

# Challenging Problems of Ecology



# Core Case Study: It's All About Sustainability (1)

- “The ability of the earth’s various natural systems and human cultural systems and economies to survive and adapt to changing environmental conditions indefinitely.”
- United Nations *Millennium Ecosystem Assessment*:
  - Human actions of put long-term sustainability in doubt
- Life on earth for 3.5 billion years
  - Survived many catastrophes
  - Humans have caused major changes in the last 500 years
  - Humans are smart, but are they wise?

# Core Case Study: It's All About Sustainability (2)

- Sustainability depends on three key principles
- 1. **Solar energy**
  - Warms earth
  - Provides energy for plants to make food for other organisms
  - Powers winds
  - Powers the hydrologic cycle – which includes flowing water
  - Provides energy: wind and moving water can be turned into electricity

# Core Case Study: It's All About Sustainability (3)

- **2. Biodiversity** (biological diversity)
  - Large variety of species
  - Many ecosystems
    - Deserts
    - Forests
    - Oceans
    - Grasslands
  - Species and systems renew soil and purify air and water.

# Core Case Study: It's All About Sustainability (4)

- **3. Chemical Cycling**
  - Natural processes recycle nutrients
  - Recycling is necessary because there is a fixed supply of these nutrients on earth
  - Nutrients cycle from living organisms to the nonliving environment and back
  - Chemical cycles are necessary to sustain life

# Solar Energy



**Chemical Cycling**



**Biodiversity**

# Solutions

- Understand our environment
- Practice sustainability

# *1-1 What Is an Environmentally Sustainable Society?*

- **Concept 1-1A** *Our lives and economies depend on energy from the sun and natural resources and natural services (natural capital) provided by the earth.*
- **Concept 1-1B** *Living sustainably means living off earth's natural income without depleting or degrading the natural capital that supplies it.*



# Studying Connections in Nature

- **Environment**
- **Environmental Science**
- **Ecology**
- **Organisms**
- **Species**
- **Ecosystem**
- **Environmentalism**

# Living More Sustainably

- **Sustainability** – central theme
- **Natural capital**
  - **Natural resources**
  - **Natural services**
  - **Photosynthesis**
    - Powered by solar energy
- Human activities degrade natural capital

# Natural Resources

- Materials
  - **Renewable**
    - Air, water, soil, plants
  - **Nonrenewable**
    - Minerals, oil, coal

# Natural Services

- Functions of nature
  - Purification of air, water
  - **Nutrient cycling**
    - From the environment to organisms and back to the environment

