

## Chapter 2: Humans and the Resources of the Earth: Sources and Sinks

### CHAPTER SUMMARY

The earth can be conceptualized as a series of sources (from which we draw resources) and sinks (into which we put wastes). Land and soil, water, and biodiversity and forests are important resources for life. Soil is a living layer of the biosphere, and is rich in nutrients needed for primary producers to carry on photosynthesis. Humans are dependent on the land for food; 98% of our food is produced on the land. However, land can be degraded and eroded so that it is less productive, or even useless for human cultivation. A critical question regarding soil and land is the rate at which it is being eroded and degraded in relation to soil formation. Agriculture has contributed to the erosion problem and subsequently to declining crop and livestock yields. Soil problems can be addressed to some extent by means of terracing, contour plowing, multiple cropping, and using low tillage methods. Direct costs of soil erosion, as measured by the costs of replacing lost water and nutrients on agricultural land, amount to about 250 billion dollars per year globally. Even more than soil, water is essential to the biosphere. Life exists only because of the solar-driven circulation of water through the hydrological cycle from the ocean to the atmosphere, from the atmosphere to the land, and back to the ocean. Water is a renewable resource, but most of it circulates from the ocean to the atmosphere and back. Water is distributed very unevenly over the earth's surface, so adequate supplies of water have always been a source of political conflict. While surface water and groundwater each supply about half the needed water, groundwater recharges very slowly, so this adds to the problems associated with water supplies. Agriculture, industries, and cities are major consumers of water. Of these, agriculture uses the most. Growing water usage in the United States has meant falling water tables, shrinking lakes, and disappearing wetlands. When water tables sink in coastal areas, salt water may seep in, contaminating the groundwater. The rate of water use has extreme consequences for many of the world's aquifers. For example, the High Plains Ogallala Aquifer under the Great Plains from Texas to South Dakota supplies 30% of the country's groundwater used for irrigation, and it is being depleted eight times faster nature can replenish it. At this rate, much of this aquifer will be deleted in several decades. Water problems generate social and political conflict. In California, farmers use 80% of its water, but produce only 3% of its wealth. The social consequence of water shortages in the United States are that litigation simmers among states, regions, and urban and rural water users. As with soil problems, solutions to water shortages involve improved efficiencies. One solution is drip irrigation. With available tools and technologies, farmers could cut their water needs by 10-50%, industries by 40-90%, and cities by one third. As with soil problems, solutions to water shortages involve improved efficiencies. One water controversy concerns its status either as a basic human right, or as a commodity to be sold like all others. Vivendi, Suez, and RWE, three transnational corporations, have a plan to buy up as much of the world's water supply as possible, including water in the U.S. While economic and social capital are understood and appreciated, the biological dimension of nature (natural capital) is not. Two thirds of the forests that existed historically are gone. In the north, this is due to commercial logging, but in the tropics, it is due to commercial loggers, farmers and ranchers. Temperate zone forests are roughly stable in area, but tend to be regrown

secondary forests deficient in biodiversity. Europe has no primary forests left. Standing forests provide many functions, including stabilizing landscapes, preventing soil erosion, helping to retain moisture, storing and recycling nutrients, and serving as a buffer against pests and diseases. They also regulate quantity and quality of water flows, and help to prevent or moderate floods, and store water against droughts. They help to keep rivers free from silt and are critical to the energy balance of the earth. A 1997 study by the World Conservation Union (IUCN) found that one out of eight plant species surveyed is potentially at risk of extinction. Many animal species are threatened as well. Research by the IUCN shows plants, reptiles, birds, fish and mammals, all carnivores (wild cats and bears), and primates are declining in population or are seriously threatened with extinction. Research indicates that there were four previous waves of extinction—it took millions of years for biodiversity to return. We often fail to appreciate the importance of biodiversity. There are three reasons why this is a mistake. First, natural diversity is the source of many medicines, foods, and commercially valuable substances. Second, biologically diverse ecosystems help to maintain food chains and energy and matter cycles. Third, other species are part of the heritage of the earth. Human economies must address declining biodiversity, deforestation, and wastes and pollution. Chemical pollution, solid waste, and e-waste are all problems that must be recognized and addressed. Finally, there is the potential to underestimate the scope of the problem, as “model” countries such as the Netherlands appear to be frugal, yet import most of their needed goods and food.

## LEARNING OBJECTIVES

After reading Chapter 2, students will be able to:

Distinguish between sources and sinks.

Discuss the importance of soil as an environmental resource, and identify at least three threats to land and soil.

Discuss the importance of water as an environmental resource, and identify at least three threats to the global water supply.

