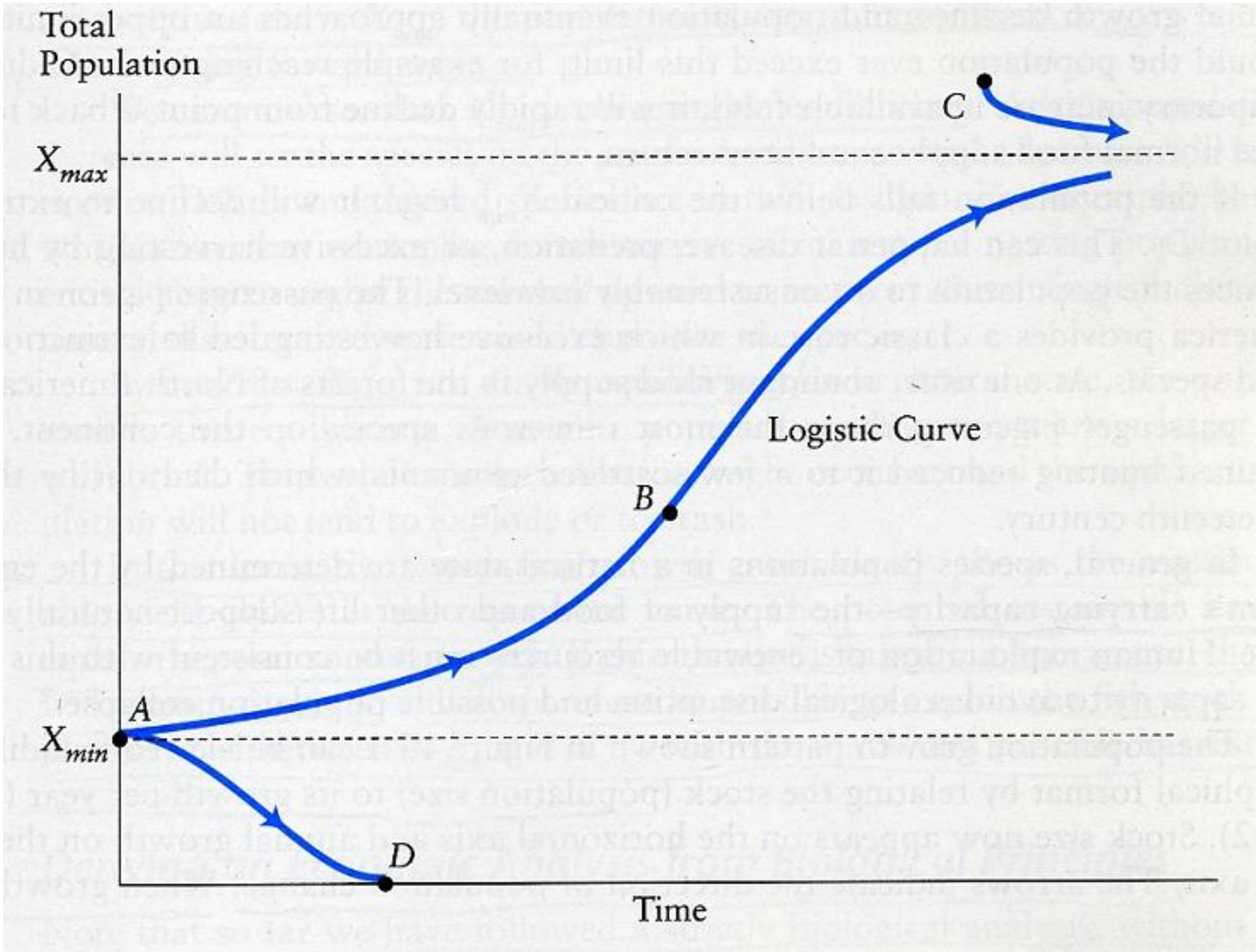


FIGURE 14-1 *Species Population Growth over Time*

The economics of forest management

- However, the logic of harvesting is different. From an economic point of view, we can see a standing forest as an asset, or stock that can also yield a flow of use value to humans.

