

MILLER/SPOOLMAN
LIVING IN THE ENVIRONMENT

17TH



CHAPTER 1
**Environmental Problems,
Their Causes, and
Sustainability**

Core Case Study: A Vision of a More Sustainable World in 2060

- A transition in human attitudes toward the environment, and a shift in behavior, can lead to a much better future for the planet in 2060
- **Sustainability**: the capacity of the earth's natural systems and human cultural systems to survive, flourish, and adapt into the very long-term future



Fig. 1-1a, p. 5

1-1 What Are Three Principles of Sustainability?

- ***Concept 1-1A*** *Nature has sustained itself for billions of years by using solar energy, biodiversity, and nutrient cycling.*
- ***Concept 1-1B*** *Our lives and economies depend on energy from the sun and on natural resources and natural services (natural capital) provided by the earth.*

Environmental Science Is a Study of Connections in Nature (1)

- **Environment:**
 - Everything around us
 - “The environment is everything that isn’t me.”
- **Environmental science:** interdisciplinary science connecting information and ideas from
 - Natural sciences: ecology, biology, geology, chemistry...
 - Social sciences: geography, politics, economics
 - Humanities: ethics, philosophy

Environmental Science Is a Study of Connections in Nature (2)

- How nature works
- How the environment affects us
- How we affect the environment
- How to deal with environmental problems
- How to live more sustainably

Nature's Survival Strategies Follow Three Principles of Sustainability

1. **Reliance on solar energy**

- The sun provides warmth and fuels photosynthesis

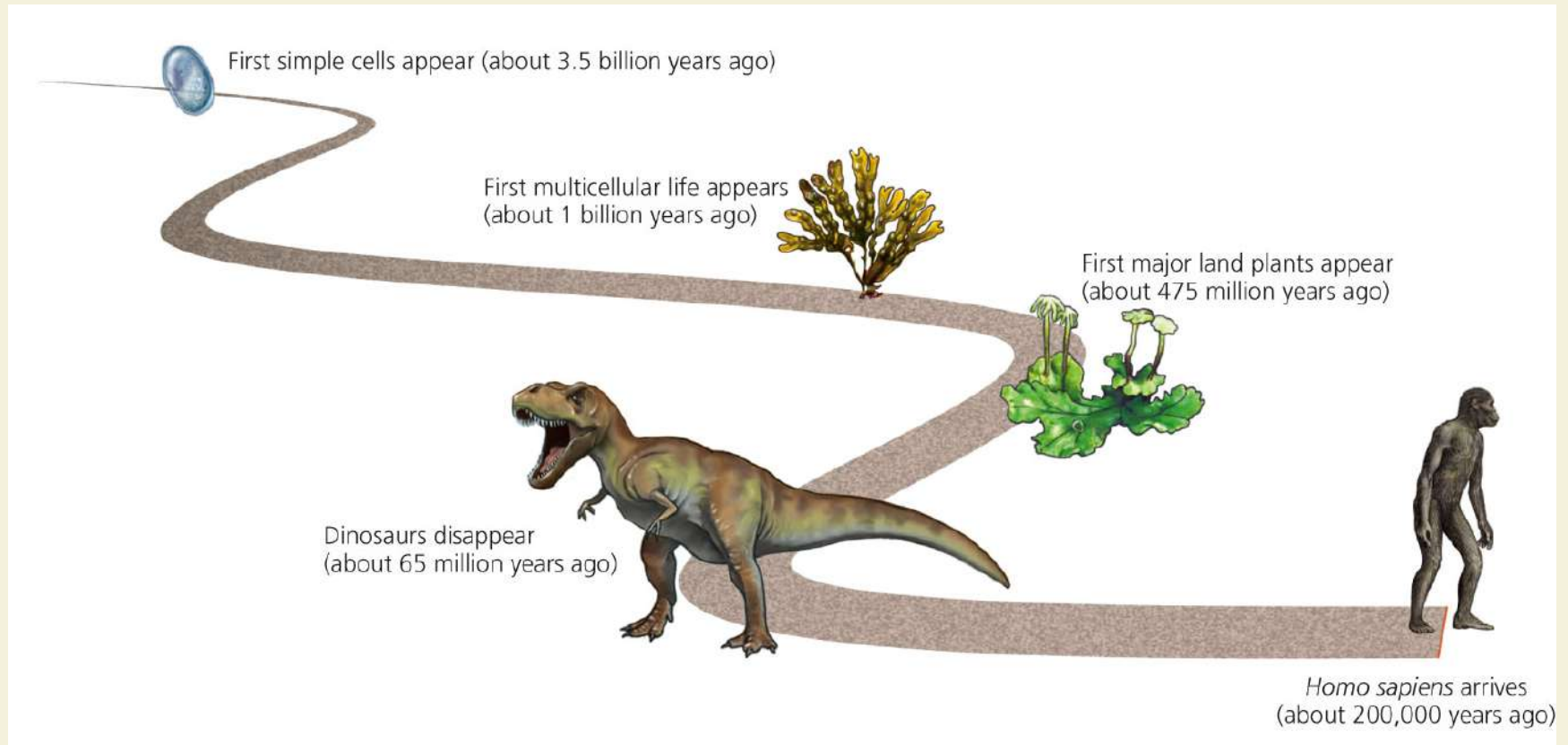
2. **Biodiversity**

- Astounding variety and adaptability of natural systems and species

3. **Chemical cycling**

- Circulation of chemicals from the environment to organisms and then back to the environment
- Also called **nutrient cycling**

From Simple Cell to *Homo Sapiens*



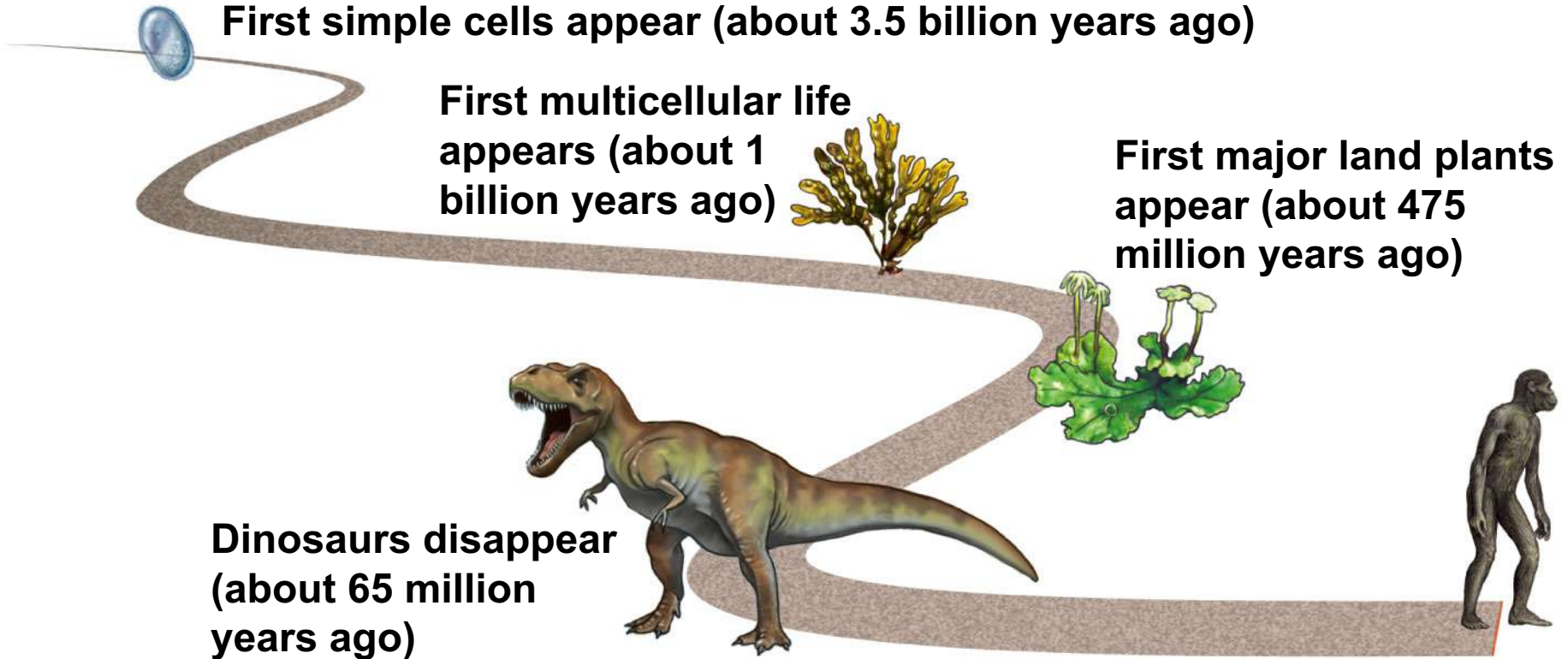
First simple cells appear (about 3.5 billion years ago)

**First multicellular life
appears (about 1
billion years ago)**

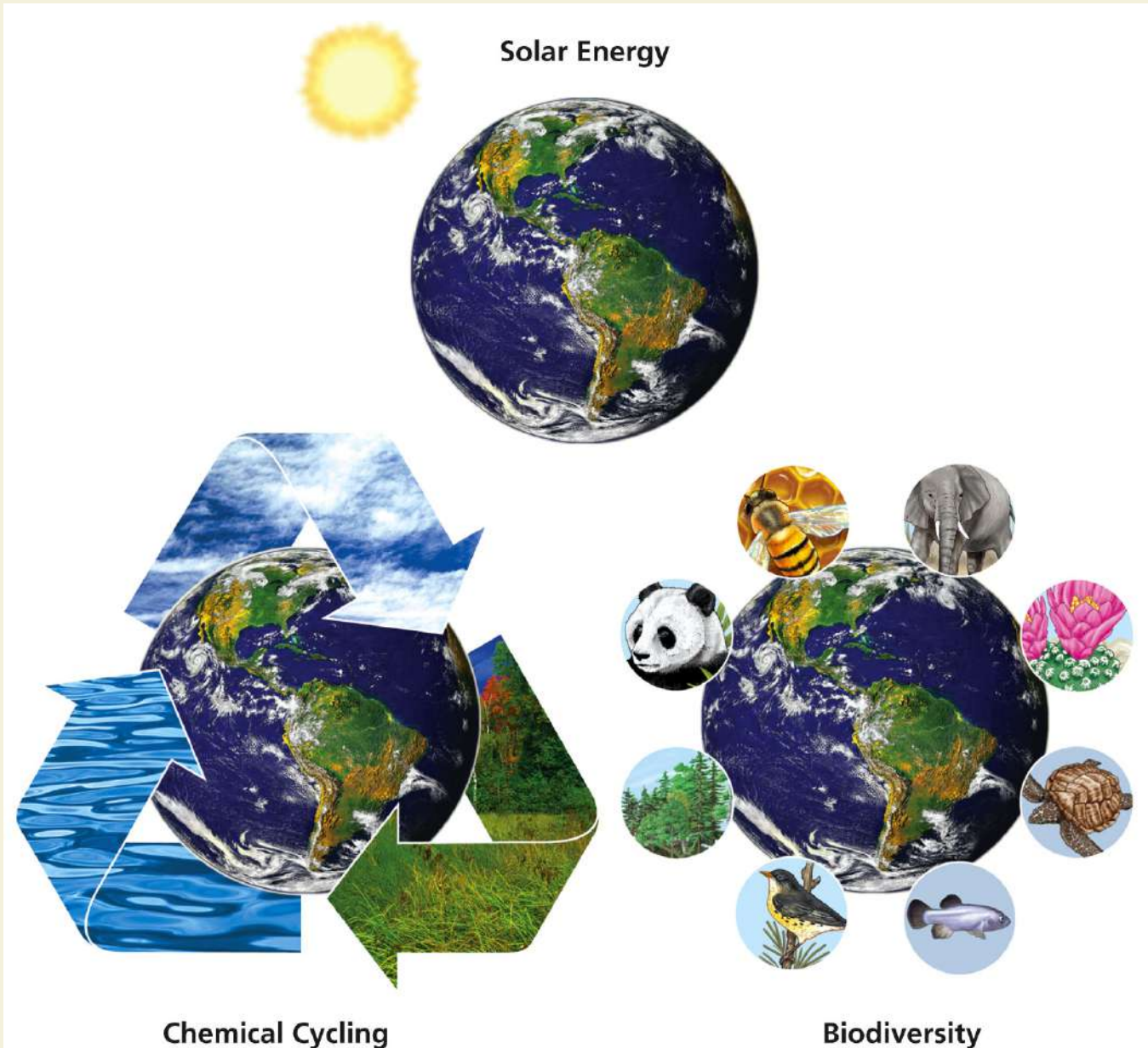
**First major land plants
appear (about 475
million years ago)**

