Environmental Science *Systems and Solutions*

FOURTH EDITION

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Chapter 6

PRINCIPLES OF RESOURCE MANAGEMENT

Griest away Wed and Fri

- **Saturday, Oct 24, noon: class walk through Torrey Pines State Park; put it on your calendar (Optional: Not Required)**
- **Wed, prof. Tom Murphy on energy and home photovoltaics**
- **Fri, prof. Eric Martin, on wilderness and human values: suggested reading for this class is the essay: http://www.williamcronon.net/writing/Trouble_with_Wilderness_Main.html**
- **Homework due on Wed, and new homework will be posted, perhaps tomorrow (so don't get confused by 2 new homeworks!)**

Question

- How fast is California moving relative to the Pacific Ocean due to plate tectonics?

A. About 1 mile per year
B. Speed of a tortoise
C. Speed of fingernail growth
D. About 1 mile per 10 million years
E. California is not actually moving relative to th Ocean

Modified by kg

Question

- Ocean currents are caused by?

A. Tidal motions
B. Plate tectonics
C. Coriolis force
D. Friction of the wind
E. Large boats and whales

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Introduction

- The goal of much of resource management is sustainable resource use.
- Slowing or stopping the rate of resource use usually has the added benefit of reducing pollution.
- Historically, resource management has not led to sustainable use because social, economic, and political pressures emphasize rapid resource exploitation.
- In addition, overpopulation is resulting in an even greater consumption of resources.

Trends in U.S. Materials Consumption

- A sustainable world meets today's needs without reducing the quality of life of future generations.
- Since 1900, material consumption in the U.S. increased about six times faster than population.
- Modern resource exploitation is not even close to being sustainable.

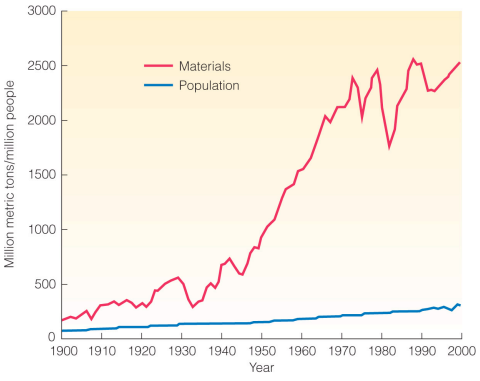

Figure 6-9 Consumption of materials in the United States has grown much faster than population.

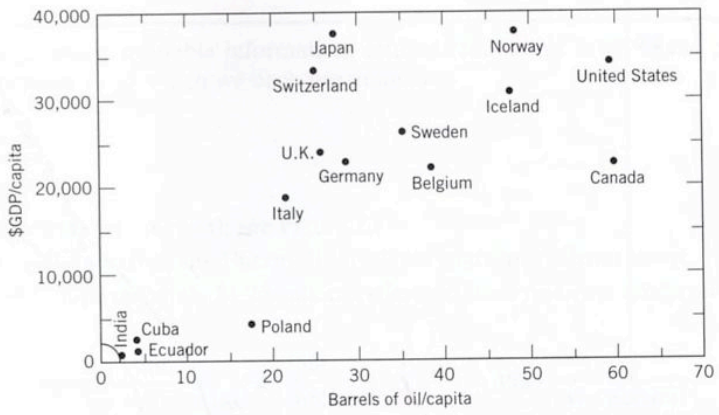

Figure 1.3 The Gross Domestic Product (GDP) per capita in U.S. dollars is compared to the total energy consumed per capita in equivalent barrels of oil for several countries. The small quarter-circle at the lower left corner is discussed in the text. (*Source*: *United Nations Statistical Yearbook*; data January 2003.)

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Kinds of Resources

- **A *resource* is a source of raw materials used by society.**
- ***Reserves* are the subset of resources that have been located and can be profitably extracted at current market prices.**
- ***Renewable resources* can be replaced within a few human generations (timber, food, solar power, etc.).**
- ***Nonrenewable resources* cannot be replaced within a few human generations (oil, coal, ore deposits, soil, ground water in the desert, etc.).**

People Managing Resources

- Some people reject the concept of resource management as invalid because it presumes humans have the right and the ability to manage nature.
- In spite of these valid concerns, resource management is inescapable and can help minimize environmental damage. The alternative is unmanaged resource exploitation; the tragedy of the commons.