Describe trends in deforestation.

Describe services provided by forests.

Discuss the importance of biodiversity and causes of declining biodiversity.

Identify and discuss reasons why we should care about wild creatures.

Identify and discuss the major forms of solid wastes.

Describe problems associated with municipal pollution.

## I. Chapter 2: Humans and the Resources of the Earth: Sources and Sinks

### A. The Earth as Sources and Sinks

- a) We draw resources from soil, water, biotic resources (forests and species diversity).
- b) Pollution sinks are repositories of solid wastes and chemical pollutants.
- c) Each resource problem is also a social issue connected to one of the four sociocultural driving forces list at the end of Chapter 1.

### B. Land and Soil

#### 1. Soil

- a) Soil is formed from minerals derived from weathered rock, decaying organic materials, and dead and decaying remains of plants.
- b) It is a living layer of the biosphere.
- c) 98% of human food is produced on the land. Worldwide, food and fiber crops are cultivated on 12% of the land surface. 24% is pasture used for livestock, while forests cover another 31%.
- d) Land can be degraded and eroded and become useless for human cultivation. A critical question concerns the rate at which soil degradation occurs relative to soil formation.
- e) Agriculture has contributed to the erosion problem and subsequently to declining crop and livestock yields.

#### 2. Soil and Food

- a) Modern intensive agriculture increased yield, but also destroyed traditional methods of preserving soil.
- b) Since 1950, manufactured inorganic chemicals, capital, and energy inputs made it possible to expand food supply. As a consequence, net food production has not increased much because such production techniques overdraws and degrades natural resources.
- c) A recent study estimated that one third of the soil that ever existed has been lost. Other studies find that soil erosion has occurred on 38% of the world's cropland, and that soil erosion and degradation had reduced food production on about 16% of the world's cropland.

d) After the massive soil erosion of the 1930s dustbowl, the U.S. was among the few nations to make soil conservation a priority.

e) Despite this, the USDA estimates that American soil is eroding 16 times faster than it can form; the Great Plains have lost half their topsoil since agriculture began there. Other experts think that the world loses 24 billion tons of topsoil per year.

### 3. Addressing Soil Problems

a) To feed a growing global population, we must find a way to increase productive yield while protecting the fertility of the cropland soils. This is a significant challenge.

b) There are various ways to reduce erosion, including terracing, contour plowing, multiple cropping, and using low tillage methods. Organic matter helps with nutrient recycling.

c) There is increased use of organic matter for fertilizer; many Asian cities recycle human waste for this purpose.

d) Some propose land reforms to encourage smaller, privately-held farms because they are more productive. Others argue for the application of technology and large-scale management. Many nations need food price policies that encourage profitable agriculture.

e) Few governments have been willing to tackle these issues because land reform and price policies are political dynamite.

### 4. Economic and Ecosystem Services: Pricing Soil Degradation

a) Direct costs of soil erosion amount to about 250 billion dollars per year.

b) Additional costs, including damage to recreation, human health, private property, navigation, and so on, amount to about 150 billion globally, and 44 billion in the United States alone.

## C. Water Resources

a) Water is the lifeblood of the biosphere even more than soil.

b) Water is a renewable resource, but most water circulates from the ocean to the atmosphere and back. A much smaller fraction falls as precipitation over land, and of that, much evaporates or runs off back to the ocean so that even less is available for human agricultural, industrial and household use.

- c) Usable water is very unevenly distributed over the earth's surface, so getting enough water is a source of conflict.
- d) Worldwide, surface and ground water each supply about half of the needed fresh water, but the recharge rate for ground water is very slow, about 1% per year.
- e) There are relatively fixed minimum requirements for water needs. To assure adequate health, people need a minimum of about 100 liters of water per day (26.5 gallons) for drinking, cooking, and washing.
- f) Agriculture accounts for the most water use, about 70% worldwide, and it is the most inefficient use of water.
- g) Industry accounts for about 20% of water use globally. It takes over 400,000 liters of water to produce one car, and industrial societies produce about 50 million cars per year.
- h) A nuclear reactor needs 1.9 cubic miles of water per year to function and all U.S. reactors use the equivalent of one and a third Lake Eries per year.