**Dinosaurs disappear
(about 65 million
years ago)**

***Homo sapiens* arrives
(about 200,000 years ago)**



Three Principles of Sustainability



Solar Energy



Chemical Cycling



Biodiversity

Sustainability Has Certain Key Components

- **Natural capital:** supported by solar capital
 - **Natural resources:** useful materials and energy in nature
 - **Natural services:** important nature processes such as renewal of air, water, and soil
- Humans degrade natural capital
- Scientific solutions needed for environmental sustainability

Natural Capital = Natural Resources + Natural Services

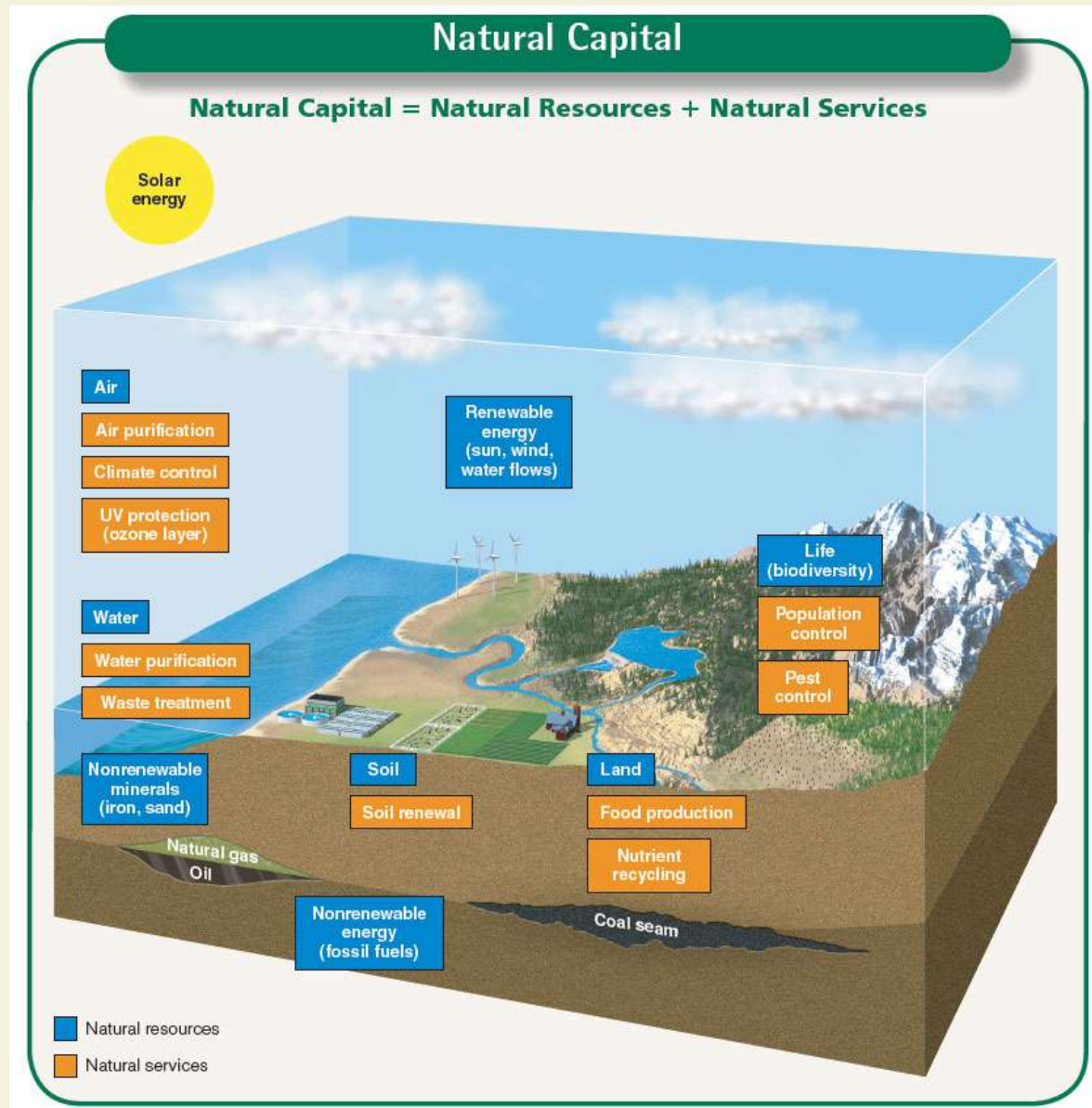


Fig. 1-4, p. 9

**Solar
energy**

Natural Capital

Natural Capital = Natural Resources + Natural Services

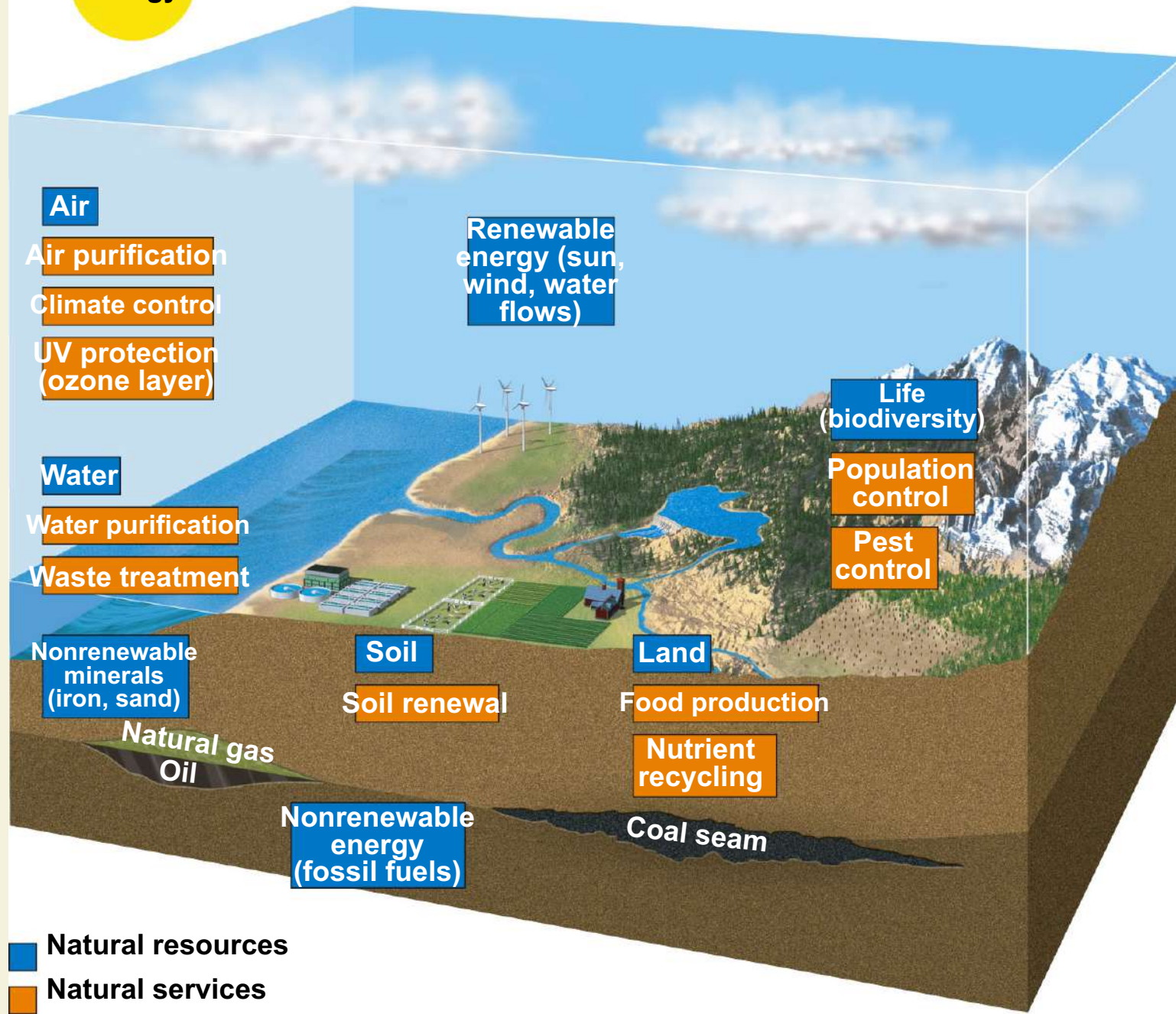


Fig. 1-4, p. 9

Nutrient Cycling

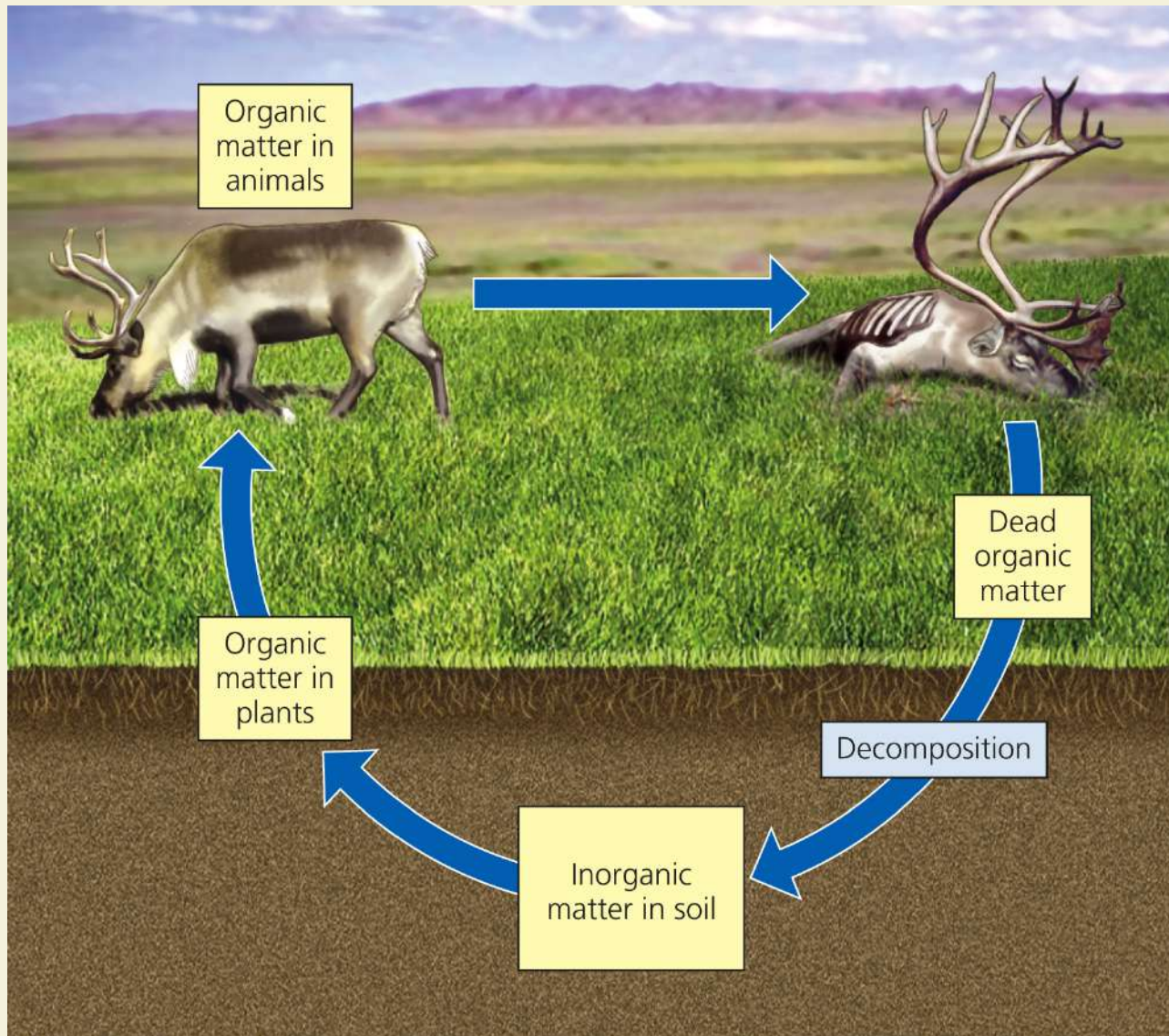


Fig. 1-5, p. 10

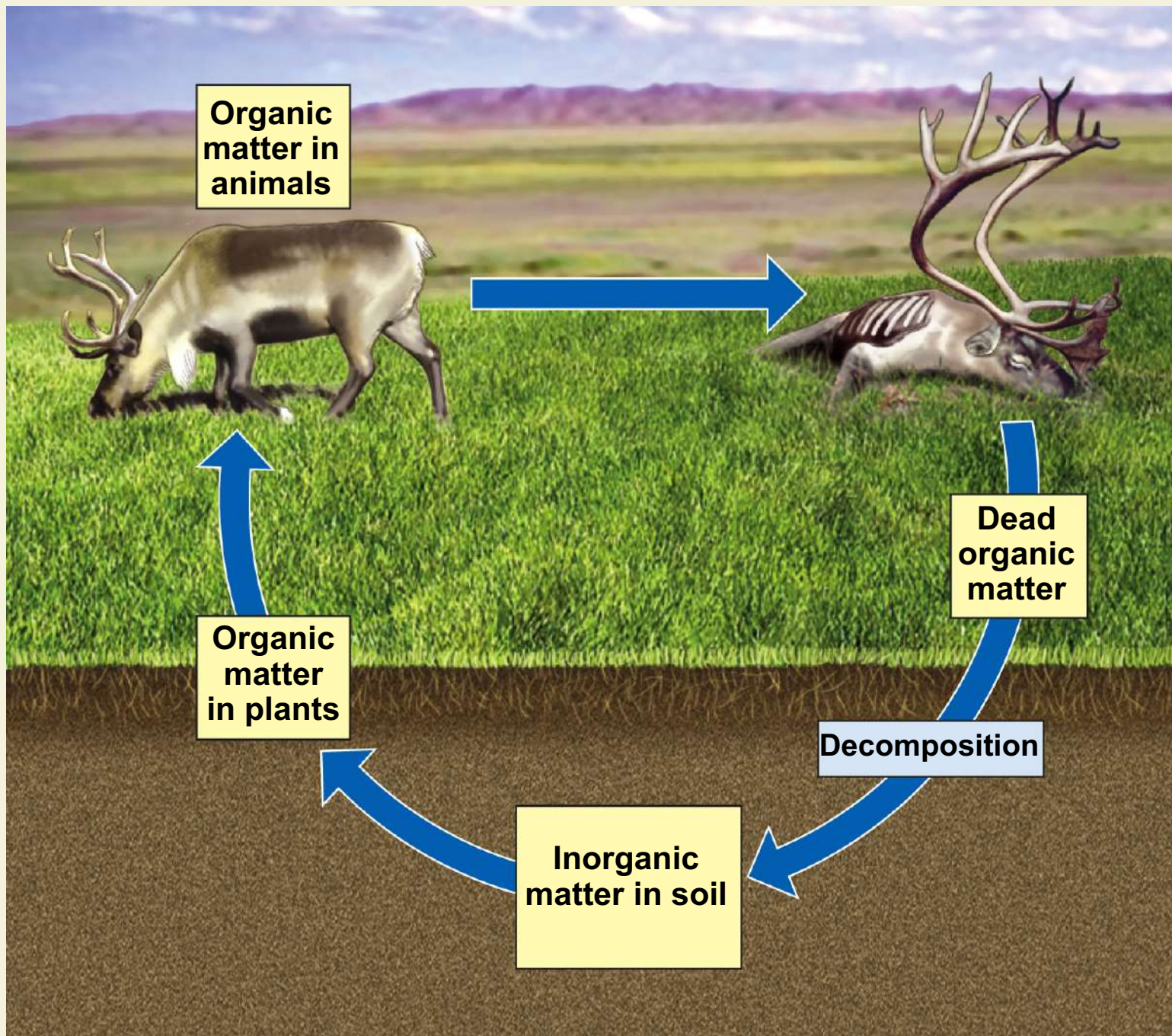


Fig. 1-5, p. 10

Natural Capital Degradation



Fig. 1-6, p. 10

Some Sources Are Renewable and Some Are Not (1)

- **Resource**
 - Anything we obtain from the environment to meet our needs
 - Some directly available for use: sunlight
 - Some not directly available for use: petroleum
- **Perpetual resource**
 - Solar energy

Some Sources Are Renewable and Some Are Not (2)

- **Renewable resource**
 - Several days to several hundred years to renew
 - E.g., forests, grasslands, fresh air, fertile soil
- **Sustainable yield**
