

## **CHAPTER 23 ECOLOGICAL ECONOMICS**

### **Chapter Overview**

This chapter covers the relationship between resources and economics; it examines both renewable and nonrenewable resources. While neither classical economics nor neoclassical economics can explain environmental resource values and the relationship between the economy and the use of our environment, ecological economics is explored. The chapter also discusses the concepts of cost-benefit analysis, cap-and-trade, and the term carbon neutral.

### **Topics and Key Concepts**

#### The Living World

- Link intangible resources to aesthetics, ecosystem services, and ethics.

#### Land and Water Use

- Differentiate renewable, potentially renewable, and nonrenewable resources. Categorize which may be used sustainably.
- Diagram a supply and demand curve and compare internal and external costs.
- Describe the relationship between GDP and GNP.
- Justify the use of the Environmental Performance Index as a measure of sustainability and use of the HDI to measure a society's progress.
- Relate microlending to alleviation of poverty and women's roles in a society.
- Summarize the role of GATT and NAFTA in international trade.

#### Pollution

- Explain how a cost-benefit analysis might be used to determine which is preferable to a company: pollution cleanup or pollution abatement.
- Discuss two policies which use cap and trade approaches to control specific pollutants.

## Key Terms

*cap-and-trade policy	gross national product	nonrenewable
capital	(GNP)	resources
cost-benefit analysis	human development	political economy
(CBA)	index	price elasticity
demand	(HDI)	renewable resources
ecological economics	intangible resources	resource
ecosystem services	internal costs	steady-state economy
externalized costs	marginal costs and	supply
*GATT	benefits	sustainable
gross domestic	market equilibrium	development
product (GDP)	*microlending	throughput
	*NAFTA	

## Pacing Guide

Students are not very knowledgeable about economics and development. At the same time, these areas of concentration are not often addressed in an environmental science course. If time permits, spend 3–5 days on this chapter. If you are short on time, have students cover the information on their own and allow for 1 day of discussion.

## Approach and Tips

Chapters 23, 24, and 25 make up the global change unit, which accounts for 10–15% of the course as outlined in the AP course outline. The basis of chapter 23 is the economic cost and benefit of using or preserving our resources.

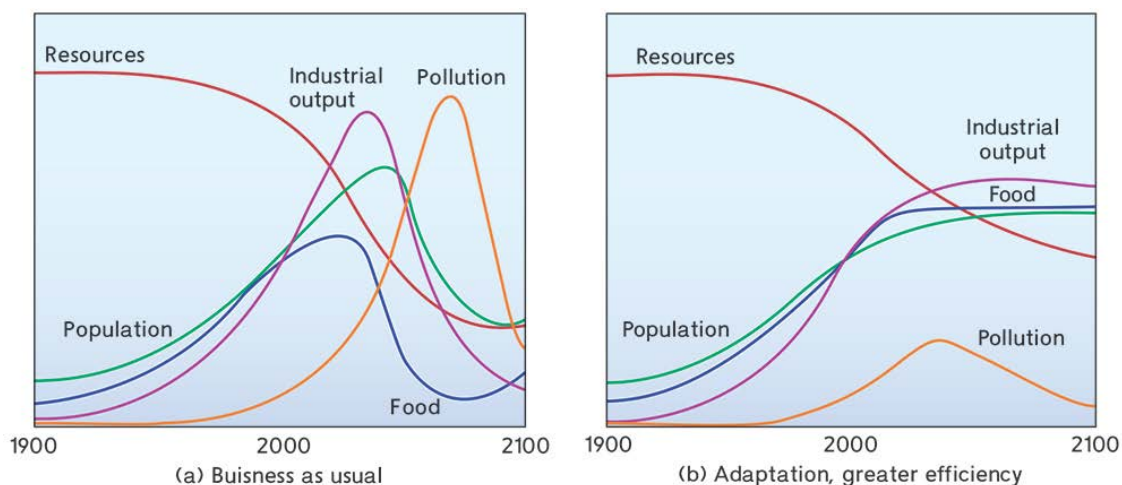
The remaining chapters are a culmination of concepts covered in previous chapters. Emphasize the importance of being able to differentiate between renewable and nonrenewable resources. Students tend to think of renewable as something that can be made again and nonrenewable as used up, rather than thinking of both of the as resources which may have finite amounts. Stress the importance of sustainability.