# Natural Capital

**Natural Capital = Natural Resources + Natural Services**

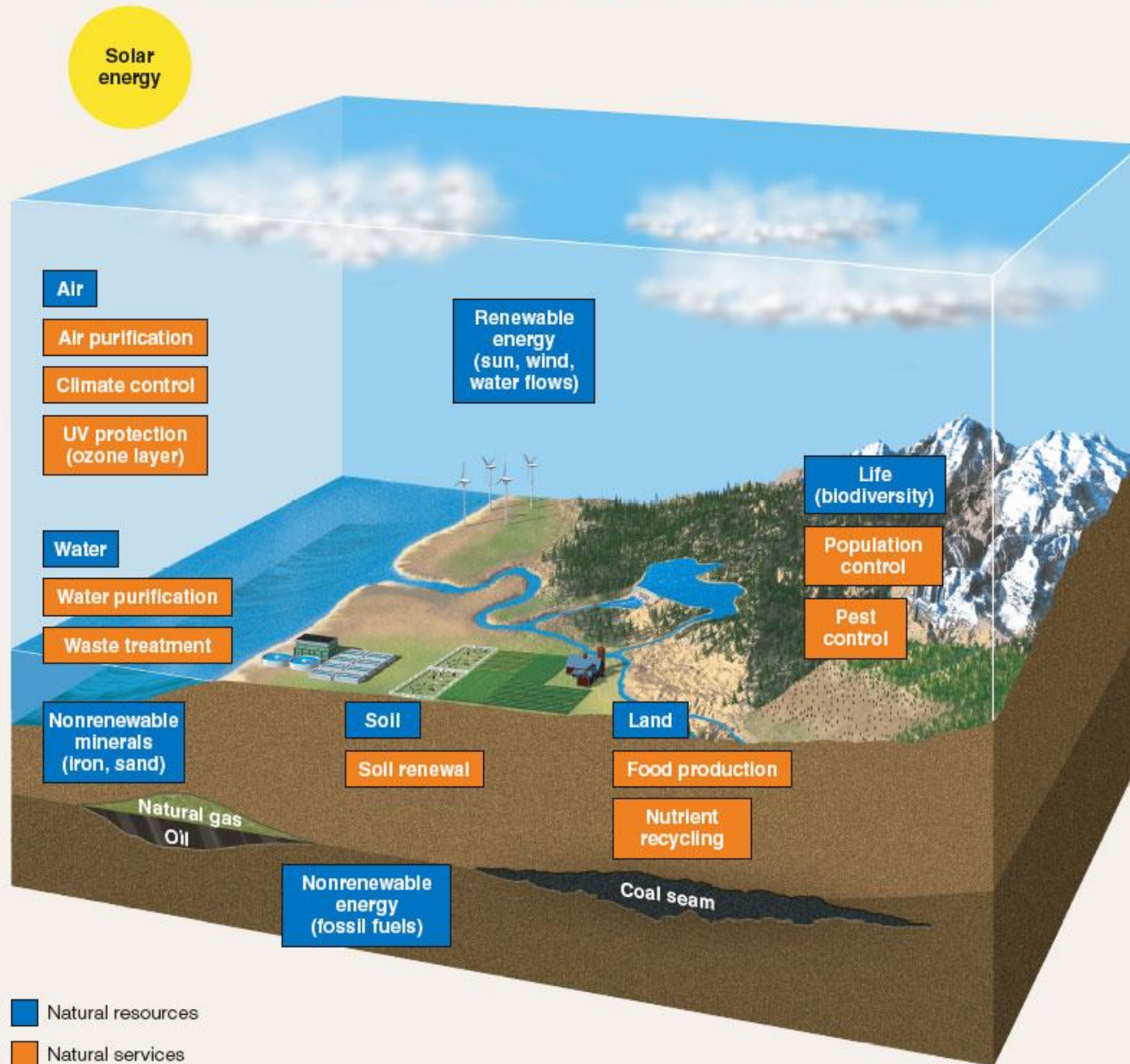


Fig. 1-2, p. 7

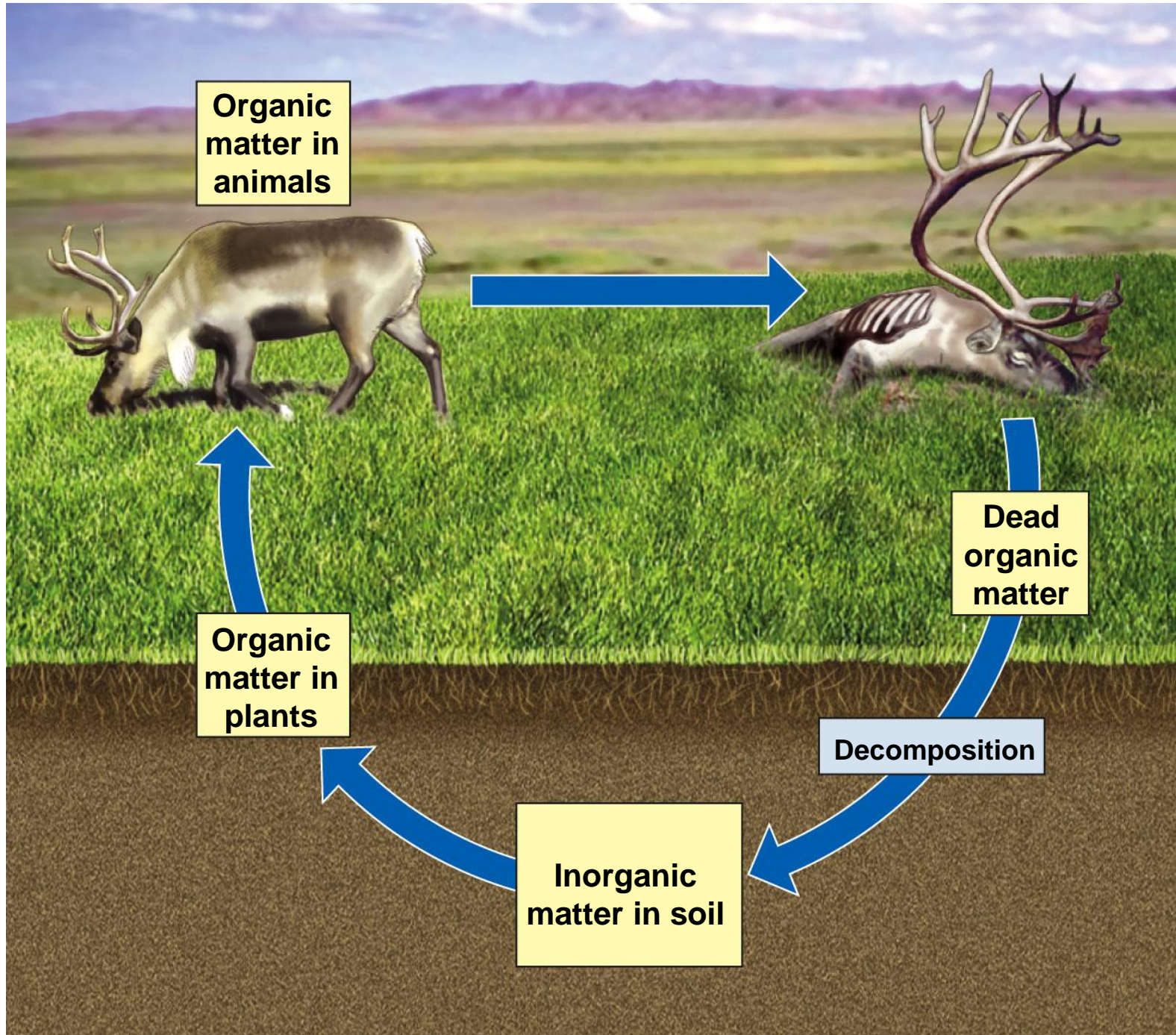


Fig. 1-3, p. 8

# Environmental Sustainability

- Trade-offs (compromises)
- Sound science
- Individuals matter
  - Ideas
  - Technology
  - Political pressure
  - Economic pressure

# Sustainable Living from Natural Capital

- **Environmentally sustainable society**
- Financial capital and financial income
- **Natural capital** and **natural income**
- **Living sustainably**: living on natural income only