 - Highest rate at which we can use a renewable resource without reducing available supply

Some Sources Are Renewable and Some Are Not (3)

- **Nonrenewable resources**
 - Energy resources
 - Metallic mineral resources
 - Nonmetallic mineral resources
- **Reuse**
- **Recycle**

Reuse



Recycle



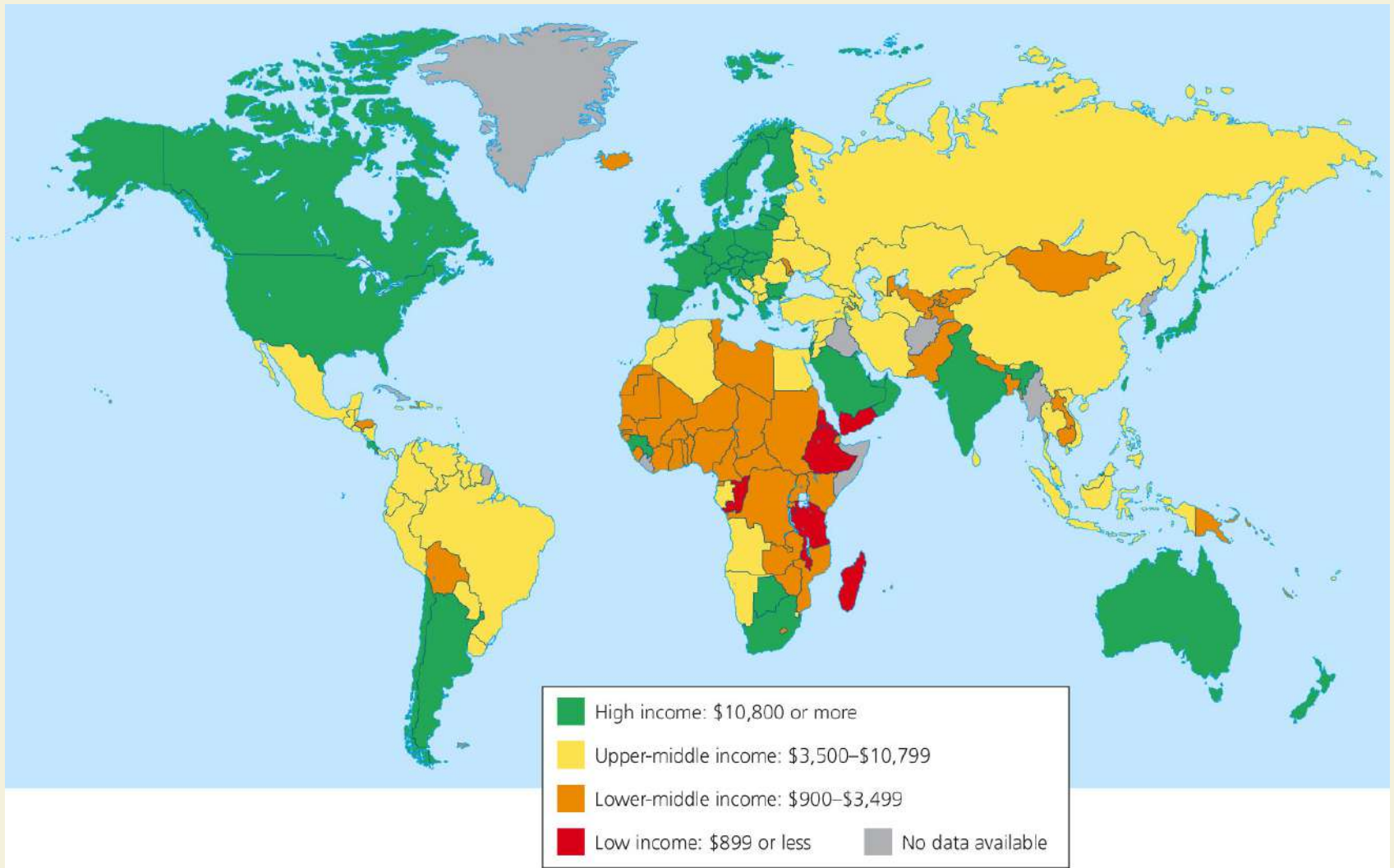
Countries Differ in Levels of Unsustainability (1)

- **Economic growth:** increase in output of a nation's goods and services
- **Gross domestic product (GDP):** annual market value of all goods and services produced by all businesses, foreign and domestic, operating within a country
- **Per capita GDP:** one measure of economic development

Countries Differ in Levels of Unsustainability (2)

- **Economic development:** using economic growth to raise living standards
- **More-developed countries:** North America, Australia, New Zealand, Japan, most of Europe
- **Less-developed countries:** most countries in Africa, Asia, Latin America

Countries by Gross National Income per Capita



1-2 How Are Our Ecological Footprints Affecting the Earth?

- ***Concept 1-2*** *As our ecological footprints grow, we are depleting and degrading more of the earth's natural capital.*

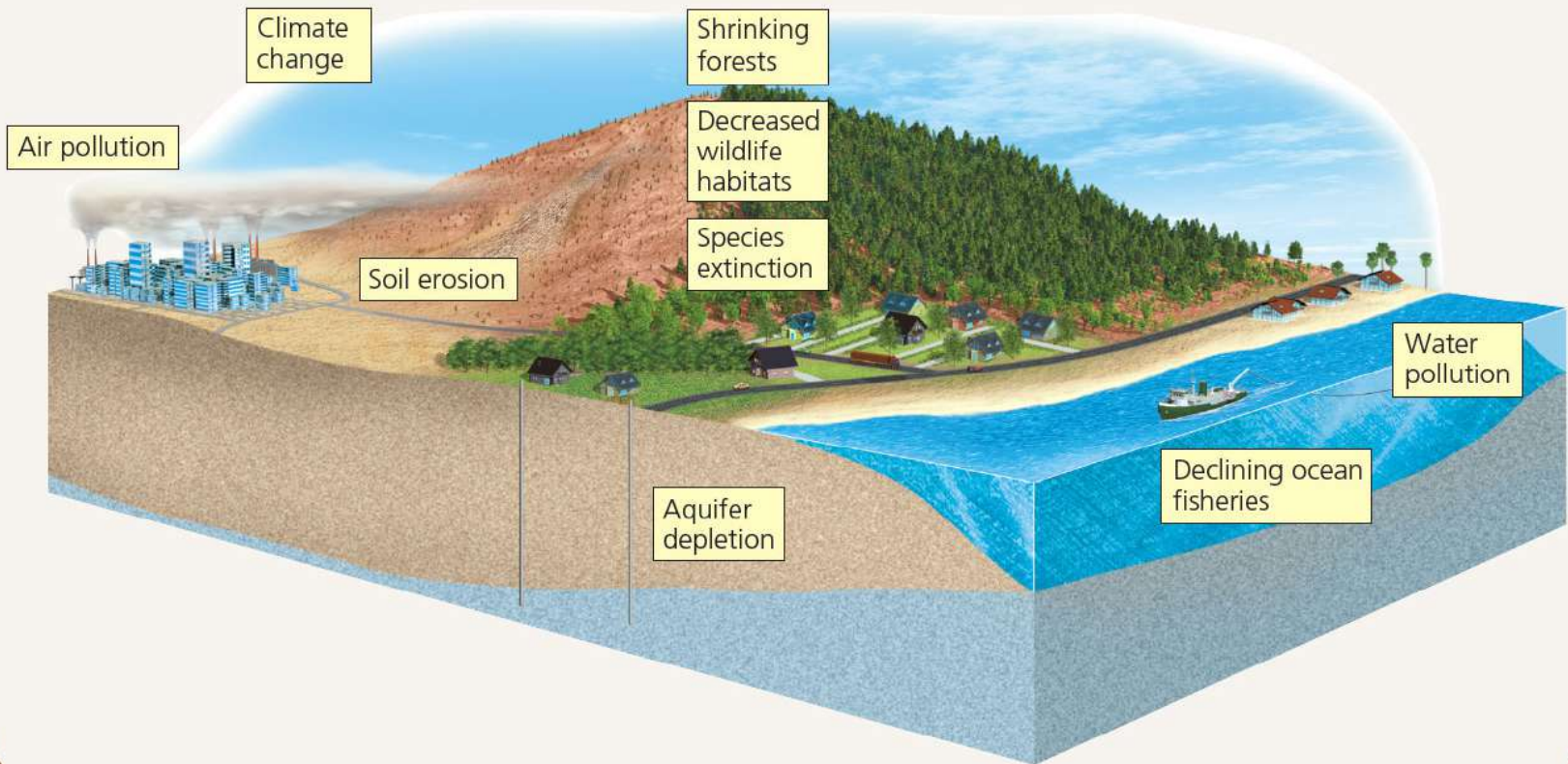
We Are Living Unsustainably

- **Environmental degradation**: wasting, depleting, and degrading the earth's natural capital
 - Happening at an accelerating rate
 - Also called **natural capital degradation**