First, it is important to discuss what intangible resources mean to students in your class—what having access to these resources, or not having them available, contributes to, or detracts from, quality of life. Use examples of pristine areas that we may value as examples of intangible resources. All AP students should understand the concept of aesthetics as an important environmental characteristic. Aesthetic value of an area can be for pristine beauty, as aesthetic pollution might take the form of a wind turbine or coal mine. They are “ugly” to the

human eye. The “tragedy of the commons” should be explained using examples of specific commons, such as the oceans, the atmosphere, and public grazing land.

The most important concept in this section is the concept of ecosystem services. Use Table 23.3 (p. 526) in the textbook to discuss examples of ecosystem services. Quite frequently on the AP exam students are asked to explain an ecosystem service derived from a particular area, and recent exams have asked students to explain the value of the ecosystem service to humans. Move on to supply and demand in the study of economic market equilibrium. Stress to students that communal property often results in ecological economic problems. Refer back to the quality-of-life issues you just discussed as you explore the “tragedy of the commons.” Make sure students are able to define clearly what a commons is and is not. This is a concept addressed over several years in questions on AP exams, and students still have difficulty writing adequate definitions and giving plausible examples. This can often be accomplished by playing a fishing game. There are a plethora of these types of games available for perusal on the Internet. Make sure students understand the term *scarcity*. It is also important that they realize how scarcity occurs, and that scarcity is often a catalyst for innovations and change.

Models are used in industry to explore market economics and to determine the growth and development of new and existing technologies.



Have students interpret and compare the graphs presented in the models illustrated in Figure 23.17 (p. 529).

Students need to understand the concepts of GNP, GDP, EPI, and cost-benefit analysis. Use specific examples for each term. Also, have students do a cost-benefit analysis of a particular action. Perhaps they can give the economic/environmental costs-benefits of building a dam for hydroelectric power.

Expand the discussion to the advancements and progress each figure illustrates in different aspects of the economy. Include the goals given in Table 23.4, particularly in relation to pollution and alternative energy use.

Table 23.4 Goals for an Eco-Efficient Economy
• Introduce no hazardous materials into the air, water, or soil.
• Measure prosperity by how much natural capital we can accrue in productive ways.
• Measure productivity by how many people are gainfully and meaningfully employed.
• Measure progress by how many buildings have no smokestacks or dangerous effluents.
• Make the thousands of complex governmental rules unnecessary that now regulate toxic or hazardous materials.
• Produce nothing that will require constant vigilance from future generations.
• Celebrate the abundance of biological and cultural diversity.
• Live on renewable solar income rather than fossil fuels.

Some economists believe that market forces can combat the issue of global climate change. Others believe that we need to enact regulations and laws. The Kyoto Protocol is one treaty that attempts to limit greenhouse gas emission. Emphasize the importance of the Kyoto Protocol, and stress that this treaty uses the idea of cap-and-trade to regulate greenhouse gases. Explain that the US has cap and trade policies for sulfur dioxide which works well to limit this gas in the atmosphere. Also, make sure students are aware that every industrialized nation except the United States and Australia has signed this treaty. Students should also know what is meant by *carbon-neutral*. Stress examples of successful cap-and-trade programs.

Students should realize that many businesses could save money and protect the environment by adopting new green business practices. Stress that operating in a socially responsible manner consistent with the principles of sustainable development and environmental protection can be good for employee morale, public relations, and the bottom line simultaneously. Discuss why this happens. Emphasize that green consumerism gives the public a voice, often encouraging businesses to produce a green product, eliminate packaging, and provide organic products.