#### D. Growing Water Use and Its Problems

- a) Water usage tripled since 1950, and by 1992 used more than 8 times the flow of the Mississippi River. Planners met growing demand by means of water development projects, including dams, irrigation, and river diversion schemes.
- b) However, around the world, water tables are falling, lakes are shrinking, and wetlands are disappearing. When wetlands disappear, salt water often infiltrates and makes groundwater unusable.
- c) About one in six people worldwide do not have access to clean and affordable water.
- d) It takes 1,000 tons of water to produce one ton of grain. This means that farmers are pumping water from aquifers faster than nature can recharge them.
- e) The rate of water use has extreme consequences for many of the world's aquifers. For example, the High Plains Ogallala Aquifer under the Great Plains from Texas to South Dakota supplies 30% of the country's groundwater used for irrigation, and it is being depleted eight times faster nature can replenish it. At this rate, much of this aquifer will be deleted in several decades.

f) The United States uses 30% less water than it did in 1975. The lower per capita use was produced by increased agricultural efficiencies, but not reduced household use.

g) Water problems generate social and political conflict. In California, farmers use 80% of its water, but produce only 3% of its wealth. The social consequence of water shortages in the United States are that litigation simmers among states, regions, and urban and rural water users.

#### E. Water and Political Conflict

a) The water conflicts in a wealthy nation like the United States will be mild compared to those in poorer, drier nations.

b) Conflict between India and Pakistan and between India and Bangladesh are partly about control of water resources. India's dam projects in the Himalayas and in the Ganges have produced conflict between these nations.

#### F. Addressing Water Problems

a) As with soil problems, solutions to water shortages involve improved efficiencies. One solution is drip irrigation. With available tools and technologies, farmers could cut their water needs by 10-50%, industries by 40-90%, and cities by one third.

b) But, when governments make water cheap, there is no incentive to invest in more efficient systems.

c) Bottled water use by the affluent is also a problem. Bottled water costs between 500-1,000 dollars per cubic meter, compared to 50 cents per cubic meter for quality tap water.

d) One water controversy concerns its status as either a basic human right, or as a commodity to be sold like all others. Vivendi, Suez, and RWE, three transnational corporations, have a plan to buy up as much of the world's water supply as possible, including water in the U.S.

e) To address water problems will require more than conservation—it will require a combination of regional cooperation in allocation, slowed population growth, higher prices to improve irrigation and efficiency, and sometimes, imported grain and food to reduce water needs.

#### G. Freshwater Economic and Ecosystem Services

a) Rivers, lakes, aquifers and wetlands provide many benefits to human economies—water for drinking and hygiene, irrigation, and manufacturing, recreation, flood control, bird and wildlife habitat, and the dilution of pollutants.

b) The total value of all services and benefits provided by freshwater systems is impossible to gauge correctly, but would certainly measure in the trillions of dollars.

## H. Biodiversity and Forests

1. While economic and social capital are understood and appreciated, the biological dimension of nature (natural capital) is not.

### 2. Forest Resources

a) Two thirds of the forests that existed historically are gone. Of the three major intact, unfragmented forest biomes that cover about 12% of the earth's surface, boreal forests are the largest.

b) Temperate zone forests and tropical zone forests cover about 6% of the earth's surface, and just four countries, Brazil, Indonesia, Zaire, and Peru contain more than half of the world's tropical forests.

c) Humans are rapidly destroying boreal and tropical forests. In the north, this is due to commercial logging, but in the tropics, it is due to commercial loggers, farmers and ranchers.

d) Temperate zone forests are roughly stable in area, but tend to be regrown secondary forests deficient in biodiversity. Europe has no primary forests left.

### 3. Tropical Deforestation

a) It is unlikely that tropical forests will follow the same path as temperate forests because tropical forests grow faster, are more fragile, and richer in species.

b) When cleared of tree cover, tropical rains leach and erode soil nutrients, making agriculture unsustainable and forest regrowth difficult. Tropical forests should be seen as nonrenewable resources.

c) At the current rate, experts estimate that tropical forests will be gone sometime between 2020 and 2090.

d) The major causes of deforestation are population growth, poverty, government politics, expanding agricultural lands, urbanization, lumber exports, and not valuing the economic and ecological services of standing forests.

#### 4. Forest Economic and Ecosystem Services

a) Standing forests provide many functions, including stabilizing landscapes, preventing soil erosion, helping to retain moisture, storing and recycling nutrients, and serving as a buffer against pests and diseases.

b) They also regulate quantity and quality of water flows, and help to prevent or moderate floods, and store water against droughts. They help to keep rivers free from silt, and are critical to the energy balance of the earth.

c) Nepal and India illustrate some of the economic value associated with forests. In Nepal, topsoil is washed away each year and ends up in the Ganges. This has serious consequences for Nepalese agriculture. In India, soil conservation benefits associated with forests have been valued at between 5 and 12 billion dollars per year. The value of flood control is estimated to be worth more than 72 billion dollars per year.

d) The economic value of forests in the Mediterranean basin is estimated to be worth 1 to 5 billion dollars per year; in North America, the salmon industry, which is dependent on forestation, is worth 1 billion dollars per year.