Natural Capital Degradation

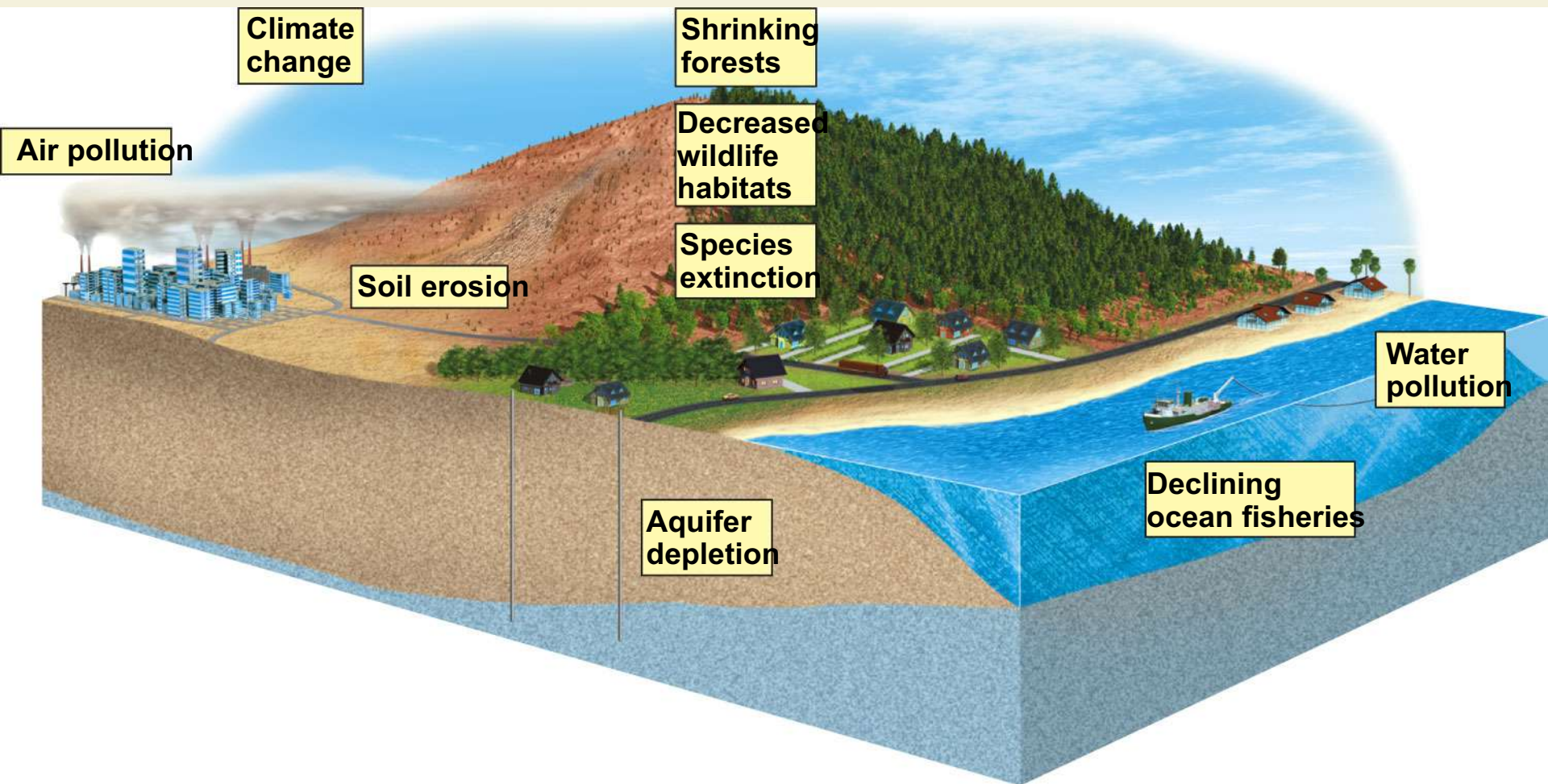
Natural Capital Degradation

Degradation of Normally Renewable Natural Resources



Natural Capital Degradation

Degradation of Normally Renewable Natural Resources



Pollution Comes from a Number of Sources (1)

- Sources of pollution
 - **Point sources**
 - E.g., smokestack
 - **Nonpoint sources**
 - E.g., pesticides blown into the air
- Main type of pollutants
 - **Biodegradable**
 - **Nondegradable**
- Unwanted effects of pollution

Pollution Comes from a Number of Sources (2)

- **Pollution cleanup (output pollution control)**
- **Pollution prevention (input pollution control)**

Point-Source Air Pollution



Nonpoint Source Water Pollution



Overexploiting Shared Renewable Resources: Tragedy of the Commons

- Three types of property or resource rights
 - Private property
 - Common property
 - Open access renewable resources
- Tragedy of the commons
 - Common property and open-access renewable resources degraded from overuse
 - Solutions

Ecological Footprints: A Model of Unsustainable Use of Resources

- **Ecological footprint:** the amount of biologically productive land and water needed to provide the people in a region with indefinite supply of renewable resources, and to absorb and recycle wastes and pollution
- **Per capita ecological footprint**
- Unsustainable: footprint is larger than biological capacity for replenishment

Patterns of Natural Resource Consumption



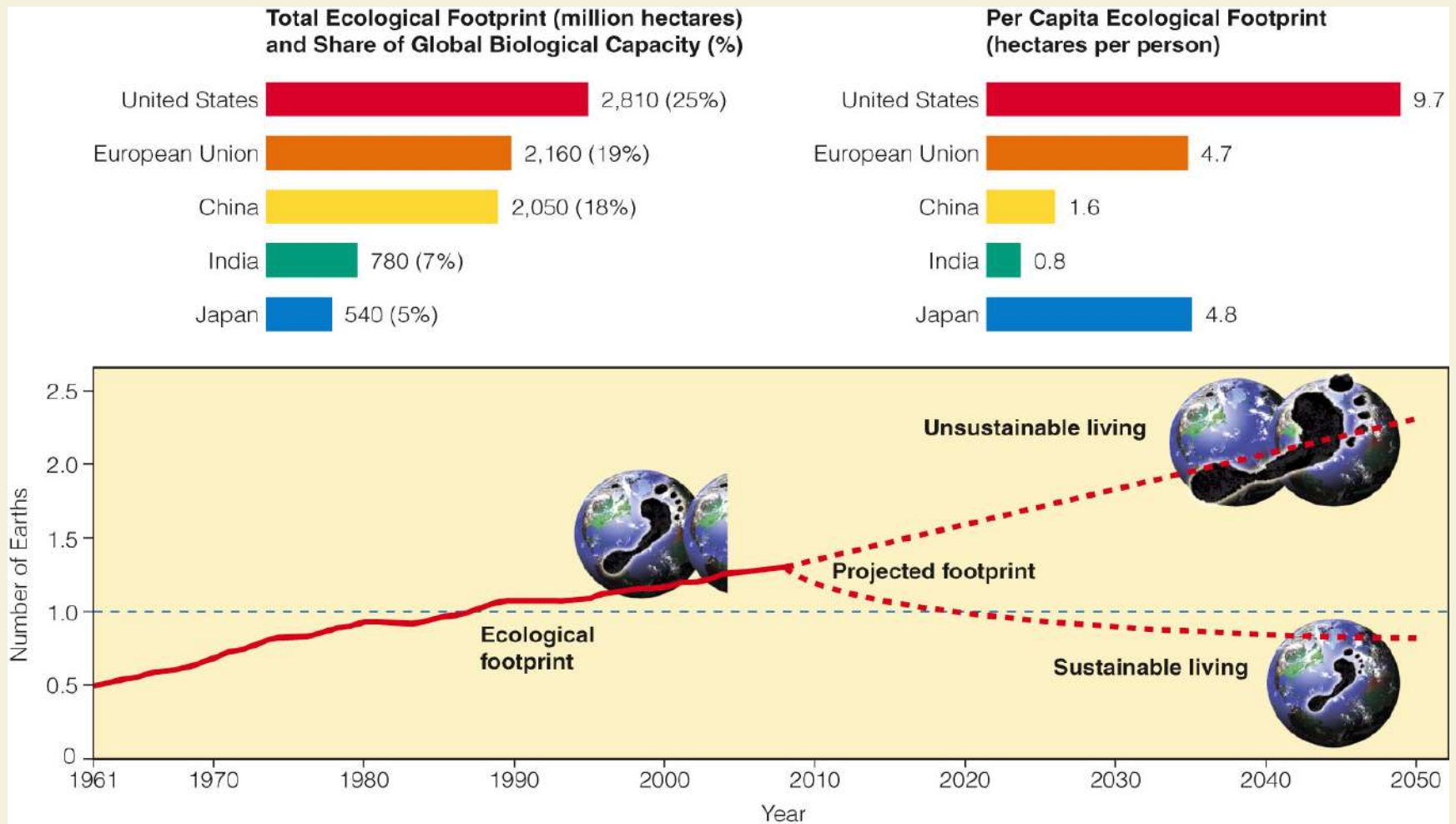
Fig. 1-12a, p. 15

Patterns of Natural Resource Consumption

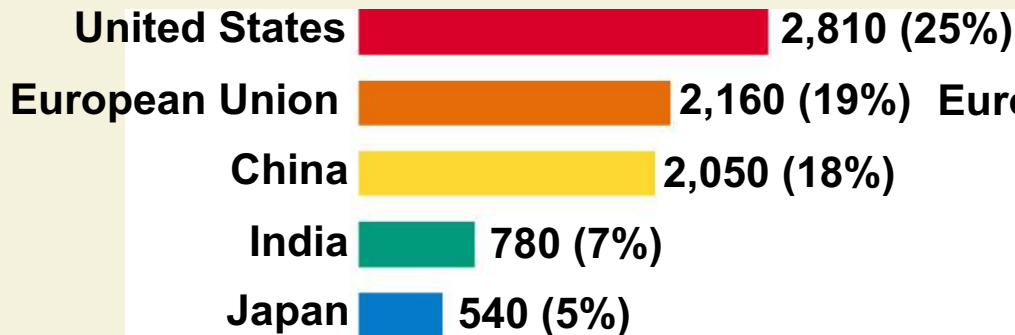


Fig. 1-12b, p. 15

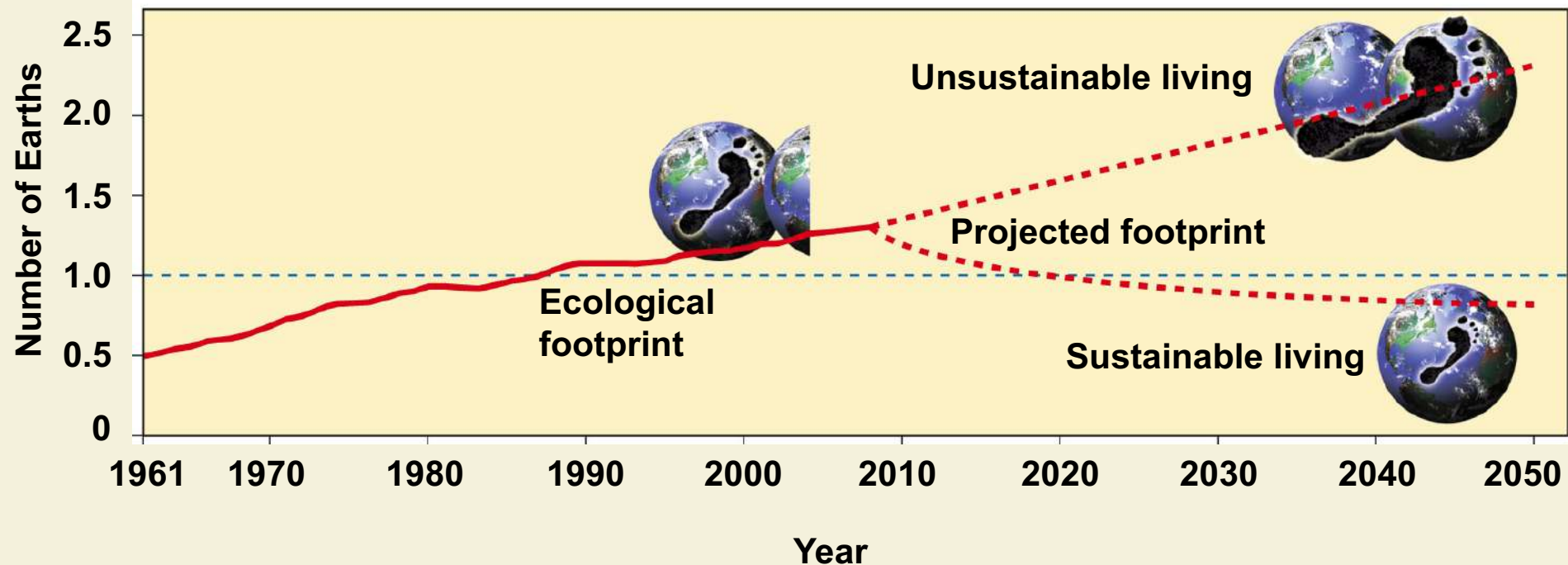
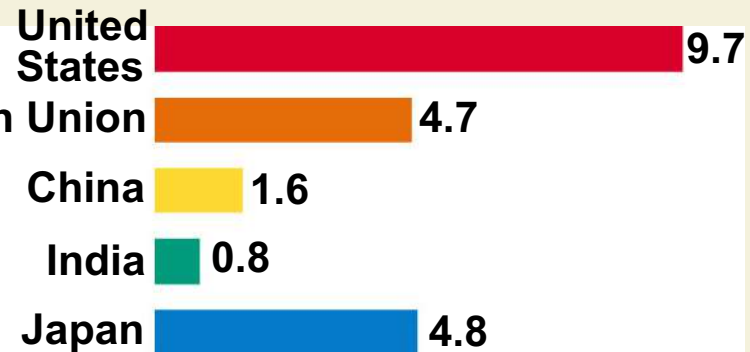
Natural Capital Use and Degradation