## Common Mistakes and Misconceptions

Students do not always understand the distinction between GNP and GDP. Also, many AP questions have included the concept of ecosystem services. Students should be familiar with this concept and be able to identify and explain several ecosystem services. Students should also ensure that they can differentiate renewable, potentially renewable and nonrenewable resources. Nonrenewable resources cannot be used sustainably.

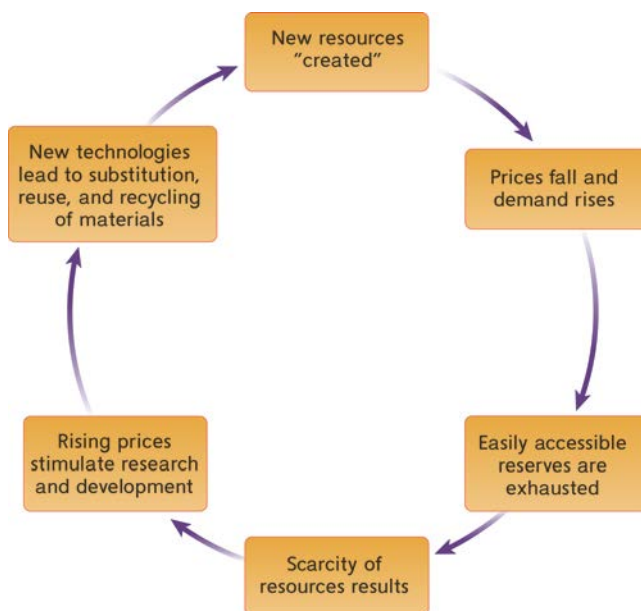
## Activities

### Review Activity

Have students read the information on pages 530-531 in the textbook. Discuss what is meant by *carbon trading*, and why it is a controversial topic.

Review the differences and similarities between renewable and nonrenewable resources. What is the cost of obtaining each? Discuss how a resource can be potentially renewable, but at a certain point is unable to replenish itself fast enough and becomes nonrenewable, depending upon the demand.

Continue the discussion of the economics of supply and demand. You may want to enlist the help of a social science teacher for ideas and planning assistance. If time permits, use the oil industry as an example in the scarcity/development cycle in Figure 23.15 (p. 528).



Make sure students can explain and give an example of GNP (Gross National Product) and GDP (Gross Domestic Product). Reference has been made to both on various AP exams.

## Questions for Review

1. What is the goal of the Kyoto Protocol? How close are we to achieving that goal? Explain.

*The goal of the Kyoto Protocol is to reduce greenhouse gas emissions by using a cap-and-trade approach. We are not close to achieving the goal because one of the largest industrialized nations (the United States) has not ratified this treaty.*

2. What is the difference between a nonrenewable resource, a renewable resource, and an intangible resource? Give an example of each.

*A nonrenewable resource has a finite supply. An example is oil. A renewable resource is one that is continually renewed or can be if used sustainably. An example is timber. An intangible resource is something that we value, but doesn't exist as a material entity. An example is the beauty of a mountain range.*

3. How does environmental protection create more jobs?

*Environmental protection can create jobs in the fields of energy conservation, ecosystem restoration, recycling materials, climate remediation, and clean energy.*

4. What is meant by “tragedy of the commons”? Give an example of a commons, and why it might become a tragedy.

*The “tragedy of the commons” is a parable that explains in any commonly-held resource, people will try to maximize their personal benefit, which will lead to the collapse/overexploitation of the resource. Examples include individuals or companies overfishing ocean species in an attempt to maximize their profits, leading to the collapse of said fishery.*

## Practice Questions

### Multiple Choice:

*Directions for questions 1–5:* The lettered choices below correspond to the descriptions given in questions 1–5. Select the one lettered choice that best fits each statement. Each choice may be used once, more than once, or not at all.