#### 5. Declining Biodiversity

a) We do not appreciate the value of biodiversity. Tropical forests and wetlands are rich repositories of species and are now threatened.

b) A 1997 study by the World Conservation Union (IUCN) found that one out of eight plant species surveyed is potentially at risk of extinction. Many animal species are threatened as well. Coral is a good example of this. By 2005, 20% of the world's coral reefs had been destroyed, with no prospects for recovery.

c) Research by the IUCN shows that 70% of assessed plants, 26% of assessed reptiles, 12% of assessed birds, 39% of assessed fish and mammals, all carnivores (wild cats and bears), and half of all primates are declining in population or are seriously threatened with extinction.

d) We know that there have been at least four waves of extinction, but at present, there is no way to estimate the consequences of present species extinction. After each of the previous waves of extinction, it took many millions of years for biodiversity to make a comeback.

6. The Human Causes of Declining Biodiversity

a) The acronym HIPPCO is used to summarize threats to biodiversity. It stands for Habitat destruction, Invasive species, Pollution, Population (human), Climate change, and Overharvesting.

b) The greatest threat to all kinds of wild species is the destruction and fragmentation of habitats as humans control more of the planet. Tropical deforestation is the greatest eliminator of species, followed by coral reefs and wetlands. Tropical forests contain more than 50% of all terrestrial species.

c) Modern agriculture destroys biodiversity. People have historically used more than 7,000 plant species for food—this is now reduced to about 20 species around the world. These are mainly corn, wheat, millet, rye, and rice. The varieties of rice have declined substantially. India used to have 30,000 varieties of rice, but now only have about 10.

d) The U.N. Food and Agriculture Organization estimated that by the year 2000 two-thirds of all seeds planted in LDCs were of uniform genetic strains. Nonnative species, usually highly adaptable plants and animals that spread outside their native ranges, often without human help, do well in disturbed habitats.

e) Climate change (the greenhouse effect) will cause reduction in biodiversity. Climate change may be geophysical, but it has human causes. It will mean changes in seasons, rainfall patterns, ocean currents, and other parts of the earth's life support systems. Climate change could cause dieback and decomposition in forests. In Canada and Siberia, climate change could start desiccation, and could seriously increase the number of forest fires in Canada.

7. Concern for Biodiversity: Who Cares about Wild Creatures?

a) There are three reasons why we should care about wild creatures.

b) The natural diversity of living things has great actual and potential value as food, medicine, and other substances important for commercialism.

- (1) Tropical forest examples include essential oils, gums, latexes, resins, tannins, steroids, waxes, acids, phenols, alcohols, rattans, bamboo, flavorings, sweeteners, spices, balsam, pesticides, and dyes. Some plants contain hydrocarbons, which make up petroleum. Some trees can clean up urban pollution, especially sulfur dioxide. More than half of all modern medicines are either derived from or modeled on natural compounds from wild species (e.g., taxol, and rosy periwinkle).
- (2) Amphibians provide many useful compounds, including painkillers. Snakes, insects, and sponges are all sources of medicines.
- (3) Biodiversity is important to agriculture as well. For example, grains like corn have become vulnerable to disease. In 1970, a leaf fungus blighted cornfields and caused more than 2 billion dollars in damages. Blight resistant wild corn helped to stop the damage.
- (4) Pollinators like bees are essential to pollinating about 30 billion dollars worth of U.S. crops in addition to pollinating natural plants. Humans cannot easily survive by relying on only a few livestock and crop species.
- (5) Biodiversity provides ecosystem services that play important roles in different niches in ecosystems upon which all life depends. Ecosystem services include the roles in particular niches that a diversity of species play in maintaining the food chains, energy, and matter cycles, and population balances of entire ecosystems.
- (6) As part of the earth's evolutionary and biological heritage, the diversity of species is irreplaceable and valuable in itself. There are aesthetic and spiritual reasons for preserving biodiversity.

8. Addressing Deforestation and Declining Biodiversity

- a) There are many ways that the nations of the world could slow or halt unsustainable forest use. Greater efficiency in use, eliminating waste, and recycling would help. The U.S. has the world's highest per capita use of paper, half of this is quickly discarded packaging. Only one third of this is recycled.
- b) LDCs could introduce more efficient cooking fuels.
- c) Specific initiatives to preserve forests and biodiversity.