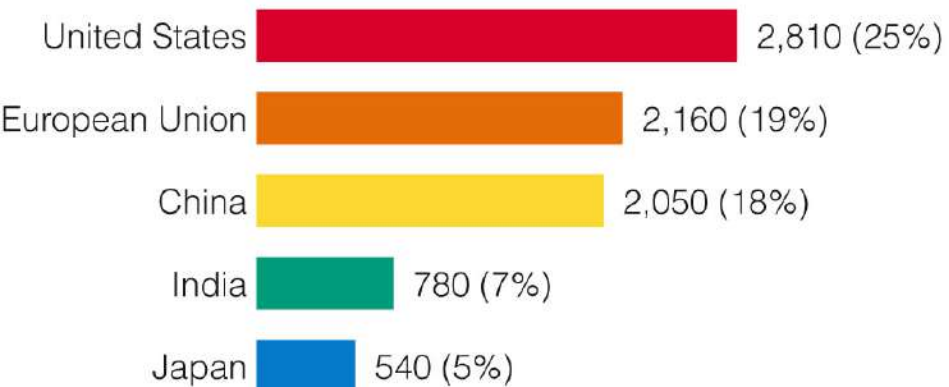
Total Ecological Footprint (million hectares) and Share of Global Biological Capacity (%)



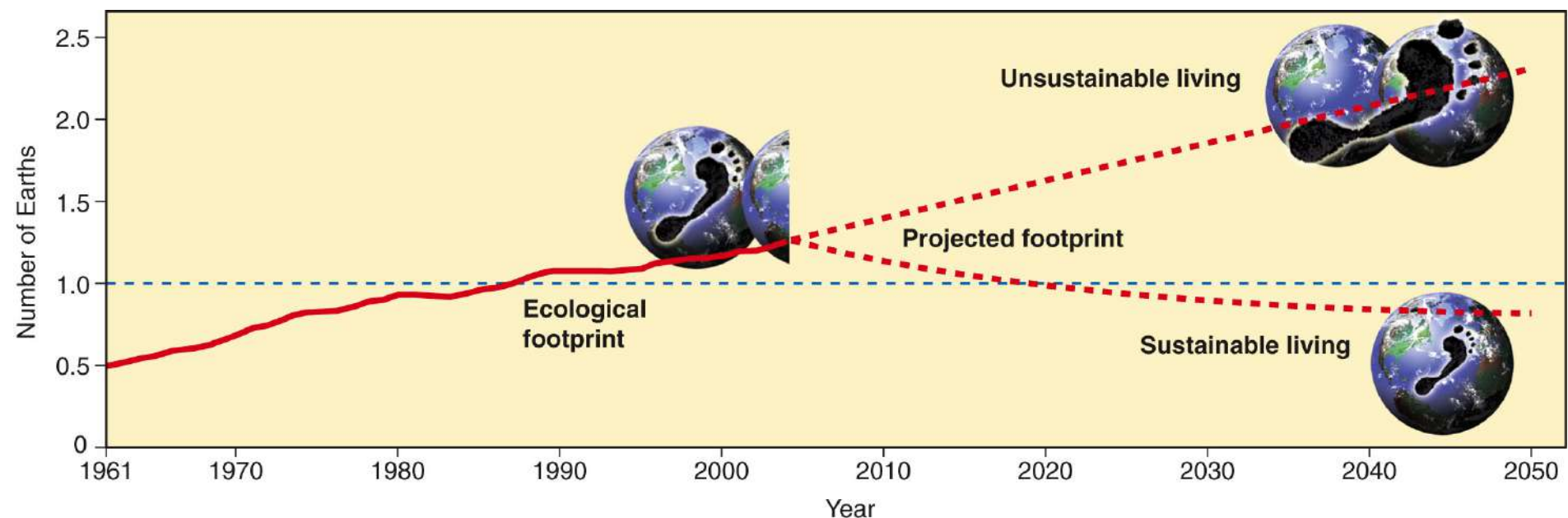
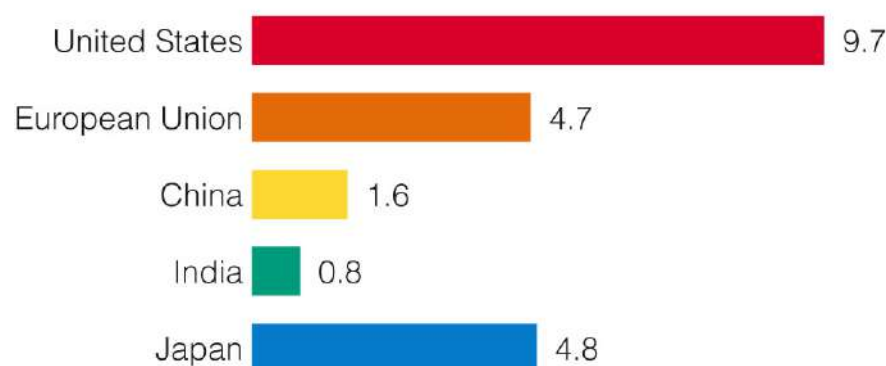
Per Capita Ecological Footprint (hectares per person)



Total Ecological Footprint (million hectares) and Share of Global Ecological Capacity (%)



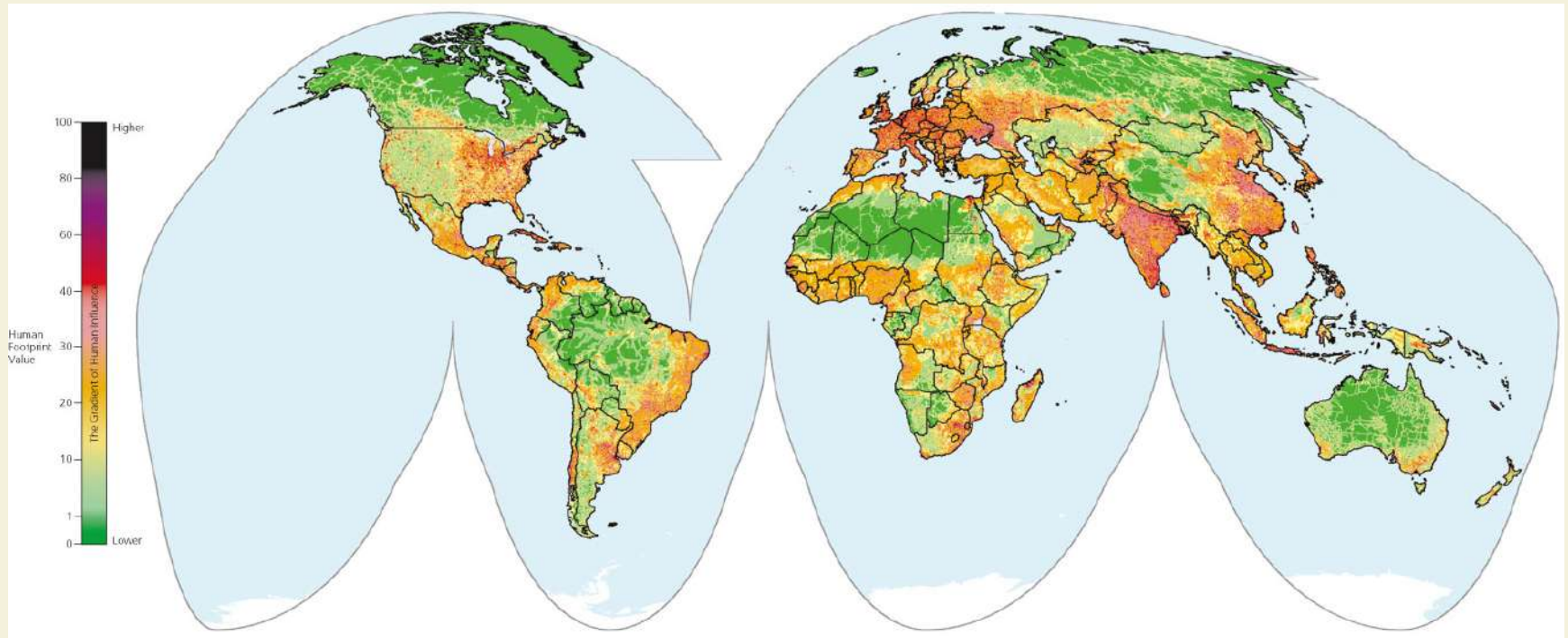
Per Capita Ecological Footprint (hectares per person)