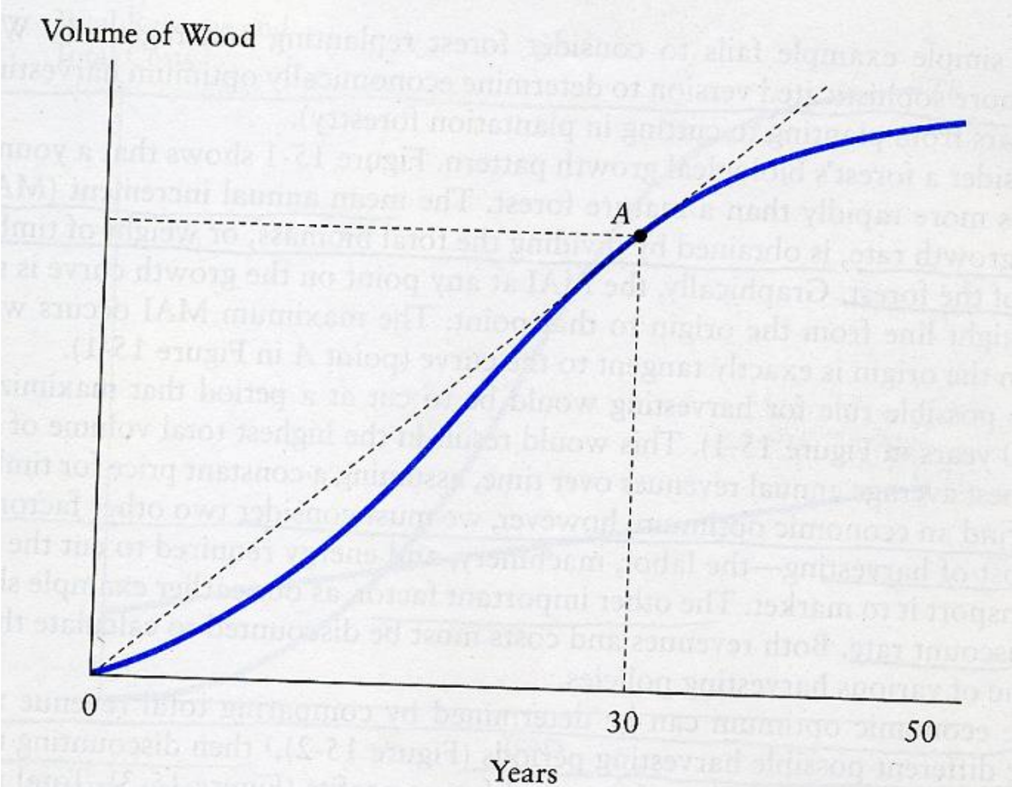


FIGURE 15-1 *Forest Growth over Time*

The economics of forest management

- How to determine economically optimum harvesting periods?
- One possible rule for harvesting would be to cut at a period that maximized the MAI: “ mean annual increment” (average growth rate = total biomass/the age of the forest).
- To find an economic optimum, however, we must consider two other factors:

    1. Cost of different harvesting periods
    2. Discount rate

- Both revenues and costs must be discounted to calculate the present value of various harvesting policies.

The economics of forest management

- The economic optimum can be determined by comparing total revenue total cost for different possible harvesting periods, then discounting this figure to obtain the present value of expected future profits.

- Total revenue minus total cost (TR – TC) indicates the profit from harvesting at some future point. Profits expected at a future time must be discounted to calculate their present value.

- The point at which the discounted value of (TR – TC) maximized gives the optimum rotation period for harvesting.

The economics of forest management

- **This principle helps to explain why plantation forestry is generally based on fast-growing softwood trees.**
- **Slower-growing hardwoods or mixed forest might be profitable over the long term, but at a commercial rate of discount the present value of slower-growing trees will be too low to be attractive to timber companies.**
- **The principles of such commercial forest management can often conflict with ecological costs!**

Forest loss and biodiversity

- Human activity has reduced forest area in some cases as well as changed forest biodiversity.
- Losses of tropical forest have been severe over the past decades. Estimates of forests loss range from 50,000 km^3 to 170,000 km^3 per year.
- From 1980 to 1995, Africa and Latin America lost about 10% of their forests, while Asia and Oceania lost more than 6%.
- Even in areas where forest area is increasing, the threat to biodiversity from economic uses of forests may still be great! The artificial forests displace natural forests.

