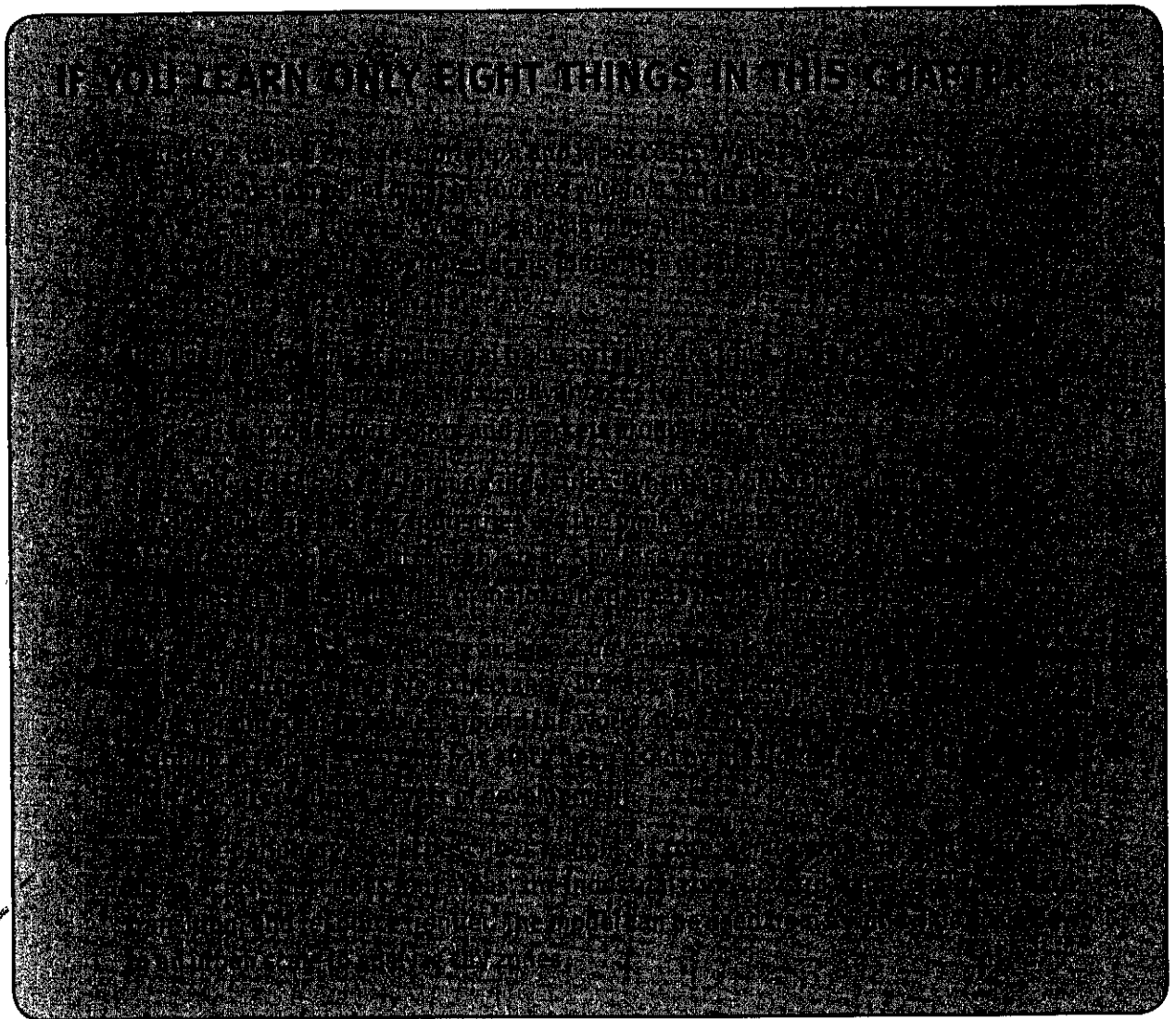


# CHAPTER 8: INDUSTRIALIZATION AND ECONOMIC DEVELOPMENT



6. The latest development strategy, sustainable development, attempts to improve the lives of people without depleting resources for future generations. This approach is often successful on a small geographic scale and with women who have lower levels of development in all areas of the world.
7. Natural resources are either renewable or nonrenewable. The most important nonrenewable resources for industrial purposes are fossil fuels. The burning of fossil fuels and extraction of natural resources can have negative environmental consequences.
8. The United States is the leading consumer of fossil fuels in the world today. China, with its growing economy, is quickly increasing its energy consumption levels. There are alternative forms of energy such as hydroelectric, solar, nuclear, wind, and biomass, but it is debatable if these alternative sources of energy can seriously reduce carbon emissions from the industrialized countries of the world.