- (1) Promoting sustainable use: the sustainable exploitation of forests by local and indigenous people is worth more than commercial exploitation.
- (2) Debt for nature swaps: participating nations act as custodians for protected forest reserves in return for foreign aid or debt relief.
- (3) Preserving nature in place: conservationists have lobbied to set aside parks and nature preserves. Such nature preserves now account for about 8% of the earth's surface. Costa Rica has set aside 12% of its land; the U.S has set aside only 1.8% of its land.
- (4) Gene banks and conservatories: a major approach to preserving plants and animals has been to remove them from their habitats and protect them in specialized institutions, such as zoos, botanical gardens, nurseries and gene banks.
- (5) Bioprospecting: in 1991, Merck and Company paid the Costa Rica Biodiversity Institute 1 million dollars to search for and locate tropical organisms as sources of pharmaceuticals.
- (6) International treaties: The 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora provides a powerful tool for controlling international trade in threatened plants and animals.

9. Wastes and Pollution

- a) Human economies generate huge amounts of waste. EPA and the Bureau of Mines estimates that 75% of solid wastes are produced by mining and oil and gas production, 13% by agriculture, 9.5% by industry, 1.5% by municipal garbage, and 1% by sewage sludge.
- b) E-waste consisting of discarded TVs, cell phones, computers and other electronic devices is the fastest growing solid waste problem in the United States, and the world. Only 2% of e-waste is currently recycled.
- c) Chemical Pollution from Agriculture
  - (1) Agriculture is an important source of pollution and toxic substances due to the intensive use of pesticides, fungicides, nitrates, phosphates, and salt. These chemicals have toxic effects on humans and other species.

(2) Some of the most dangerous chemicals, like DDT and chlordane have been banned from use in the U.S., but have been replaced with equally dangerous chemicals such as organophosphates (e.g., Roundup). Research shows that exposure to Roundup nearly tripled people's chances of getting cancer. Use of dangerous chemicals has shifted to the LDCs, from which many foods are imported to the U.S.

(3) The World Health Organization has estimated that as many as 25 million agriculture workers in LDCs are seriously poisoned by pesticides each year, and that at least 20,000 die. In the U.S., high levels of exposure adversely affect Hispanic farmworkers.

(4) In the long run, mounting evidence suggests that pesticides are not effective in protecting crops from loss. Insects develop resistance, and chemicals kill good predators.

(5) Synthetic agrochemicals accumulate in living tissues through various levels of food chains (bioaccumulation). Because of these characteristics, they are called persistent organic pollutants (POPs). The endocrine disruption hypothesis suggests that POPs can mimic hormones in people, especially estrogens, and can cause behavioral and reproductive problems.

(6) Inorganic chemical fertilizers also cause many problems. For example, they leave nitrates and phosphates that wash into streams, rivers, lakes and groundwater. During warm weather, this leads to rapid growth of aquatic plants that use up available oxygen. They then die, sink to the bottom to decay, and rob other organisms of needed oxygen. Ultimately, nothing can survive in this environment, except a few scavenger species. This process is called eutrophication.

(7) Salinization of land from long-term irrigation is another cause of chemical pollution. Crops take up freshwater, but leave salt in the soil. Eventually, the build up exceeds the salt tolerance of crops. The soil must be flushed with freshwater periodically, or the soil will become barren.

## 10. Addressing Solid Waste Problems

a) In the MDCs, sanitary landfills are state of the art constructions that have barriers and caps to keep leachate from seeping into social and drainage pipes. However, seeping does occur and leachate, which contains more than 100 toxic chemicals, has the potential to contaminate wells.

b) Dumps are filling up, and there is resistance on the part of many communities to building more. Governments and industries have responded by burning or recycling. There are problems with both. Incineration reduces solid waste by about 90%, but is costly. It also creates ash that is highly toxic. It does little to discourage the production of such wastes and transfers many from one sink (the landfill) to another (the atmosphere).

c) Recycling has been the most publicized solution to reduce solid waste. Switzerland and Japan recycle about half of their municipal solid waste. The U. S. recycles about 30%, up from 6.4% in 1960.

d) Reuse of materials is even more effective. It extends resource supplies and reduces energy use and pollution more than incineration or recycling. Obvious examples are refillable bottles. Refillable bottles create local jobs related to collection and refilling. Few U.S. bottles are refilled. 95% of bottles in Germany are refillable. Denmark has banned all bottles that cannot be reused.

e) Source reduction is the most effective way to deal with waste. This is also known as dematerialization of production and consumption. It is accomplished by introducing efficiencies in extraction, production, or consumption so that less waste is generated. This implies fewer throwaway goods, less packaging, and more reuse. Whole economies would have to be restructured to do this.