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

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

# Natural Resources (1)

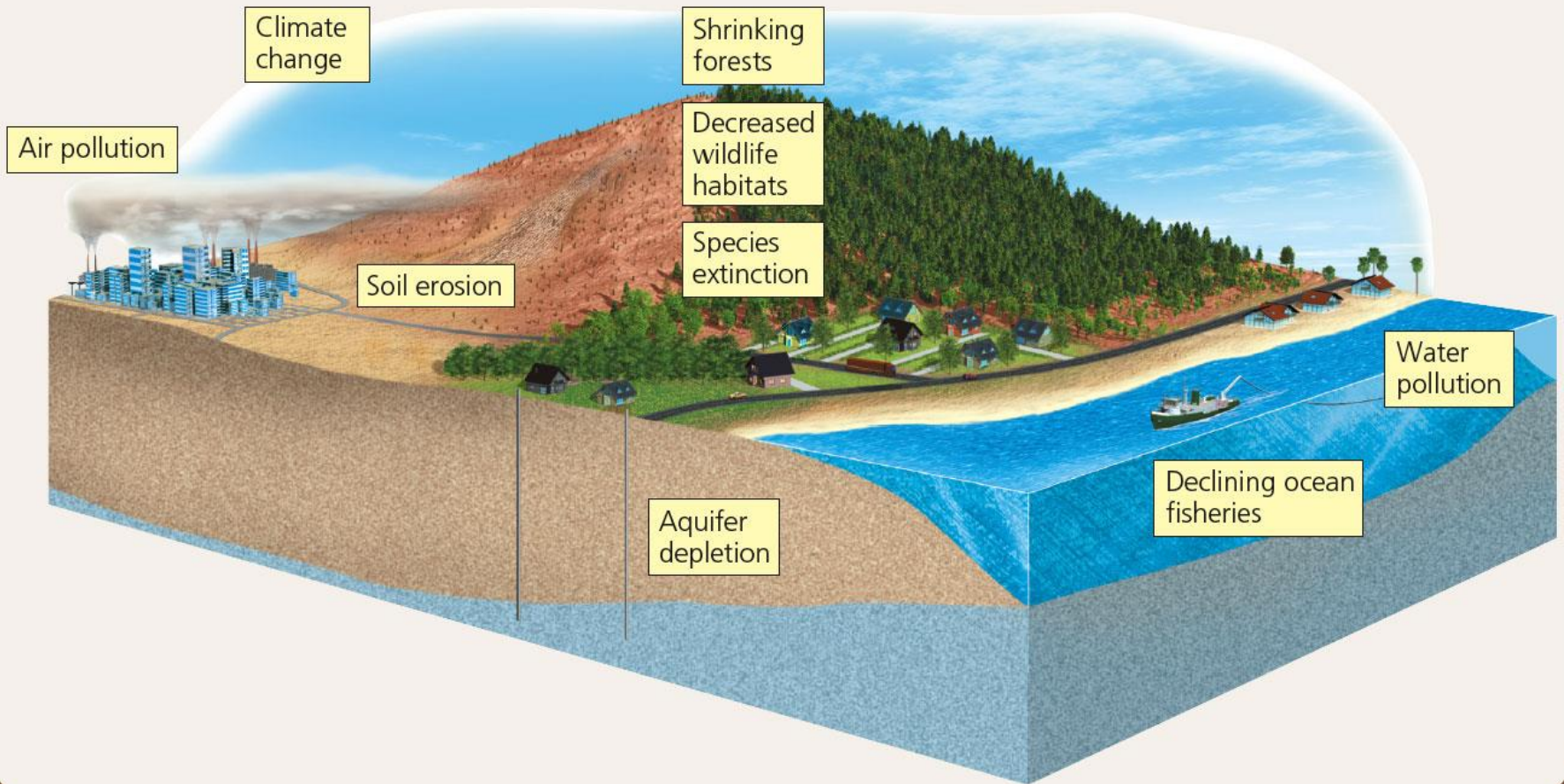
- **Perpetual** – renewed continuously
  - Solar energy
- **Renewable** – days to centuries
  - Water
  - Air
  - Grasslands
  - Forest
  - Soils
  - Fish populations

# Natural Resources (2)

- **Sustainable yield**
  - Highest use while maintaining supply
- **Environmental degradation**
  - Use exceeds natural replacement rate