Stepped Art

Fig. 1-13, p. 16

Global Human Footprint Map

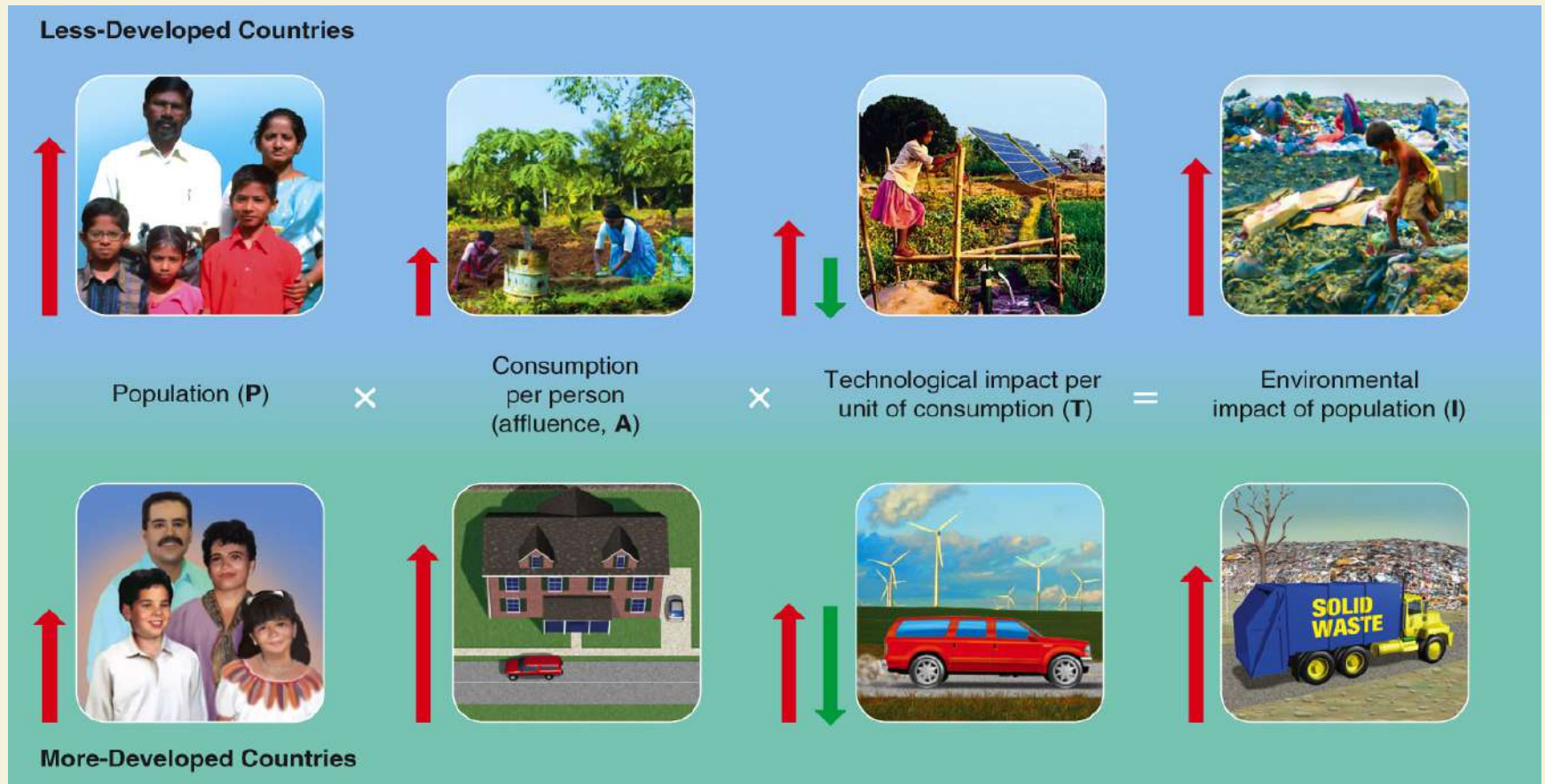


IPAT is Another Environmental Impact Model

$$I = P \times A \times T$$

- I = Environmental impact
- P = Population
- A = Affluence
- T = Technology

IPAT Illustrated



Less-Developed Countries

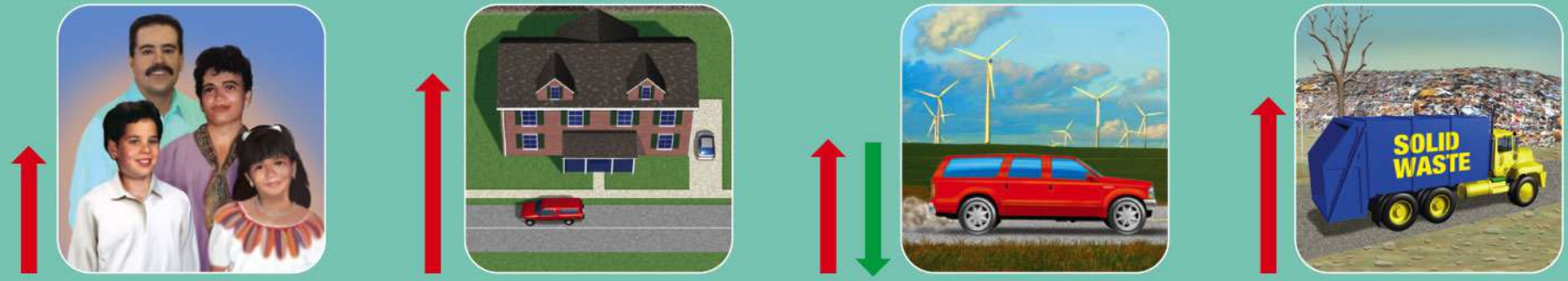


Population (P) ×

Consumption
per person
(affluence, A)

× Technological
impact per unit of
consumption (T) =

Environmental
impact of
population (I)



More-Developed Countries

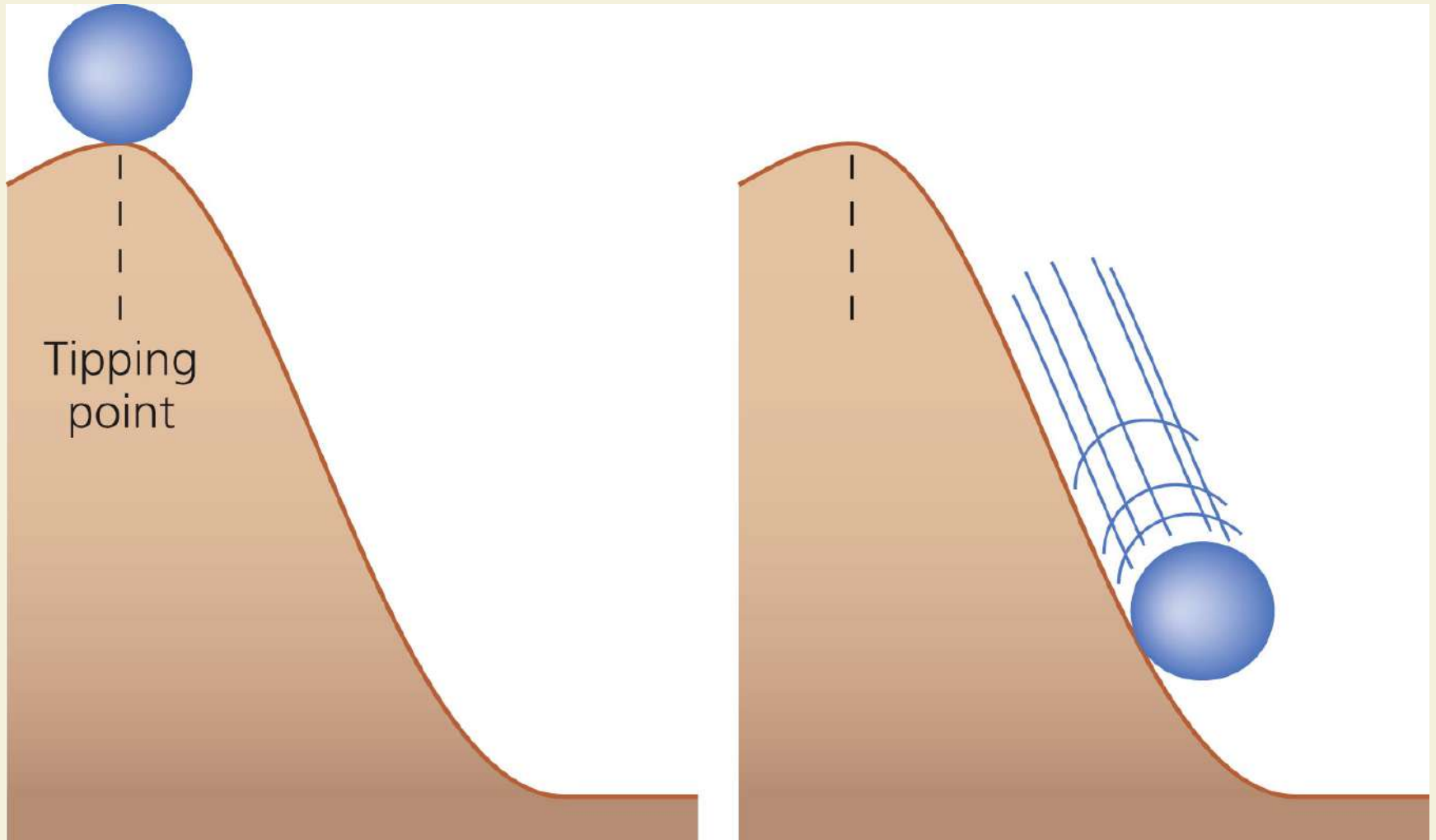
Case Study: China's New Affluent Consumers

- Leading consumer of various foods and goods
 - Wheat, rice, and meat
 - Coal, fertilizers, steel, and cement
- Second largest consumer of oil
- Two-thirds of the most polluted cities are in China
- Projections for next decade
 - Largest consumer and producer of cars

Natural Systems Have Tipping Points

- **Ecological tipping point:** an often irreversible shift in the behavior of a natural system
- Environmental degradation has time delays between our actions now and the deleterious effects later
 - Long-term climate change
 - Over-fishing
 - Species extinction

Tipping Point



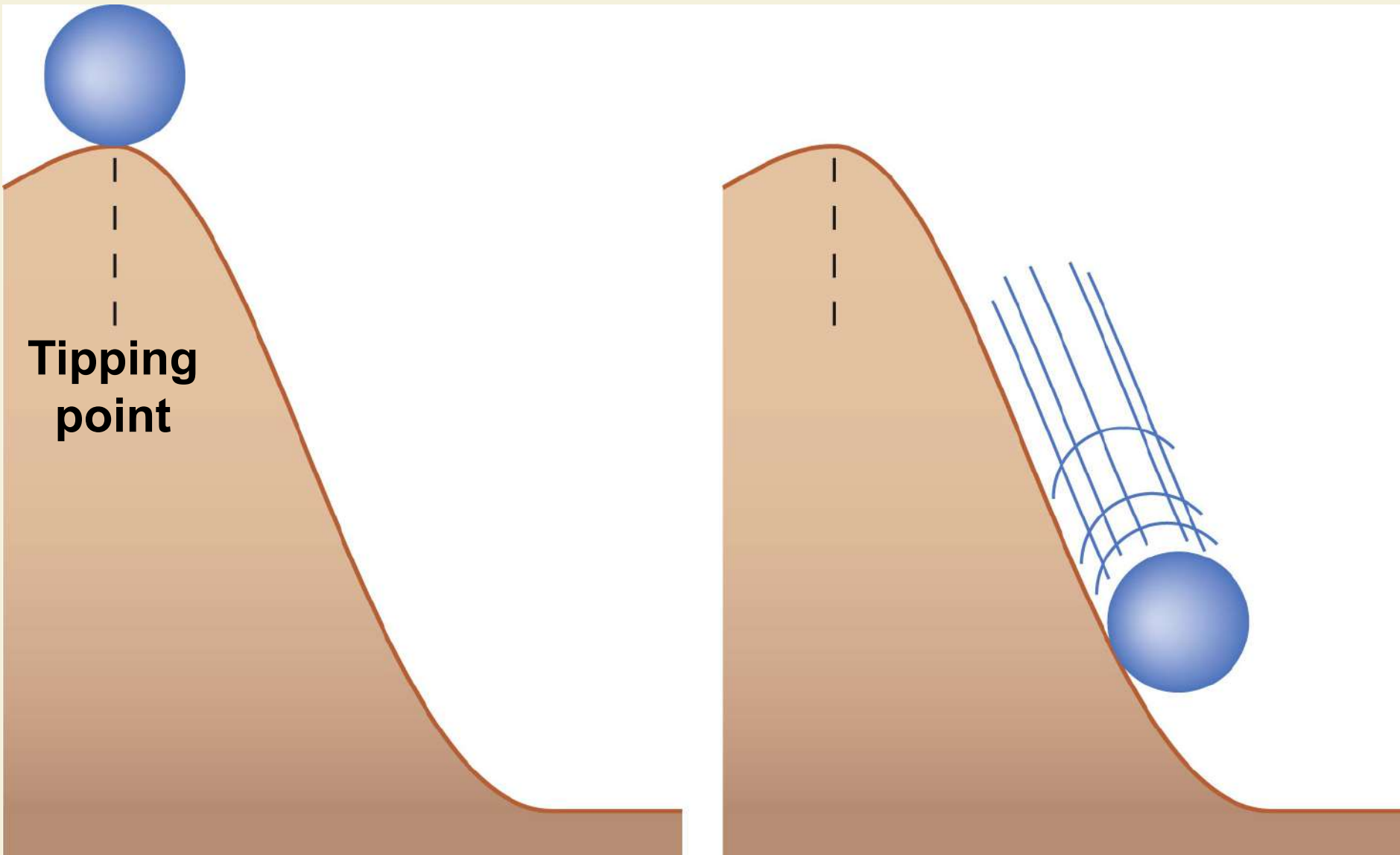
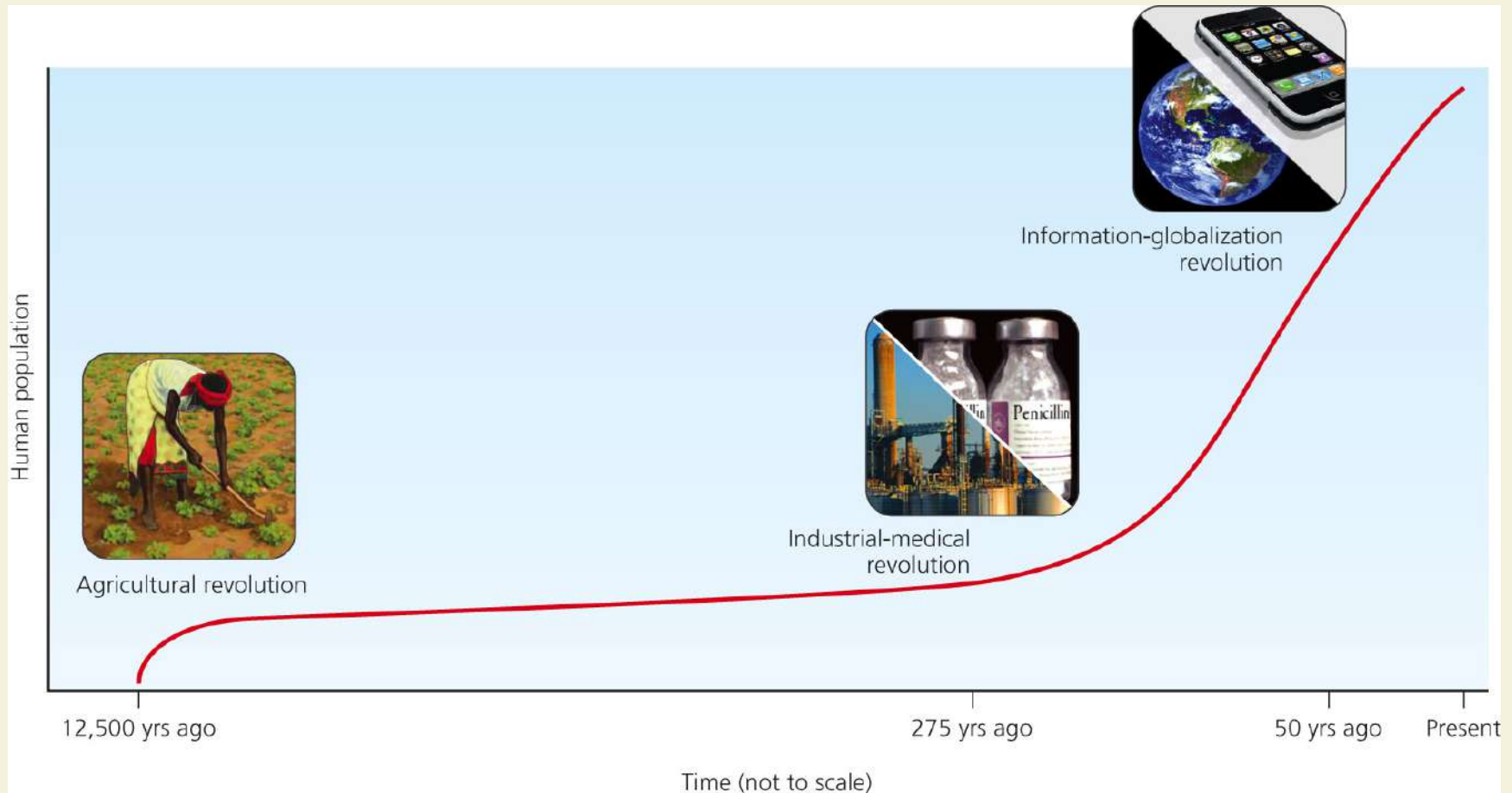