- (A) GNP
- (B) GDP
- (C) EPI
- (D) ecological economics
- (E) cost-benefit analysis

1. used to evaluate national sustainability
2. used to find optimal efficiency
3. includes economic activity within national boundaries
4. the most common way to measure a nation's output
5. attempts to understand the relationship between the economy and the environment
6. Which of the following are renewable resources?
  - I. water
  - II. wood
  - III. uranium
  - (A) I only
  - (B) II only
  - (C) I and II
  - (D) II and III
  - (E) I, II, and III
7. Which of the following is **NOT** a commons?
  - (A) the Atlantic Ocean
  - (B) the air in a forest
  - (C) a national park
  - (D) public grazing land
  - (E) privately owned timber land

Use the following for questions 8–10.



8. Approximately what percentage is the cost of restoration compared to the benefits provided by coral reefs?
  - (A) 10%
  - (B) 20%
  - (C) 30%
  - (D) 50%
  - (E) 70%
  
9. Which two ecosystems will provide the most benefits over the 40 years?
  - (A) tropical forests and coral reefs
  - (B) mangroves and coral reefs
  - (C) tropical forests and mangroves
  - (D) coastal wetlands and coral reefs
  - (E) inland wetlands and lakes/rivers
  
10. Which ecosystem gives the greatest return on investment on restoration costs?
  - (A) tropical forest
  - (B) coral reefs
  - (C) lakes/rivers
  - (D) inland wetlands
  - (E) coastal wetlands

Free-Response Question:

*Directions:* Answer all parts of the following question. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. When a calculation is required, be sure to show how you arrived at your answer.

1. The Bureau of Land Management monitors public rangelands in the western part of the United States. They conduct wild horse roundups on a regular basis.



- (a) Give one reason why wild horse roundups are conducted.
- (b) This rangeland is a commons.
  - (i) Explain **two** possible outcomes as a result of overuse of this land.
  - (ii) Identify and explain another commons.
  - (iii) Describe **two** ecosystem services supplied by the commons you identified in (ii).
- (c) Describe one method that would prevent the overuse of the rangeland.
- (d) Explain **two** environmental/economic costs-benefits for the method described in (c).

## Answers to Practice Questions

### Multiple Choice:

1. C
2. E
3. B
4. A
5. D
6. C
7. E
8. D
9. D
10. A

### Free-Response Question:

This question is based on 10 points.

1. (a) 1 point for indicating that the horses are competing with the ranchers' cattle for food.
- (b) (i) 2 points total. 1 point for each outcome. Possible outcomes include: erosion, compaction of the soil, and desertification.
- (ii) 2 points total. 1 point for identifying a commons, and 1 point for an explanation of that commons. Commons include oceans, the atmosphere, and forests (if explained that it can be used by everyone).
- (iii) 2 points total. 1 point for each ecosystem service. Ocean services include: fish, fishing, recreation, aesthetics, and boating.
- (c) 1 point for describing a feasible method that would prevent the tragedy. A feasible method could be limiting the amount of cattle that can graze in any one area at a time.
- (d) 2 points total. 1 point for each cost and/or benefit. Each one can be either economic or environmental. Economic costs: fewer cattle means lower profits for the rancher, so the rancher may have to lease private land for grazing. Environmental benefits: lessen the effects of erosion, compaction, and desertification.

## Answers to questions in the Student Edition:

### Case Study AP Document-Based Question (page 519)

- (A) When considering a carbon emissions tax one would think that companies would suffer and therefore the economy would suffer as well. Contrary to this, carbon emissions taxes lead to more revenue and a healthier economy. It actually leads to tax breaks for corporations and also for individuals. Environmentally, carbon taxes lead to decreased emissions and increased environmental conservation. Emissions taxes also lead to the use and further development of alternative energy sources, which further decreases the carbon dioxide released to the atmosphere. The cost of implementing this new tax can be offset by the revenue generated by the tax.
- (B) Charging for emissions can lead to a large decrease in fossil fuel use because both large and small companies will reduce their emissions if they have to pay for them. Small companies that do not have large incomes will be more likely to cut their emission levels to below the chargeable level because they cannot afford to pay for them. Wealthy companies that can afford to pay for emissions will still decrease them because it does not make economic sense to pay for an expense that can be cut. Either way, carbon emissions are decreased by the use of economics.
- (C) Economic pressures could present a challenge to reducing emissions because some community members resist paying taxes of any kind and their concerns need to be addressed before acceptance of a carbon tax. Also, a tax could be difficult in places where the infrastructure for alternative energy sources does not exist or is poor—many front-end expenses to build this infrastructure could be unaffordable to small businesses who may risk closure under the increased costs.