# Natural Capital Degradation

## Degradation of Normally Renewable Natural Resources



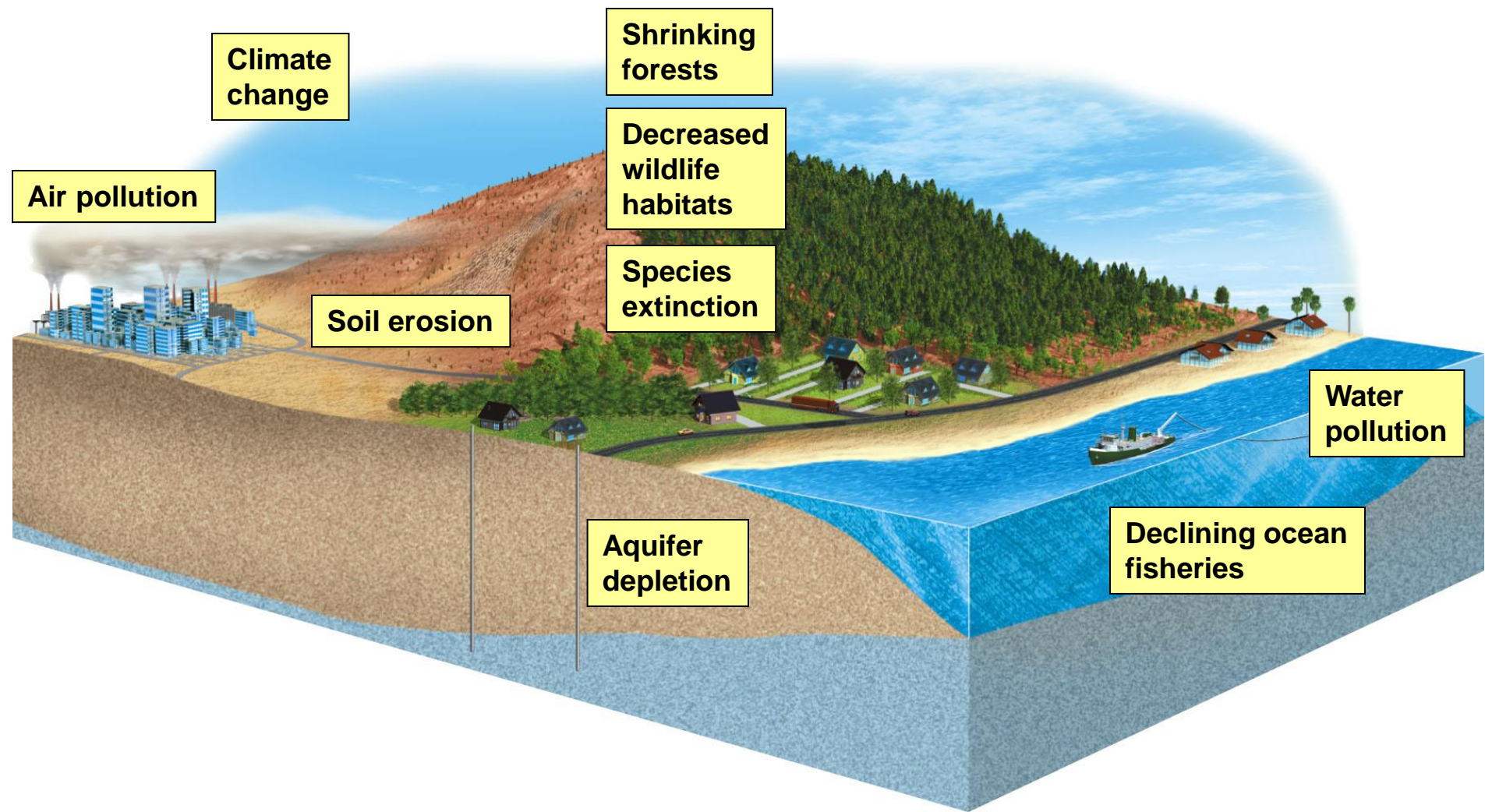


Fig. 1-4, p. 10

# Tragedy of the Commons

- Environmental degradation of openly shared renewable resources
- Users focus on their own selfish, short-term gain
- Works when only a small number of users
- Big part of why humans now live unsustainably

# Ecological Footprint (1)

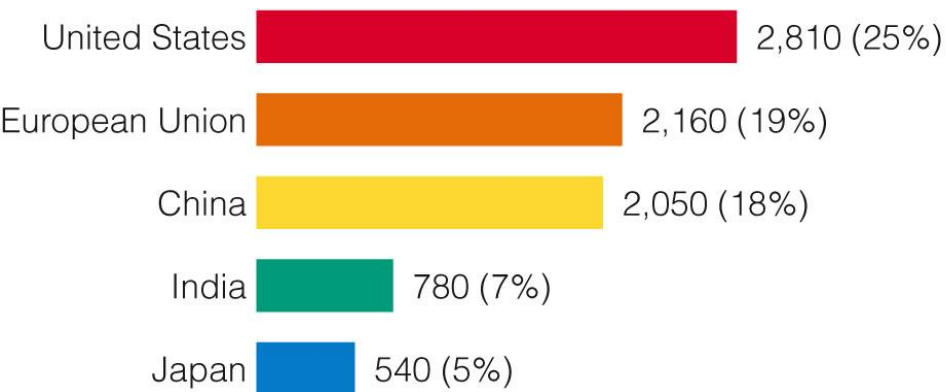
- **Ecological footprint**
  - The amount of biologically productive land and water needed to indefinitely supply the people in a given area with renewable resources
  - Also includes the land and water necessary to absorb and recycle wastes and pollution
- **Per capita ecological footprint**
  - Average ecological footprint of an individual in a given area

# Ecological Footprint (2)

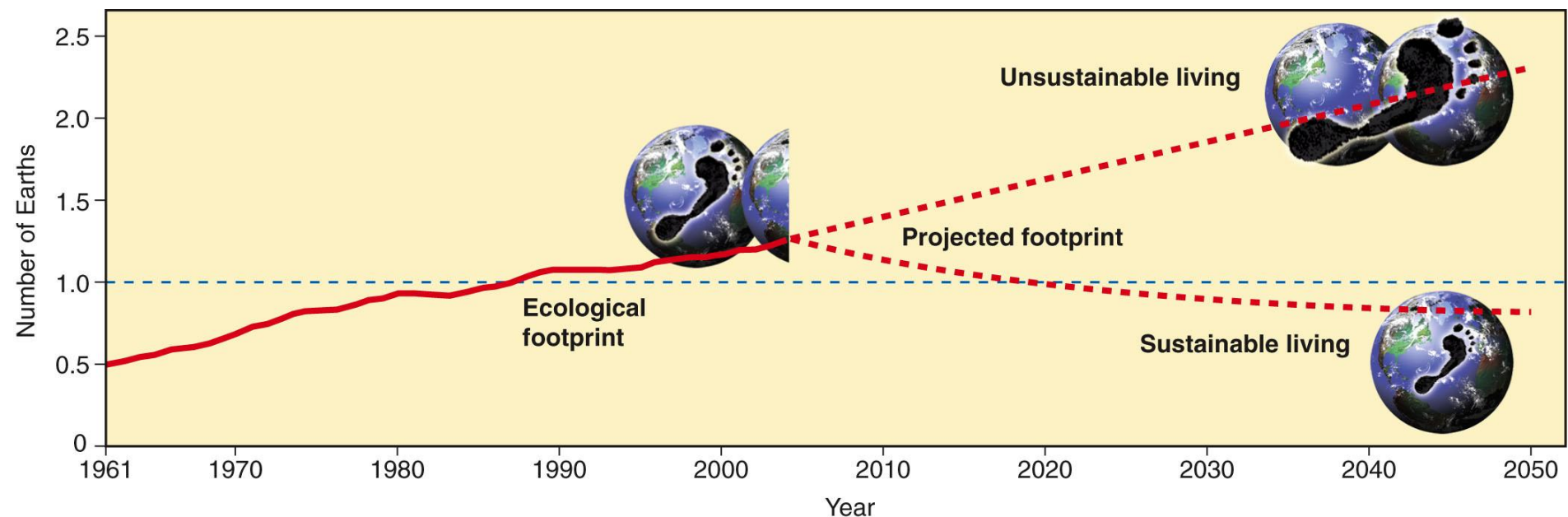
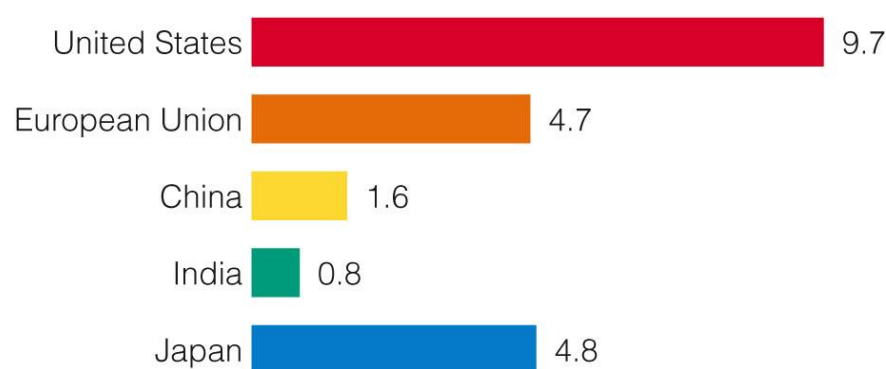
- **Ecological deficit**
  - Total ecological footprint greater than biological capacity for resource renewal and absorption of wastes and pollution
  - 2008 study: at least 30% global excess
  - 88% for high-income countries
  - Humans currently need 1.3 earths