## KEYS TO ECONOMIC AND INDUSTRIAL DEVELOPMENT

When discussing industrialization and economic development, it's important to note that some countries develop faster than other countries. Some urban areas develop faster than other urban areas. Why is this the case, particularly when different areas seem to have the same natural resources? There are several reasons for the economic success and failure of certain countries and urban areas.

Industrialization is one of the main components of economic success. Today, a country must make the leap to the industrial and tertiary sector to enjoy economic development. How countries do this is the real issue. Most societies want economic success and want to be modernized, to have the conveniences, including automobiles, cell phones, and refrigerators, that people in developed countries have become accustomed to. Why do the United States, Europe, and some Asian countries possess these amenities, while many countries in Africa are struggling to free themselves from abject poverty?

One of the most important factors is the economic system of each country. There is a saying that suggests that capitalism is the uneven distribution of wealth, whereas communism or socialism is the even distribution of poverty. However, many Scandinavian countries, which profess to be socialist, enjoy some of the highest standards of living in the world. By allowing people the freedom to obtain their own wealth, societies can grow through the entrepreneurial spirit of the people themselves.

## ECONOMIC SYSTEMS

There are three main types of economic systems in the world: capitalism, socialism, and communism. It is important to note that governmental systems, such as totalitarianism and monarchies, can have profound effects on economic systems, so no two countries are completely alike.

### CAPITALISM

**Capitalism**, broadly, is the process of letting the competitive market determine the price of goods. By letting the market decide prices, people have the freedom to choose their own outcomes based on their ability and freedom to pay. For example, if one person wants to sell you your school lunch for \$3.00 while another person will sell you your school lunch for \$2.00, and the lunches are of equal size and nutritional value, you will choose the \$2.00 lunch every time. Your money is valuable to you, and you want to keep as much of it as possible.

It has been suggested that capitalism, based on competition, inevitably means there are winners and losers and that those in poverty are largely ignored. Poverty is often a heavily debated issue in capitalistic countries.

### SOCIALISM

**Socialism** is the government control of basic items in an economy. Government controls basic food prices as well as transportation and energy prices to ensure that everybody can pay for essential services. Individual tax rates are usually higher in socialist societies so the government can pay for the transportation and health care for its citizens. The return for paying higher taxes is that people enjoy services, such as health care, at no or little direct expense.

It has been suggested that socialism provides no incentive for people to work, because the government provides social security for its citizens. Many young people in socialist countries refuse to work yet feel they are entitled to services and security.

### COMMUNISM

**Communism** is the total government control of all prices in a society, ranging from bread to utilities. The former Soviet Union tried communism with some success, particularly in terms of military production, but the economic well-being of its citizens was in question. In the former Soviet Union, communism did not provide basic necessities to the population, ultimately leading to the economic system's downfall.

According to its detractors, communism offers no incentive to a person to succeed. Doctors, lawyers, and custodians all make the same salary. In addition, the government dictates your

profession based on its assessment of your skills. Some people are made to train as athletes, others as scientists or doctors. These skills are sometimes determined early in life, and the government enforces mandatory training in that discipline.

### **ECONOMIC SUCCESS FACTORS**

The following economic factors are vital in determining the success of companies on a local scale: environmentally friendly policies, political support, societal acceptance, and a strong economic support base, including trained, experienced workers as well as investment capital.

### **ENVIRONMENTALLY FRIENDLY ACTIVITIES**

You simply cannot put a factory in the middle of a city and begin polluting the lakes, rivers, and air there. The citizens living near the factory will complain, and the local government will soon enforce regulations on your factory. You must show that your company treats the environment with respect. In many instances, severe fines can be levied against companies that pollute the air, soil, or water.