## 11. Municipal Pollution

a) Municipal pollution includes pollution from municipal wastes and sewage, as well as air pollution from cars, factories and homes.

b) In LDCs, sewage from human wastes is often not treated and is highly contaminated with micro-organisms that carry waterborne diseases such as dysentery, typhoid and cholera. One of the most important things that could be done to improve the health of people in LDCs is to provide access to clean water. LDCs lack the resources to build sewage treatment plants. Even in MDCs, the poor are more likely to be exposed to such hazards.

c) Most MDCs have invested in sanitation and water treatment facilities. Primary treatment involves filtration that removes the suspended contaminants, while secondary treatment uses settling basins where aerobic bacteria degrade organic pollutants. Sewage treatment leaves a goeey sludge that is dumped or recycled as organic fertilizer. This process does not remove many toxic chemical, nitrates or phosphates.

d) Other chemical byproducts of concern include carbon particles, carbon monoxide, and sulfur dioxide. Sulfur dioxide contributes to acid rain, which kills forests. Nitrous oxides and other volatile organic compounds (VOCs) are produced by incomplete combustion of fuels. In the presence of sunlight, sulfur dioxide, nitrous oxide, ozone, and VOCs combine to form smog, a toxic brew of more than 100 chemicals that hang over most cities when the weather is right.

## 12. Pollution Trends

a) Some successes include the Safe Water Drinking Act, passed in 1974. Drinking water became safer, except for runoff from agrochemicals.

b) 95% of people from MDCs and 74% of people in LDCs have access to clean water (a separate issue from shrinking water supplies).

c) Congress passed Clean Air Acts in 1970, 1977, and 1990. These required the EPA to set national standards for ambient air quality and emission standards for toxic air pollution. Congress spent about 346 billion dollars between 1970 and 1990 to comply with the Clean Air Acts. The human health and ecological benefits in that same period were estimated to be worth 2.7 to 14.6 trillion (in 1990 dollar values).

d) Still, many problems remain. Nitrogen dioxide levels have not dropped much since 1980. Urban smog remains a problem. Congress faces intense pressure to weaken the Clean Air Act of 1990.

## I. Conclusion: The Resources of the Earth

### 1. Progress and Problems

a) Overall, evidence exists for both progress and problems in dealing with pollution in the MDCs. While some things are improved in LDCs, much of the world's population lives in unsanitary conditions.

b) Wild biological resources are threatened by human activities and are underappreciated for their usefulness to humans, their role in maintaining ecosystems, and for their heritage.

c) Severe water shortages loom; water is unequally distributed, and this poses the potential for severe conflict.

d) Problems of land and food security suggest an upper limit to previously successful technologies.

e) The human footprint on nature is huge. Evidence about this relates to the human use of the earth's net primary production (NPP). One study revealed that humans used 25% of the NPP has a whole and 40% of the NPP on land. What would happen if populations were to grow larger and consume 80% of the NPP? No one knows for sure.

f) Currently, countries like the Netherlands import so many goods that in effect, it occupies somewhere between five and seven times its own territory. On the surface, the Netherlands appears to be very efficient, leading some proponents to suggest that population growth is not a problem. This is misleading, because it overlooks the Dutch dependence on foreign resources. This has been dubbed the "Netherlands Fallacy."

g) We live mostly in socialized nature. In terms of human-environmental interaction, it has become an ecosocial system.

## KEY TERMS

Sources (34)	Solid wastes (49)	Incineration (52)
Sinks (34)	E-waste (49)	Recycling (52)
Physical resources (34)	Circle of toxins (50)	Reuse (52)
Pollution sinks (34)	Herbicide and pesticide	Dematerialization (53)
Social Issue (34)	Treadmill (50)	Throwaway economies (53)
Temperate zone forest (41)	Bioaccumulation (50)	Primary treatment (54)
Tropical forests (41)	Persistent organic pollutants	Secondary treatment (54)
Greenhouse effect (44)	(51)	Net primary production (56)
Biopiracy (45)	Inorganic chemical	The Netherland's fallacy
Taxol (45)	fertilizers (51)	(57)
Rosy Periwinkle (45)	Cultural eutrophication (51)	
Pollinators (46)	Salinization of land (51)	
Ecosystem services (46)	Leachate (52)	

## QUESTIONS FOR REVIEW

1. What does it mean to speak of the economic and ecosystem services of nature? Illustrate with a real-world example.
2. What are some of the major causes of declining biodiversity? Of deforestation?
3. What are some social issues and political conflicts generated by declining biodiversity and deforestation?