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



### Per Capita Ecological Footprint (hectares per person)



# Nonrenewable Resources

- **Nonrenewable** – fixed quantities
  - Energy (fossil fuels)
  - Metallic minerals
  - Nonmetallic minerals
- **Recycling**
- **Reuse**

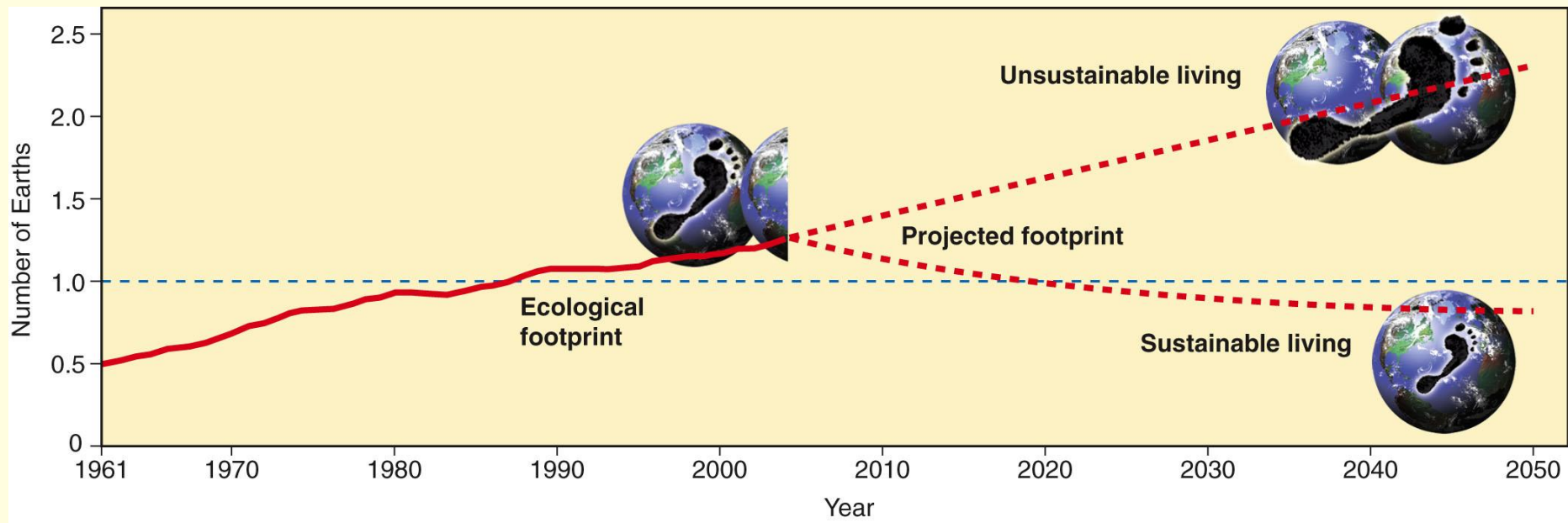
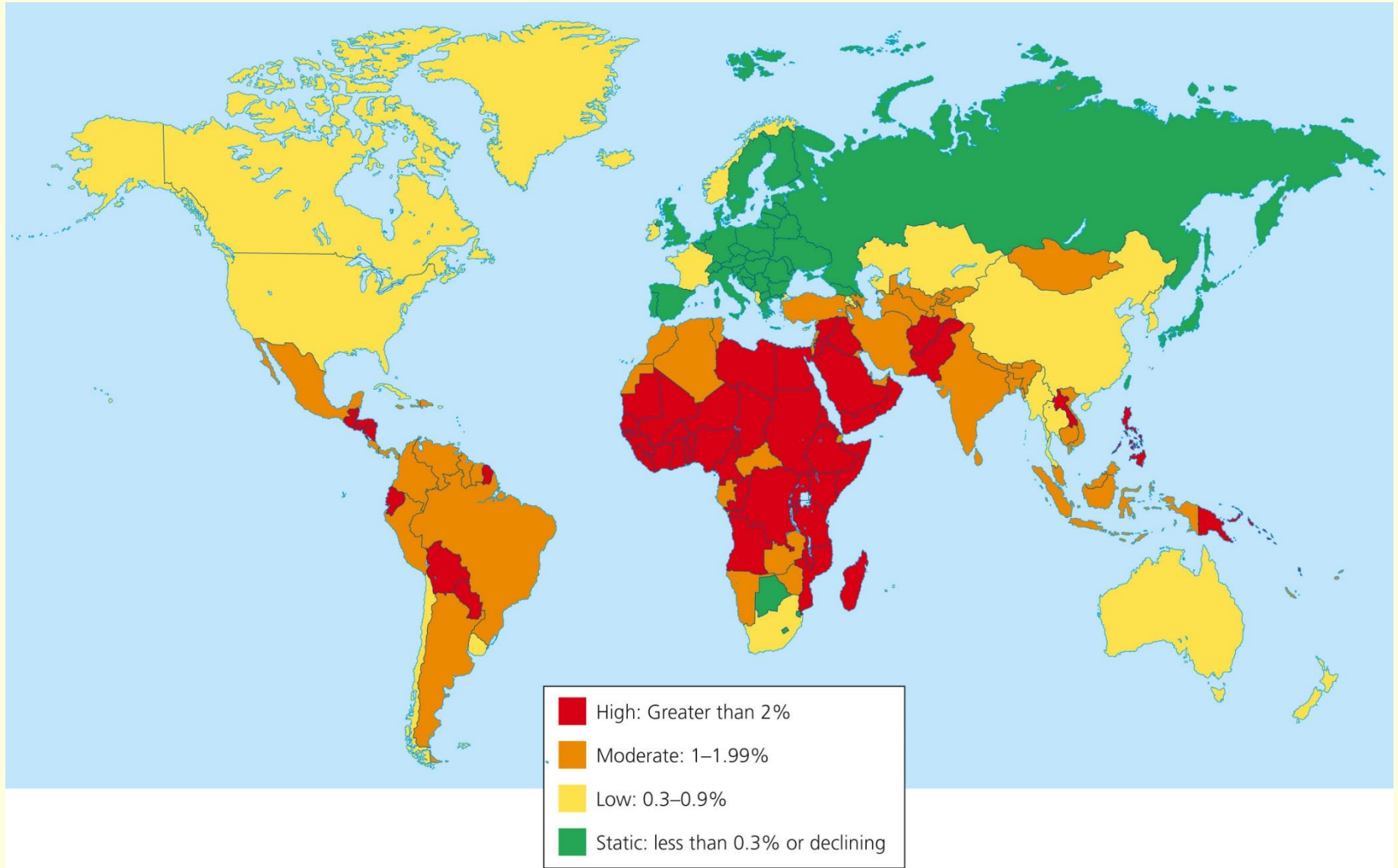