Forest loss and biodiversity

- The maximum sustainable yield principle may not be enough to achieve ecosystem sustainability.
- Ecologist C.S. Holling has identified the principle of resilience as central to ecosystem sustainability.
  " resilience is a bounce-back capacity – the ability of an ecosystem to recover from disruption"
- If a plantation forest contains only one species of tree, an attack by a single pest might destroy the entire forest!
- Loss of biodiversity is likely to be one of the most critical environmental problems of the coming century.

Policies for sustainable forest management

- Both economic and ecological theory can offer guidance in devising better approaches to forest management.
- Better policy approaches can be implemented both on the supply side, by promoting sustainable forests and on the demand side, by changing consumption patterns, reducing wastes and expanding recycling.

Policies for sustainable forest management

- **Supply side: property rights and pricing values**

  A major issue in forest management throughput the developing world is the need for secure property rights!

  Another critical issue is full pricing forest concessions.

  Economic theory supports secure proper rights and full pricing of resources. The ecological perspective adds another dimension to forest management issues: forests must be recognized as complex ecosystems.

Policies for sustainable forest management

- <u>**Supply side: property rights and pricing values**</u>

Government policy can encourage forest management by such measures as tax breaks for sustainable forestry or limitations on clear-cutting.

Programs in the US and Canada have also begun for certification of sustainably produced wood so that consumers and public agencies can encourage sound practices by their purchasing choices.

Often a key factor is the availability of credit on reasonable terms to villagers who invest in replanting and agroforestry (mixing tree crops with food crops)

Policies for sustainable forest management

- <u>**Demand side: changing consumption patterns**</u>

  Overall demand for wood products has risen steadily (Fig 15-7)

  Like other forms of consumption, paper consumption is unequally distributed. U.S paper use is 341 kilograms per year while in Germany per capita consumption is 200 kilograms, in Brazil 35 kilograms and in India only 4 kilograms!