Fig. 1-15, p. 19

Cultural Changes Have Increased Our Ecological Footprints

- 12,000 years ago: hunters and gatherers
- Three major cultural events
 - Agricultural revolution
 - Industrial-medical revolution
 - Information-globalization revolution
- Current need for a **sustainability revolution**

Technology Increases Population



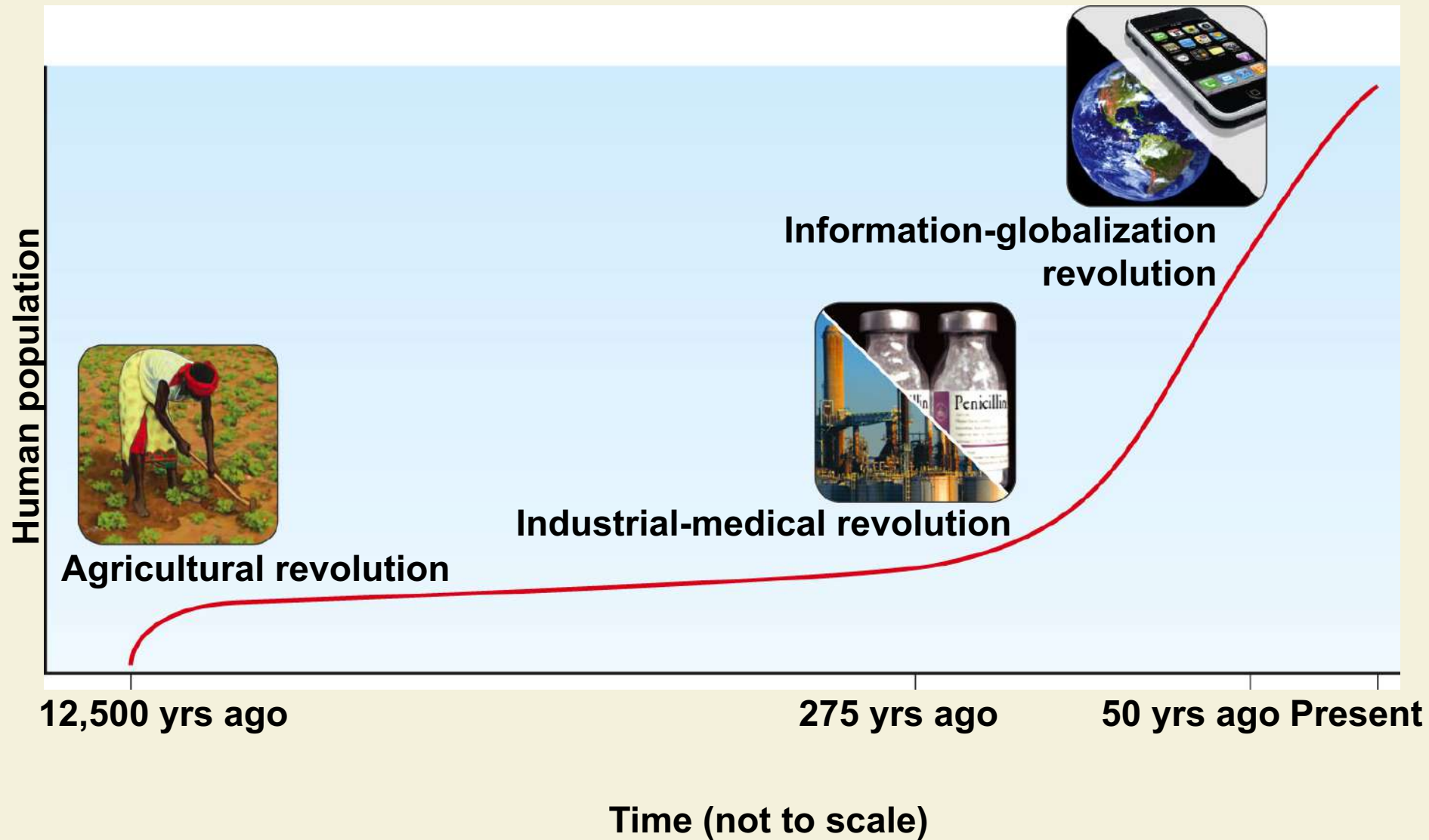


Fig. 1-16, p. 19

1-3 Why Do We Have Environmental Problems?

- **Concept 1-3** *Major causes of environmental problems are population growth, wasteful and unsustainable resource use, poverty, and exclusion of environmental costs of resource use from the market prices of goods and services.*

Experts Have Identified Four Basic Causes of Environmental Problems

1. Population growth
2. Wasteful and unsustainable resource use
3. Poverty
4. Failure to include the harmful environmental costs of goods and services in market prices