Fig. 1-5, p. 11

# Developed Countries Have Higher Impacts

- **Developed countries**

- United States, Japan, New Zealand, most of Europe, some others
- 19% world population
- Use 88% of world's resources
- Create 75% of world's pollution



# IPAT Environmental Impact Model

- Determines impact of a country or regions
- $I = P \times A \times T$
- I = environmental impact
- P = population size
- A = affluence of population
- T = technology influence

**Developing Countries**



**Population (P)**

**×**

**Consumption per person (affluence, A)**

**×**

**Technological impact per unit of consumption (T)**

**=**

**Environmental impact of population (I)**

**Developed Countries**



# Developing Countries

- 81% world population
- Middle income: Brazil, China, India
- Least developed: Haiti, Nigeria, Nicaragua
- Use far fewer resources per capita than developed countries
- Smaller per capita ecological footprint



# *1-3 What Is Pollution and What Can We Do about It?*

- ***Concept 1-3*** *Preventing pollution is more effective and less costly than cleaning up pollution.*

# Pollution

- What is pollution?
- **Point sources**
- **Nonpoint sources**
- Unwanted effects of pollution



Fig. 1-8, p. 14

# Solutions to Pollution

- **Pollution prevention**
  - Prevent pollutants from entering the environment
- **Pollution cleanup**
  - After pollutants released into environment
  - Temporary fix only
  - Often results in different pollution: burning garbage
  - Dispersed pollutants usually too costly to clean up effectively

# *1-4 Why Do We Have Environmental Problems?*

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

# Causes of Environmental Problems

- Exponential population growth
- Wasteful and unsustainable resource use
- Poverty
- Failure to include environmental costs of goods and services in market prices