4. What are some ways of addressing the extinction of species, declining biodiversity, and deforestation?
5. What are some of the advantages and disadvantages of different methods of dealing with municipal trash?
6. How has producing more food caused environmental problems? To address these, what social and political issues would have to be dealt with?
7. What does it mean to say that we live in “socialized nature,” or that we live in an “ecosocial system”? Illustrate from the community in which you live.

## ELECTRONIC RESOURCES

[www.us.ecosystems.org](http://www.us.ecosystems.org) State of the nation’s ecosystems, 2008, from the Heinze Center for the Study of the Environment.

[www.nrcs.usda.gov/gov/use/worldsoils/map/index](http://www.nrcs.usda.gov/gov/use/worldsoils/map/index) Maps of various soil characteristics in the world’s regions.

<http://soilerosion.net/> The soil erosion site brings together information on soil erosion from a variety of disciplines and sources.

<http://darwin.defra.gov.uk> The Darwin Initiative assists countries rich in biodiversity, but poor in financial resources to meet their objectives under a major biodiversity convention.

<http://worldwater.org/conflictIntro.htm> Water resources and international conflict. Updated 2009.

[http://seawifs.gsfc.nasa.gov/OCEAN\\_PLANET/HTML/peril\\_toxins.html](http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/peril_toxins.html) Toxic wastes, NASA, Smithsonian Institute, Environmental Protection Agency.

[www.scorecard.org](http://www.scorecard.org) Environmental Defense Fund environmental scorecard. Data-rich about environmental problems and pollution from firms, counties, and regions in the United States.

[Http://www.Biodiversityinternational.org](http://www.Biodiversityinternational.org) Research and information about agricultural diversity.

<http://www.colorado.edu/conflict/environment/EnvTopic.htm> A website maintained by Colorado State University. Provides information about water quality, water supply, biodiversity issues, air quality, toxic wastes, and waste management.

[www.biologicaldiversity.org](http://www.biologicaldiversity.org) This nonprofit organization focuses on endangered species, climate law, public lands, and urban wildlands.

## IN-CLASS ACTIVITIES

1. The Centers for Disease Control and Kaiser Family Foundation report on America's increasing use of prescription drugs. See KFF's report on the number of prescriptions filled in the U.S. in 2009 at <http://www.statehealthfacts.org/profileind.jsp?sub=66&rgn=1&cat=5>. Develop a lecture on pharmaceuticals, personal care products and pollution. Before the lecture, ask students to indicate what they do with unused drugs or medicines, as well as personal care products, and whether they think that flushing the unused medication presents an environmental pollution problem. See "How Prescription Drugs are Poisoning our Waters," by Elizabeth Royte online at <http://www.alternet.org/environment/43242?page=1> and "Pharmaceuticals and Personal Care Products," at the EPA, online at <http://www.epa.gov/ppcp/faq.html> for some background information on this issue.
2. Develop a lecture on game theory to give students some background on social dilemmas, including the prisoner's dilemma and the commons dilemma. Have students play a version of the prisoner's dilemma or the commons dilemma. A sample commons dilemma game is available online at [http://www.abacon.com/psychsite/tool\\_social.html](http://www.abacon.com/psychsite/tool_social.html), or at <http://www.g-r-e-d.com/Nuts%20Game.htm>. Next, divide the class into groups of four or five students and have them apply what they have learned to specific resources—e.g., watering their lawn, driving a large car, keeping their air conditioner set at a low temperature, or their heater at a higher temperature, fishing in a lake, and so on. For each resource, have students offer solutions to the dilemma. In particular, ask them to consider whether fees, incentives, or monitoring are reasonable solutions, and whether these strategies will be effective. If not, why not?
3. As discussed in Chapter 2, human activities of production and consumption, as well as disposable products play a significant role in environmental problems. Marketing and advertising play a central role in this process. To help students understand this process, show "The Persuaders" in class (available online at <http://www.pbs.org/wgbh/pages/frontline/shows/persuaders/view/>). After showing the video, discuss how marketing and advertising strategies can help reduce consumption behaviors. Consider having students develop their own advertisements that promote sustainability, and present them in class.
4. Begin a lecture by having students write down a list of what they know about what trees do for people. Then, put students in groups of no more than four or five. Have them compile and summarize their lists, striking out duplicates. Have them present their summaries to the class. Evaluate the lists to see how many described psychosocial benefits such as stress