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Resource Management

- People have generally allowed resources to be exploited without factoring in externalities, that is not including the true full cost. Resources are therefore "cheap", which speeds exploitation.
- Benefit-cost analysis (BCA) can help evaluate both short-term and long-term benefits and cost of resource exploitation.
- Resource management can include:
  - Preservation
  - Conservation
  - Restoration

Who Cares? The Many Values of Natural Resources

- **Ethical values**
  - **Intrinsic Values (ecocentric)**
- **Extrinsic Values (anthropocentric)**
  - **Aesthetic**
  - **Emotional**
  - **Economic**

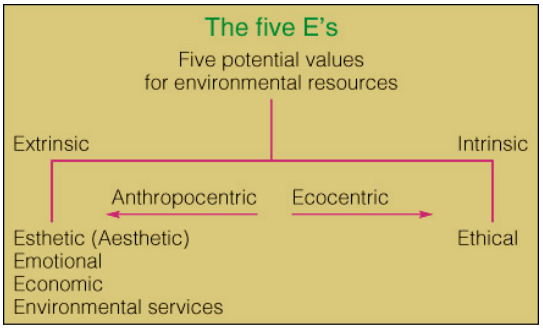

Figure 6-2

Patterns of Resource Depletion

- **Matter resources are depleted by being "lost" or dispersed.**
- **Energy resources are lost by being degraded to an unusable form, usually "waste heat."**
- **Unsustainable use of many resources exhibits a bubble pattern of depletion.**
- **The bubble pattern has two main causes:**
  - **Exponential exploitation**
  - **Exponential depletion.**

Bubble Pattern of Depletion

- **Named after M. King Hubbert who accurately predicted the bubble pattern of oil depletion in the United States in the 1950s that has been strikingly accurate**
- **Exponential exploitation occurs as long as the supply of a resource exceeds the demand.**
- **Exponential decline occurs when demand exceeds supply.**

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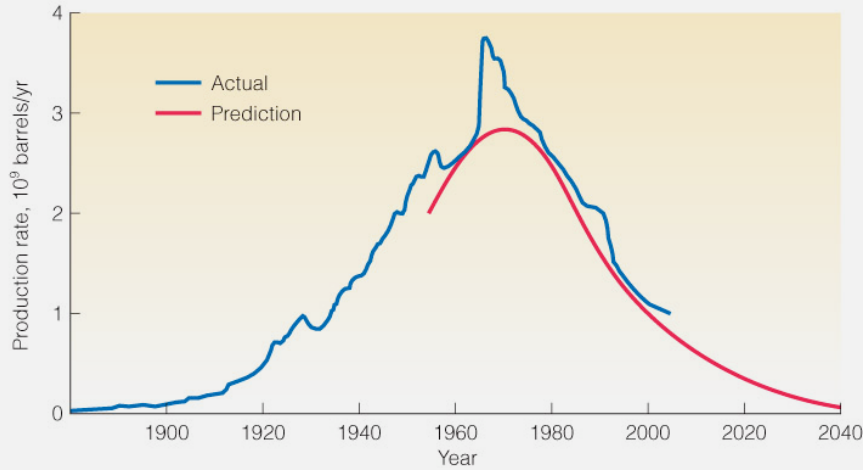

Figure 6-3 Predicted U.S. oil production by M. King Hubbert and actual U.S. oil production through 2005.