### Use the Math (page 524)

Federal subsidies cost account for 0% ( $(0¢/\text{kWh})/(18¢/\text{kWh})$ ), 3.6% ( $(1¢/\text{kWh})/(27.5¢/\text{kWh})$ ) and 2.8% ( $(1¢/\text{kWh})/(36¢/\text{kWh})$ ) of total cost under low, best, and high estimates respectively. The cost of climate impacts is approximately 1¢/kWh, 3¢/kWh, and 10¢/kWh under low, best, and high estimates respectively.

### Use the Math (page 535)

If a bag of coffee costs \$8.50, \$0.68 goes to the growers ( $\$8.50 \cdot 0.08$ ). If you removed the cuts for traders, brokers, and shippers, this would leave \$2.38 to go back to the other shareholders ( $8.50 \cdot 0.28$ ). Assuming an equal distribution of these funds, that would be an additional \$0.60 for the growers, a profit increase of 88%. ( $(\$1.28 - \$0.68)/\$0.68 \cdot 100$ )

## AP Connections Review Answers (pages 30-32)

### Multiple-Choice

1. d. Timber is a tangible resource.
2. d. The infant mortality rate is not taken into account when calculating a country's GNP.
3. e. The pollution emitted by the car would be an external cost of owning and operating an automobile.

- 4. c. The World Trade Organization, WTO, regulates international trade.
- 5. d. topsoil is not a renewable resource on a human time scale
- 6. e. Arancher building retention ponds on his land around pastures to decrease runoff into surrounding streams can harm neighboring farms and organisms downstream that also use that water.
- 7. b. A coal plant being charged for releasing SO<sub>2</sub> above the legal level is a green tax. Tax deductions, subsidies, and rebates for making environmentally friendly products is a green tax incentive.
- 8. b. They encourage companies to prevent pollution because they can sell their extra allotments to others.

### **Data Analysis and Free-Response Questions**

1A In figure (a), food crashes as does population a short time later. The two curves mirror one another because the population is dependent on food for survival.

1B In figure (b), food production stabilizes and population stabilizes shortly after. Strategies that would encourage this trajectory include policies that decrease food waste and production while increasing access to communities in need, and families making conscious decisions to limit the number of children they have and the amount of food waste they produce. Answers may vary.

1C Strategies built into the pollution model trend likely include that despite continued industrial output, waste products are controlled, re-used, or converted to usable products. It could also include less use of virgin resources, and a stabilization of human population growth and food production.

2A Cost-benefit analysis (CBA) is a process that assigns values to resources and the social and environmental effects of doing certain things. It seeks an optimal efficiency point where costs equal benefits. It's role in environmental economics is to justify the building of infrastructure while considering the cost to our environmental resources and renewable benefits. A monetary value is assigned to a project and the intangible or public resources involved and then the costs versus benefits are weighed.

2Ai Benefits of CBA include providing a method by which to consider the loss of intangible or public resources and provides the opportunity for citizens to weigh in. Challenges associated with CBA include that it is difficult to assign monetary values to these intangible or public resources, and that there are no standards and inadequate attention to alternatives.

2Aii Intangible resources are those that have potential for creating wealth or giving satisfaction, but are nonmaterial. Open space, beauty, serenity, wisdom, and diversity are examples of intangible resources. They are incorporated into CBAs as assigned monetary values that are weighed against the benefits of a given proposed project.

2B Renewable benefits include ecosystem services such as regulation (of water supplies or other factors), provision (food and other resources), support or preservation (nutrient cycling or crop pollinators), and aesthetic or cultural benefits (parks and learning/spiritual places).