Policies for sustainable forest management

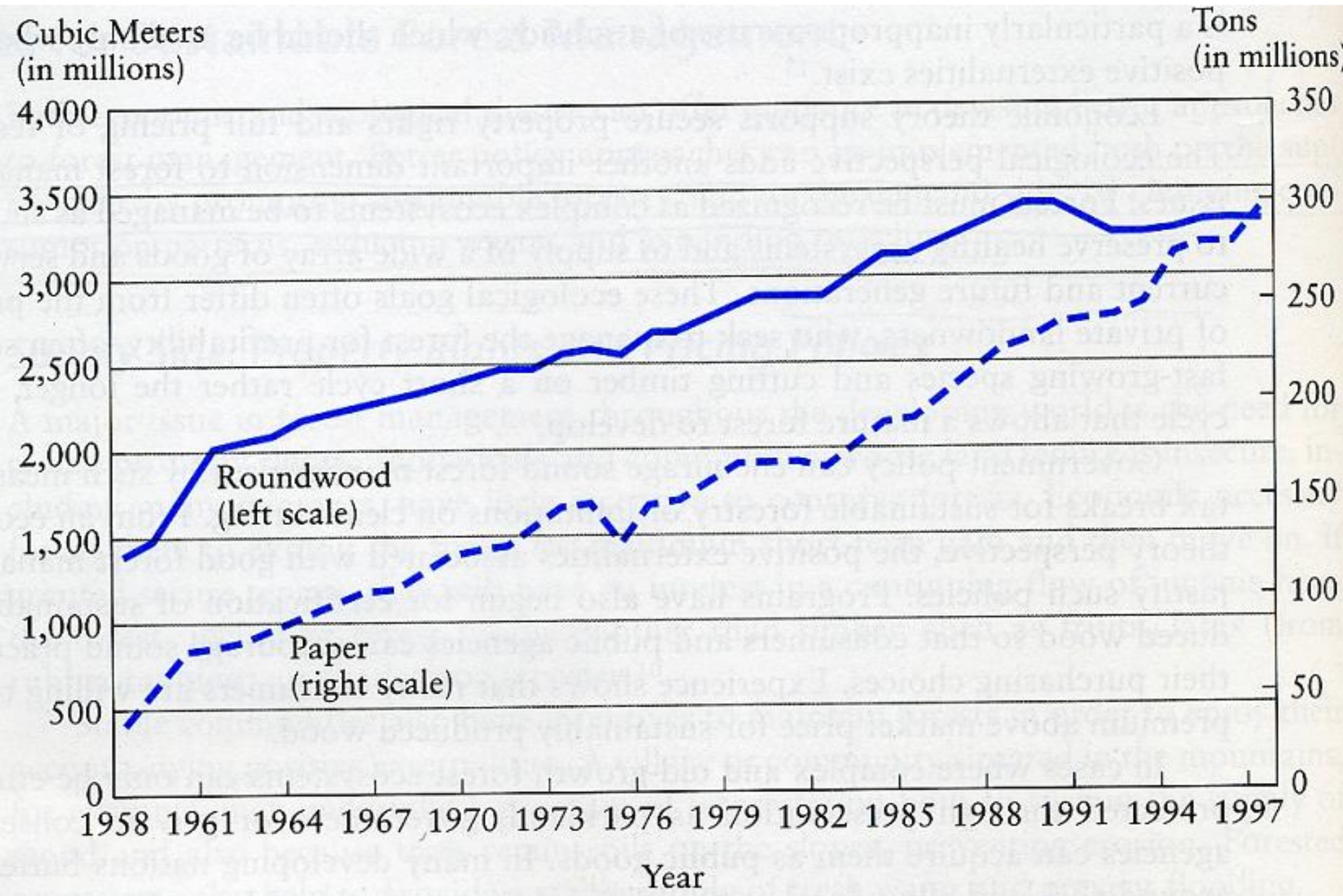


FIGURE 15-7 *Global Demand for Wood and Paper Products*

Source: Worldwatch Institute database, 1999.

Policies for sustainable forest management

Figure 1: Per capita paper consumption, by region

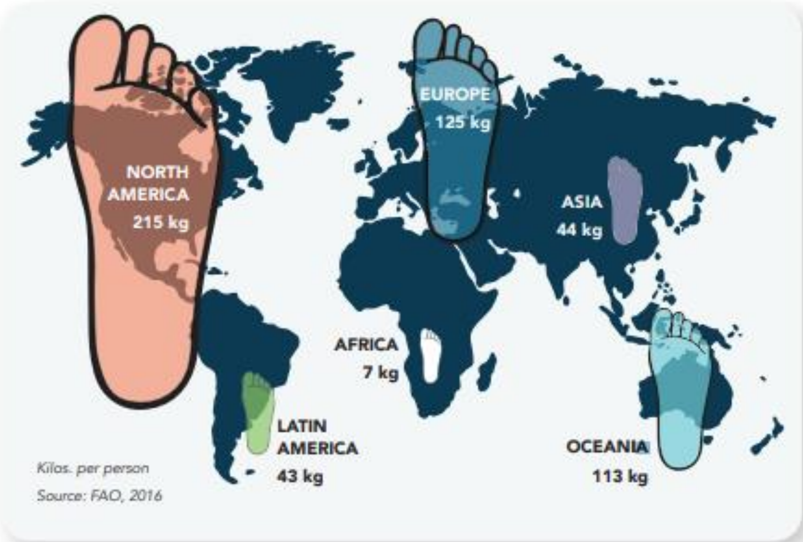
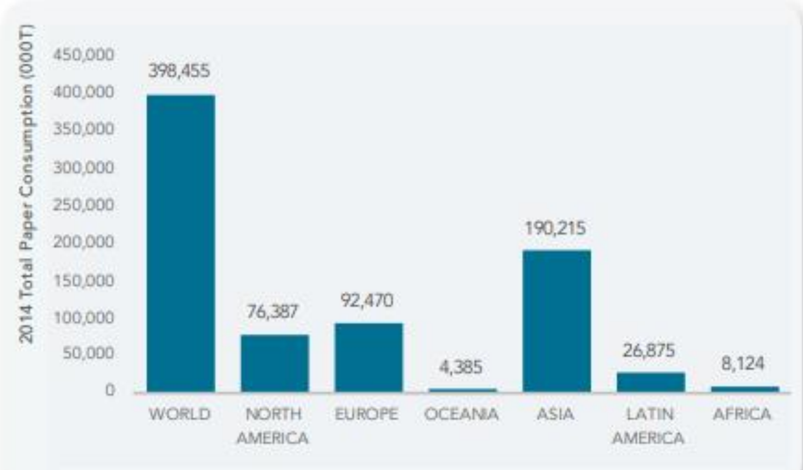