Source: U.S. Department of Energy

Diminishing Returns

- **The law of diminishing returns states that increasing efforts to extract a resource produce progressively smaller amounts.**
- **Example of the decreasing quality of copper ore mined in the United States.**

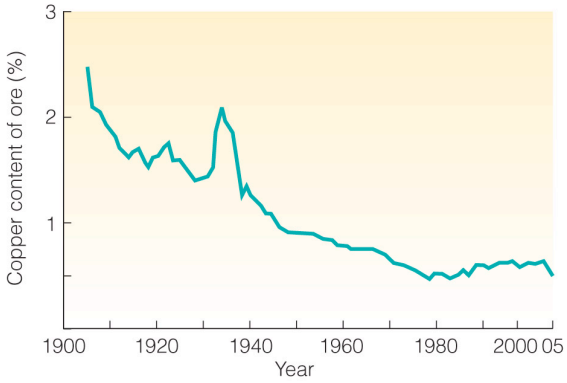

Figure 6-4 The quality of copper ore mined in the United States has declined from 2.5% to about 0.5%.

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Problems with Past Resource Management

- **Society can react to the decline of a resource in two ways:**
  - **intensify efforts to extract more of the resource**
  - **reduce the need for the resource**

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Net Yield

- The concept of net yield holds that a resource can continue to be extracted as long as the resources used in extraction do not exceed the resources gained.
- Low energy prices have encouraged switching to lower quality ores to cope with the law of diminishing returns.
- This has accelerated both depletion and pollution.

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Maximum Sustainable Yield (MSY)

- MSY holds that the optimum way to exploit a renewable resource is to harvest as much as possible up to the point at which the harvest rate equals the renewable rate.
- In practice, the MSY level is very difficult to calculate.
- Alternative is OSY (Optimal sustainable yield). Includes effects on other species, recreation, aesthetics, etc. OSY results in lower harvest rates.

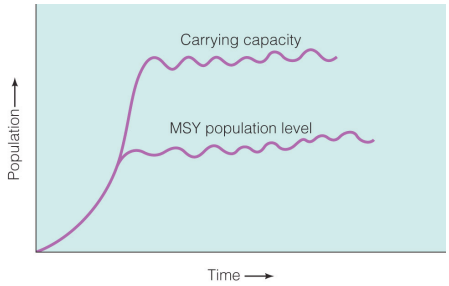

Figure 6-6 MSY occurs at population levels around one-half of the carrying capacity.

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Conservation

Reducing the Need for Resources

- Both net yield and maximum sustainable yield have emphasized maximum resource use for short-term economic gain.
- Historically, short-term economic gain has been achieved by sacrificing long-term economic welfare and also esthetic, emotional, and environmental services.
- Instead of maximizing resource use, we should emphasize accomplishing more with the resources that are used.

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Ways to Conserve

Efficiency, Recycling, and Substitution

- Efficiency improvements occur when the same task is accomplished with fewer resources.
- Reuse occurs when the same resource is used again in the same form.
- Substitution occurs when one resource is used instead of another.

Resource Economics

- The prices paid for metals, petroleum, and many other virgin natural resources do not reflect their true environmental costs.
- Including these costs will help basic market principles reward sustainable activities.
- Although 80% of U.S. household waste could be recycled, in 2004 only 20% was recycled, largely because market incentives were lacking.
- Worse, much material collected for recycling is just sent to landfill! E.g. often it is cheaper to use old growth trees than reprocessed paper. Energy and labor costs are often primary factors in price of things.

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Resource Economics

- Closing the recycling loop can be improved by:
  - Developing new products from recycled material
  - "Green taxes" on virgin materials (should be called "pollution taxes" or "environmental degradation taxes")
  - Appeals to consumers
  - But best might just be full cost pricing including cost of disposal, environmental repair, etc. (opposite of e.g. current oil depletion tax credits)

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Jobs and life in a Sustainable World

- **In a high throughput society, jobs actively promote nonrenewable resource depletion and pollution.**
- **In many cases, sustainable activities produce more jobs than unsustainable ones. But this reduces profits since labor is expensive.**
- **Designing more durable and repairable products is an important step toward reducing throughput and curbing the "throwaway" mentality. Again tax on throwaway that included full cost might make longer lasting products cheaper.**

Building Sustainability

Figure 6-10 (a) Cheap resources and environmental sinks. (b) Expensive resources and environmental sinks.