reduction, lower levels of aggression and crime, and improved concentration. It is likely that students are familiar with reduced energy costs, curbing runoff, and pollution reduction. It is unlikely that they will have thought about some of the health implications of trees (reduced rates of asthma and obesity, lower risk of low birth weights—see, for example: Donovan and colleagues, “Urban Trees and the Risk of Poor Birth Outcomes,” 2011 online at [http://donovan.hnri.info/pubs/donovan\\_et\\_al\\_health.pdf](http://donovan.hnri.info/pubs/donovan_et_al_health.pdf)), or some of the psycho-social benefits of trees, such as those listed above. The Idaho Department of Lands has an extensive list of studies demonstrating the psychosocial benefits of trees, online at [http://www.treebenefits.terrasummit.com/Files/Health\\_Benefits\\_of\\_Trees.html](http://www.treebenefits.terrasummit.com/Files/Health_Benefits_of_Trees.html)

5. Show the *Nova* video, “How Smart are Animals?” Available from PBS online at <http://www.pbs.org/wgbh/nova/nature/how-smart-are-animals.html>. As this program reveals, other species have their own types of intelligence. In some cases, (detecting cancer cells by smell, using sonar to locate objects), animals outperform humans. This video may help students to appreciate other species.

#### OUTSIDE-OF-CLASS ACTIVITIES

1. To help students understand the importance of genetic biodiversity, have them explore research on the Amish and the Mennonites. See for example, the work being done at Johns Hopkins University, online at <http://magazine.jhu.edu/2010/06/the-disease-chaser/>, or as reported by MSNBC online at [http://www.msnbc.msn.com/id/18781321/ns/health-kids\\_and\\_parenting/t/blue-light-treats-sick-mennonite-amish-kids/](http://www.msnbc.msn.com/id/18781321/ns/health-kids_and_parenting/t/blue-light-treats-sick-mennonite-amish-kids/). Both of these articles illustrate the importance of genetic diversity, and show how a lack of genetic diversity can allow recessive genes to produce serious, often fatal, diseases.
2. Have students log into Earth Trends, online at <http://earthtrends.wri.org/updates>, and select a topic to research. Some possible topics include forests, grasslands and drylands, biodiversity and protected areas, and coastal and marine ecosystems. Have them present their findings in class, or on a class blog.
3. To introduce students to research on forests in the United States, have them log into Southern Forests for the Future at <http://www.seesouthernforests.org>. Note: this website has a section for educators. Resources include guidelines for navigating the interactive mapping tool, a student handout, selected state and geography standards (Arkansas, Florida, Georgia, Mississippi, North Carolina, and Tennessee), a glossary, and several activities. These activities include exercises that ask students to create a timeline of human-environmental interactions that have shaped specific regions. Students can use the interactive mapping tool to see forest cover losses and gains over time.
4. Have students access Environmental Health News online at <http://www.environmentalhealthnews.org/>. Use EHN’s search engine to locate articles on

biodiversity. This search allows students to access many articles on human health and the environment. Have students select a health related topic (e.g., cancer, diabetes, reproductive problems, etc.), and present their findings in class.

5. To follow up on the importance of persuasive messages, have students conduct a content analysis of environmental messages. An excellent example of this is available online at Teaching Psychology for Sustainability, [http://www.teachgreenpsych.com/tg\\_socialpsychology.html#contentanalysis](http://www.teachgreenpsych.com/tg_socialpsychology.html#contentanalysis). This assignment provides an overview of the “Wise Use Agenda,” and takes students to links that support Wise Use initiatives, but which appear to be pro-conservation. The assignment also introduces students to the concept of “greenwashing.”
6. To prevent students from becoming overly pessimistic, and tuning out information, you may want to have them research some “success” stories. Have them access the International Water Management Institute online at [www.iwmi.cgiar.org](http://www.iwmi.cgiar.org) and click on “Publications.” Then select “Success Stories.” One interesting example concerns restoring water quality after the 2004 Indian Ocean tsunami.
7. Have students research the cognitive or emotional capacities of animals. The Max Planck Institute has spearheaded considerable research into the cognitive capacities of animals. An appreciation for the capabilities of other species can increase appreciation for biodiversity. Have them share their findings with the class.

## SUGGESTED READINGS

Gould, Kenneth A., David N. Pellow and Allan Schnaiberg. 2008. *The Treadmill of Production: Injustice and Unsustainability in the Global Economy*. Boulder, CO: Paradigm Publishers.

Gross, Michael. 2010. *Ignorance and Surprise: Science, Society and Ecological Design*. Cambridge, MA: MIT Press.

Taylor, Dorceta. 2009. *The Environment and the People in American Cities, 1600s-1900s: Disorder, Inequality, and Social Change*.