Figure 2: Total paper consumption, by region



Twenty-six countries have more than double the global average of per capita paper consumption (in kg per person per year)[5]:

Luxembourg (277)
Germany (251)
Austria (249)
Slovenia (247)
Belgium (241)
USA (222)
Japan (214)
Finland (200)
Denmark (198)
New Zealand (189)
Republic of Korea (186)
Netherlands (183)
Italy (170)
Sweden (165)
Canada (150)
Spain (149)
Australia (146)
UK (145)
Poland (143)
France (137)
Cayman Islands (135)
Switzerland (132)
United Arab Emirates (130
Czech Republic (126)
Slovakia (118)
Croatia (111)

Policies for sustainable forest management

- **<u>Demand side: changing consumption patterns</u>**

  Expanded recycling of paper and other wood products has significant potential to reduce pressure on forests.

  Low prices for paper and other wood products serve both as an incentive for greater consumption and a disincentive for expanded recycling!

  In some cases, direct and indirect subsidies for forest exploitation encourage use of virgin rather than recycled paper.

Water: depletion and renewal

- Water, because it can be reused indefinitely if not severely polluted, can be characterized as a renewable resource.
- But stocks of water such as underground aquifers are also depletable resources. Some aquifers have such long replenishment times as to be essentially non-renewable on a human time-scale.
- Thus, analysis of water systems combines elements of <u>renewable</u> and <u>non-renewable</u> resource theory.

Water: depletion and renewal

- **Many of the principles of renewable resource management apply to water systems, but water availability is subject to absolute limits.**
- **Although water is reusable, the amount of available in a given region is limited to the total freshwater runoff, of which only about a third is stable supply.**
- **Stable supply → 7000 m^3 per person.**

Unevenly distributed! Some areas are <u>water-abundant</u> and others are <u>water-scarce</u>.

Water: depletion and renewal

- **2000 m^3 $\longrightarrow$ per person per year represents the level above which a population can be sustained comfortably by the water available.**
- **1000 – 2000 m^3 $\longrightarrow$ the situation is water-stressed.**
- **Below 1000 $\longrightarrow$ the situation is water-scarce.**
- **There are many countries around the world already experiencing water stress or scarcity (Table 15-1 in your text book)**

Water: depletion and renewal

- **Supply side:**

  The two sides to the water-population equation are supply and demand. We can respond to scarcity by either increasing supply or decreasing demand.

  Almost all major water-scarce areas of the world suffer from groundwater overdraft!

  Another way of increasing water supply is damming surface flows. Worldwide 40,000 large dams and about 800,000 small dams are now in operation. More dams are being built but best sites are already in use.

  Existing dams often suffer problems of siltation.

Water: depletion and renewal

- **<u>Demand side:</u>**

The three major sectors of water use are:

1. **agricultural** → **Biggest consumer (2/3 of freshwater demand worldwide)**
2. **industrial** → **Grown rapidly in the developing world.**
3. **domestic** → **Urbanization and improvement of living standards have promoted domestic use**

Between 1990 and 1995, freshwater consumption rose sixfold, more than double the rate of population growth!

Policies for sustainable water management

- Micro-irrigation: allow an efficiency of 95%
- Recycling and reuse of wastewater
- Leak detection and repair
- Appropriate water pricing