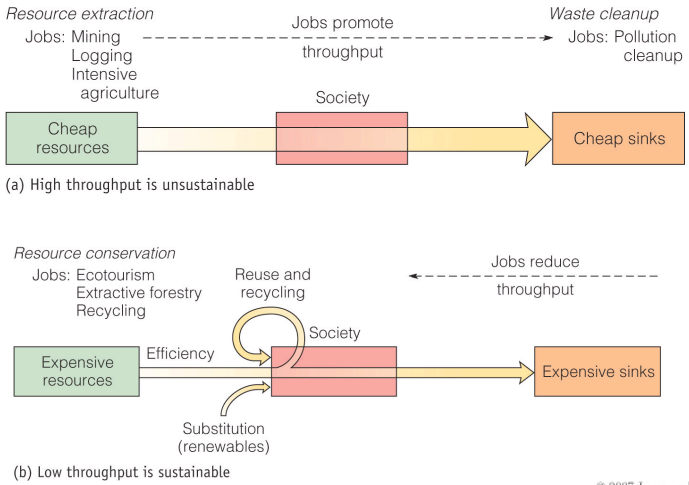

TABLE 6-1 Some Suggestions for Creating a Sustainable Society

Environmentally harmful (unsustainable) activities can be solved in many ways. All of these solutions use efficiency, recycling, and substitution promoted by economic incentives to reduce throughput.

Harmful Activity	Example	Solutions
Extraction	Mining high-grade ore and then moving on to a new site because the land is artificially cheap, while ignoring lower grade ore on the already-disrupted site	Higher land prices (through elimination of subsidies and addition of full costs of environmental disruption) would increase incentives to use more efficient extraction technologies, reducing the area of land disrupted.
Manufacture	Making paper from 90–100% virgin wood fiber	Most paperboard, paper packaging, and office paper can be made with less than 50% virgin input with no loss of quality, potentially saving millions of trees each year.
Product design	Designing discount products—from umbrellas to televisions to houses—that compete for low retail prices but do not last	Design emphasizing durability and repairability would reduce the number of times the consumer has to replace the product and would thus reduce materials consumption.
Community development	Planning communities in which residences are far from workplaces and services	Planning that puts people closer to what they need and with efficient use of already-developed land would reduce the use of cars and thus the need for materials-intensive construction projects such as roads and bridges.
Direct consumption	Stressing immediate convenience of consumption and disposal as the ultimate good, without considering the prospects for sustainable consumption	Making changes in our consumption patterns to promote a culture of conservation: Copying on both sides of the page, using canvas shopping bags, reading books from the library instead of buying new copies, and taking public transportation could ultimately save both money and materials

Source: Modified from Worldwatch Paper 121, *The Next Efficiency Revolution* by John E. Young and Aaron Sachs, with permission of Worldwatch Institute, Washington, D.C. Copyright 1994.

Table 6-1 Some suggestions for creating a sustainable society.

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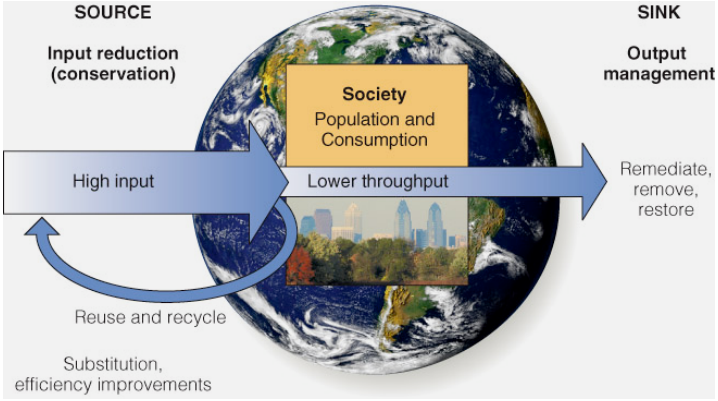

Figure 6-7 Input reduction can be achieved by efficiency improvements, reuse/recycling, and substitution.

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