## Causes of Environmental Problems



**Population growth**



**Unsustainable resource use**



**Poverty**



**Excluding environmental costs from market prices**

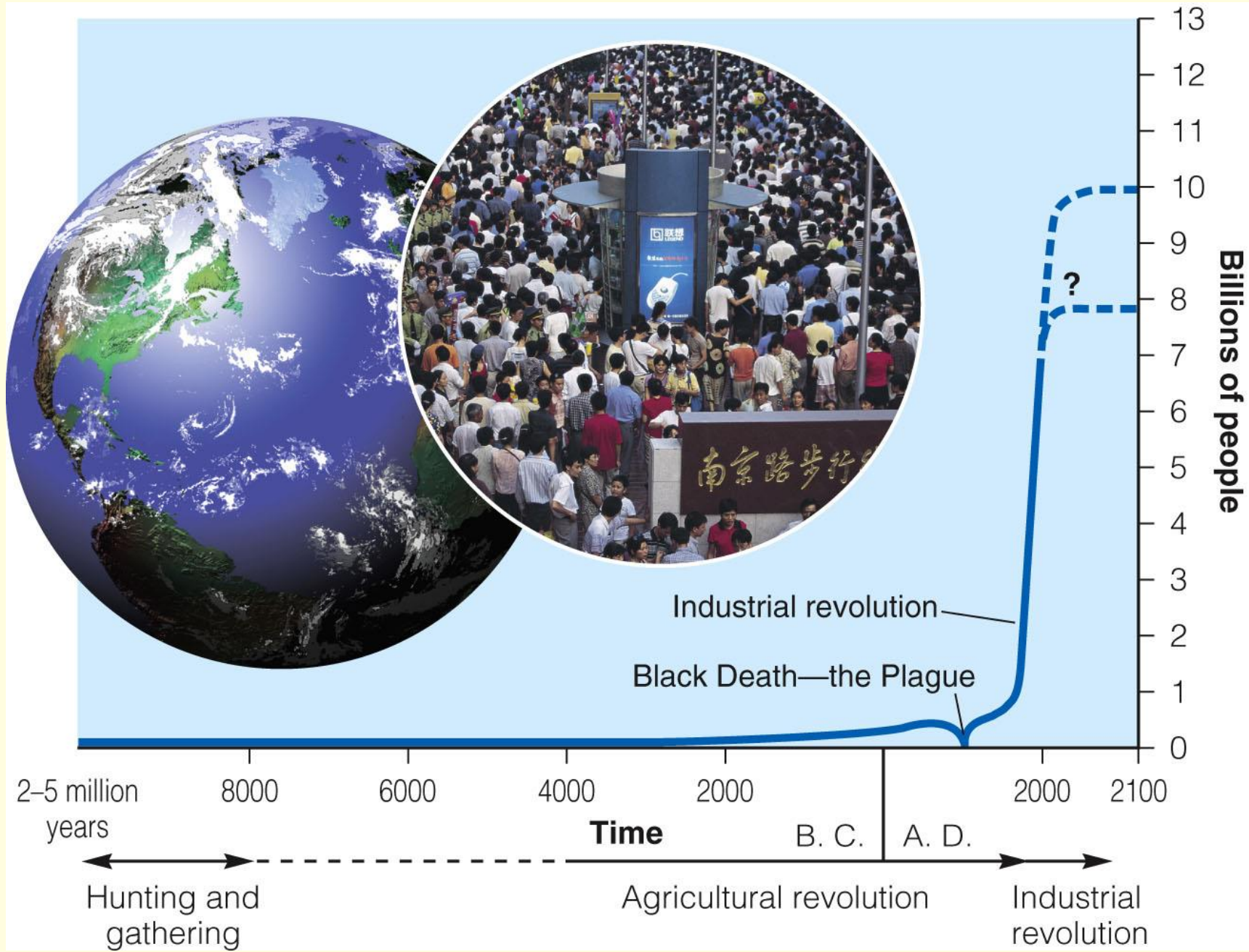


Fig. 1-10, p. 16



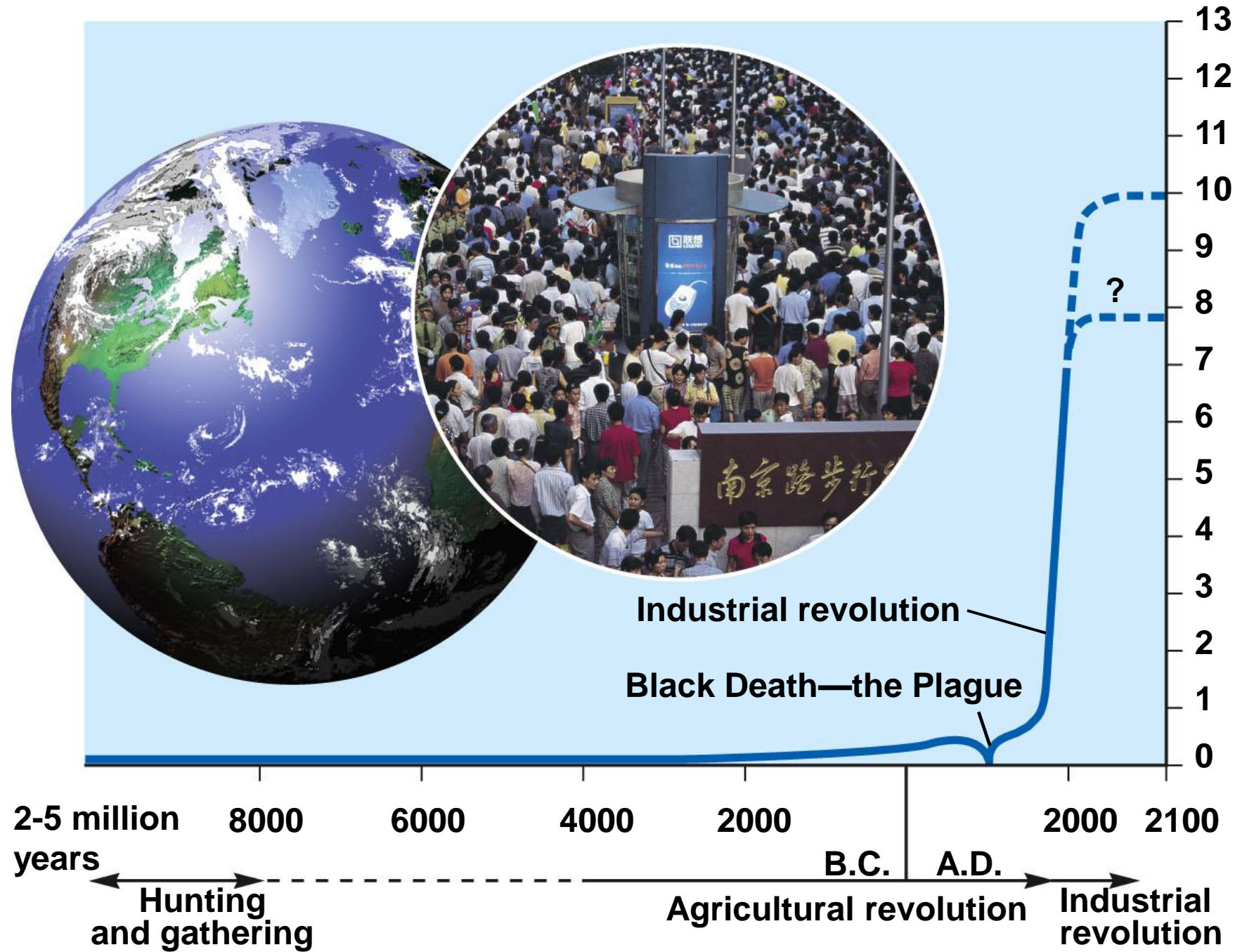


Fig. 1-10, p. 16



Fig. 1-11, p. 16

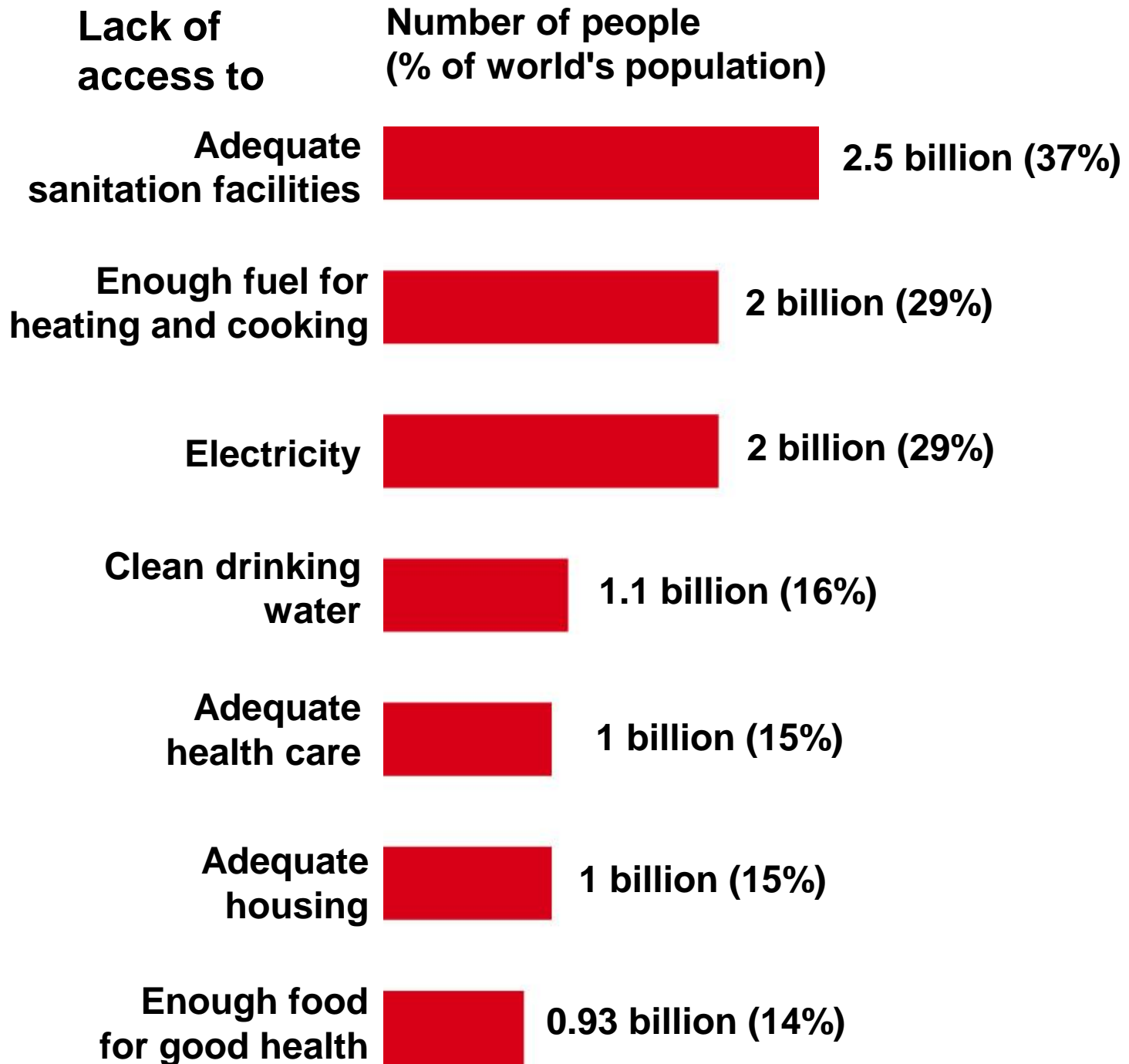


Fig. 1-12, p. 17



Fig. 1-13, p. 17

# Environmental Effects of Affluence

- Harmful effects
  - High per-capita consumption and waste of resources – large ecological footprints
  - Advertising – more makes you happy
  - Affluenza
- Beneficial effects
  - Concern for environmental quality
  - Provide money for environmental causes
  - Reduced population growth

# Evaluating Full Cost of Resources Use

- Prices do not include the value of natural capital and harmful environmental costs
- Examples
  - Clear-cutting + habitat loss
  - Commercial fishing + depletion of fish stocks
- Tax breaks
- Subsidies

# Different Environmental Views

- **Environmental worldview**
- **Environmental ethics**
- **Planetary management worldview**
- **Stewardship worldview**
- **Environmental wisdom worldview**

# *1-5 How Can we Live More Sustainably? Three Big Ideas*

- We can live more sustainably by relying more on solar energy, preserving biodiversity, and not disrupting the earth's natural chemical recycling processes.*



# Three Big Ideas for Sustainability

- Rely more on renewable energy from the sun
- Protect biodiversity
- Do not disrupt earth's natural chemical cycles