Causes of Environmental Problems

Causes of Environmental Problems



Population growth



Unsustainable resource use



Poverty



Excluding environmental costs from market prices

Causes of Environmental Problems



Population growth



Unsustainable resource use



Poverty



Excluding environmental costs from market prices

Causes of Environmental Problems



Population growth



Unsustainable resource use



Poverty



Excluding environmental costs from market prices

Exponential Growth of Human Population

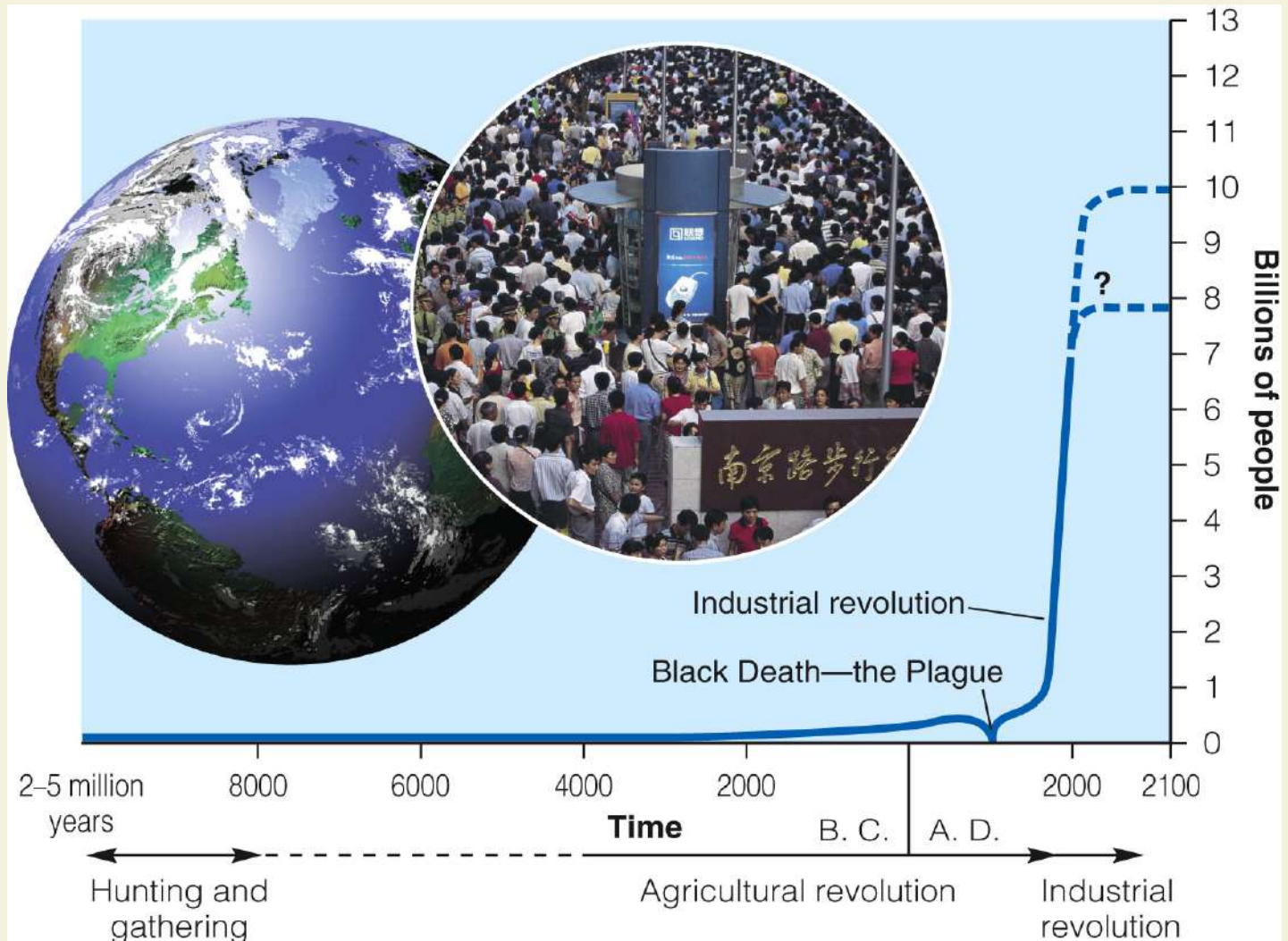


Fig. 1-18, p. 21

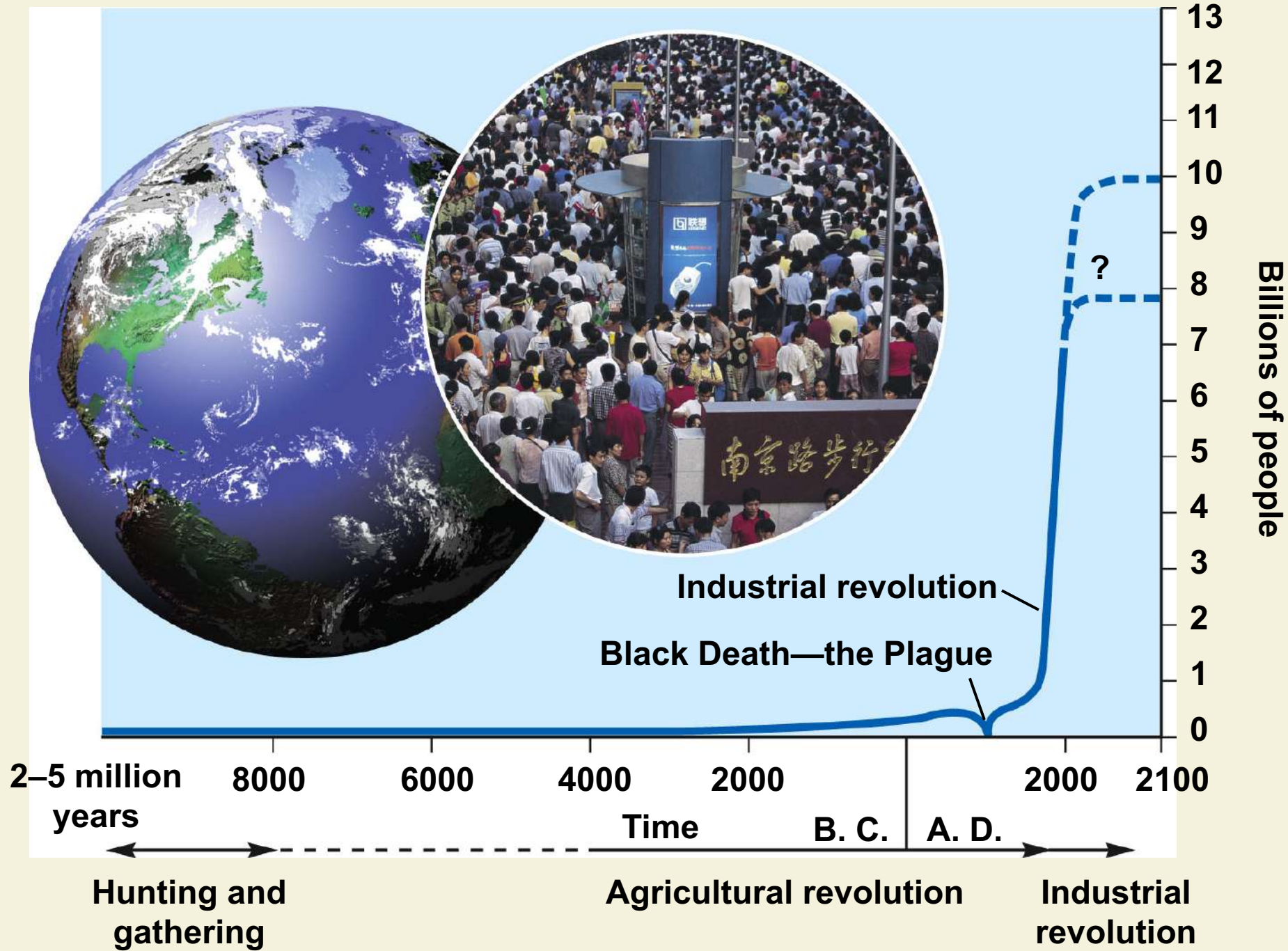


Fig. 1-18, p. 21

Affluence Has Harmful and Beneficial Environmental Effects

- Harmful environmental impact due to
 - High levels of consumption
 - High levels of pollution
 - Unnecessary waste of resources
- Affluence can provide funding for developing technologies to reduce
 - Pollution
 - Environmental degradation
 - Resource waste

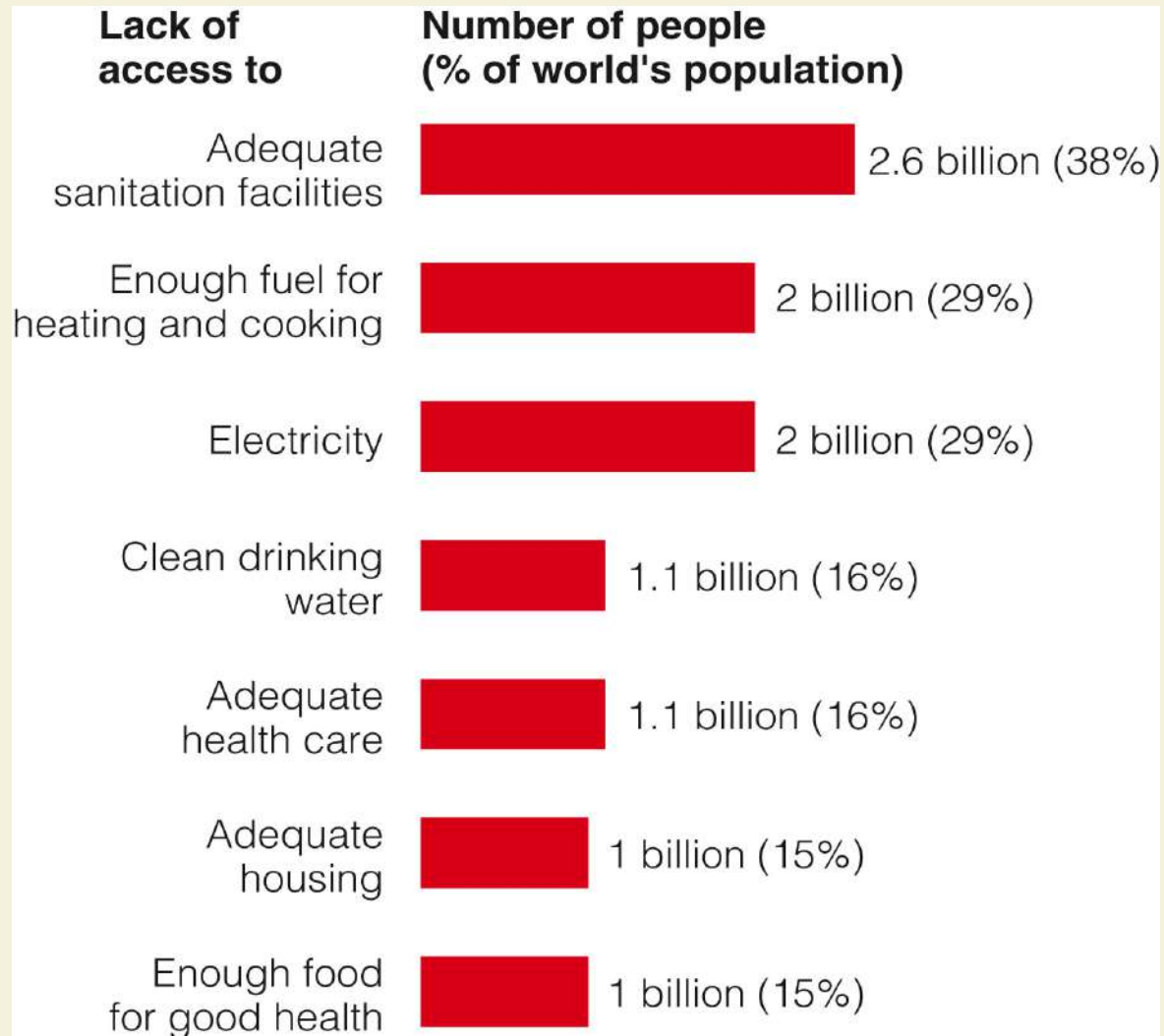
Poverty Has Harmful Environmental and Health Effects

- Population growth affected
- Malnutrition
- Premature death
- Limited access to adequate sanitation facilities and clean water

Extreme Poverty



Harmful Effects of Poverty



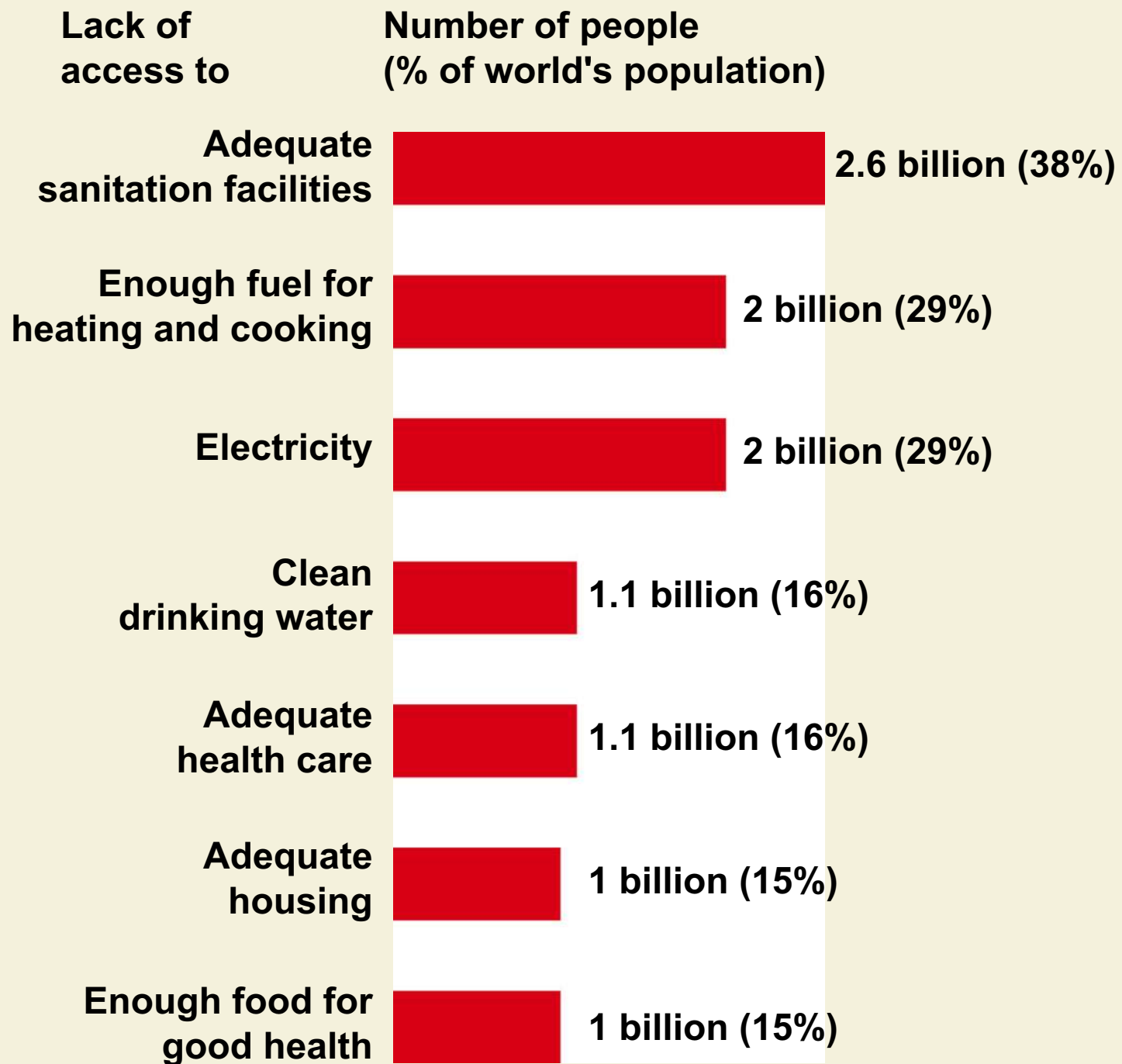


Fig. 1-20, p. 22

Effects of Malnutrition



Prices Do Not Include the Value of Natural Capital

- Companies do not pay the environmental cost of resource use
- Goods and services do not include the harmful environmental costs
- Companies receive tax breaks and subsidies
- Economy may be stimulated but there may be a degradation of natural capital

Environmentally Unfriendly Hummer



Different Views about Environmental Problems and Their Solutions

- **Environmental ethics**: what is right and wrong with how we treat the environment
- **Planetary management worldview**
 - We are separate from and in charge of nature
- **Stewardship worldview**
 - Manage earth for our benefit with ethical responsibility to be stewards
- **Environmental wisdom worldview**
 - We are part of nature and must engage in sustainable use

1-4 What Is an Environmentally Sustainable Society?

- **Concept 1-4** *Living sustainably means living off the earth's natural income without depleting or degrading the natural capital that supplies it.*

Environmentally Sustainable Societies Protect Natural Capital and Live Off Its Income

- **Environmentally sustainable society**: meets current needs while ensuring that needs of future generations will be met
- Live on natural income of **natural capital** without diminishing the natural capital

We Can Work Together to Solve Environmental Problems

- **Social capital**
 - Encourages
 - Openness and communication
 - Cooperation
 - Hope
 - Discourages
 - Close-mindedness
 - Polarization
 - Confrontation and fear

Case Study: The Environmental Transformation of Chattanooga, TN

- Environmental success story: example of building their social capital
- 1960: most polluted city in the U.S.
- 1984: *Vision 2000*
- 1995: most goals met
- 1993: *Revision 2000*

Chattanooga, Tennessee



Individuals Matter

- 5–10% of the population can bring about major social change
- We have only 50-100 years to make the change to sustainability before it's too late
- Rely on renewable energy
- Protect biodiversity
- Reduce waste and pollution

Wind Power



Planting a Tree



Three Big Ideas

- 1. We could rely more on renewable energy from the sun, including indirect forms of solar energy such as wind and flowing water, to meet most of our heating and electricity needs.
- 2. We can protect biodiversity by preventing the degradation of the earth's species, ecosystems, and natural processes, and by restoring areas we have degraded.

Three Big Ideas

3. We can help to sustain the earth's natural chemical cycles by reducing our production of wastes and pollution, not overloading natural systems with harmful chemicals, and not removing natural chemicals faster than those chemical cycles can replace them.