### **POLITICAL SUPPORT**

The support of local politicians is important to a company's success. Local politicians set up zoning ordinances and approve construction plans. The local governments need to be in agreement with your plans for your business to start up and eventually succeed.

### **SOCIETAL ACCEPTANCE**

Societal acceptance is also critical. You must be selling a product that the local citizens approve of. You cannot be selling something that violates cultural standards. For example, you will not find liquor stores located near schools.

### **ECONOMIC SUPPORT BASE**

Another key factor for economic development is having an economic base of support, which involves worker training and experience. Training new employees often means that you're paying two workers to do the job of one. For example, a new cashier must be watched by somebody who is already trained in the job. Training and on-the-job experience minimize employee turnover and improve overall production.

The other part of the economic support base is capital investment in buildings and large equipment or vehicles. Sufficient credit is often needed to establish a business; most companies need loans to get started.

## GEOGRAPHIC FACTORS

Two types of geographic factors, site and situation, contribute to the industrial development of some countries while keeping others reliant on their agriculture sectors. Some locations benefit from excellent site and situation factors. Others may have a good site but poor situation or vice versa.

### SITE FACTORS

Site is a major geographic factor contributing to a country's economic success. **Site** is the internal characteristics of a place based on its physical features. Some places have excellent sites, while others struggle because of poor sites.

The physical characteristics of a particular location determine its site. For example, New Orleans has a poor site due to its location below sea level. When Hurricane Katrina hit, the city was flooded, although levees had been built to hold back water. Often, natural disadvantages are difficult to overcome.

### SITUATION FACTORS

**Situation** is the relationship that a particular location has with the locations around it. Pittsburgh has an ideal situation for its production of steel. Iron ore, an essential component for the production of steel, comes from the Great Lakes region, including Minnesota, Wisconsin, and Michigan. High-quality anthracite coal, which can fuel blast furnaces, was found nearby in western Pennsylvania. Pittsburgh was also located on the confluence of two major rivers, the Allegheny and the Monongahela, which form the Ohio River. This river system gave the city a perfect means to ship its steel products all over the world.

Another city with an ideal situation is Detroit, which became famous for its production of cars. The city could export the cars by means of the Great Lakes and through the St. Lawrence Seaway with access to the Atlantic Ocean. Railroads could send the automobiles throughout the United States.

Both Pittsburgh and Detroit have established basic industries. **Basic industries** are the focal point of the economy for a city. For Pittsburgh, the basic industry is steel. For Detroit, the basic industry is automobiles. For Silicon Valley in California, it is the production of computer chips and equipment. For Minneapolis, it was the milling industry, which produced flour from the wheat grown on the Great Plains. There are dozens of different basic industries from which a city may grow. An urban area's site and situation determines which basic industry will work there.

**Nonbasic industries** are secondary businesses that sprout up after the city has already established its basic industry. An example of a nonbasic industry would be the construction industry needed to build homes for the workers in a city's basic industry.

All of these businesses together form the multiplier effect. The **multiplier effect** is the expansion of the economic base of a city as a result of the basic and nonbasic industries located there. For example, the steel industry in Pittsburgh led to the rise of a barge industry.

### **INDUSTRIAL FACTORS**

A variety of factors contribute to a county's industrial success or failure, which impacts overall economic success. These factors could include anything from its economic system to its governmental systems. On a micro scale, the site and situation factors, including transportation systems, affect the success of a particular business involved with manufacturing. This industrial base is a prime factor in determining the overall success of a country's economy.

### **INDUSTRIAL COSTS**

Industrial costs are either fixed or variable. **Variable costs** fluctuate based on the volume of the order. **Fixed costs** do not fluctuate based on the quantity ordered. Usually, the more of a product a customer orders, the less the price per individual item; the less the customer orders, the greater the cost per individual item. Businesses prefer to charge variable costs to encourage customers to buy more, clearing out their warehouse space and allowing them to replace old products with new ones. When businesses get buyers to purchase in greater bulk, they relieve themselves of inventory. This allows them to purchase newer materials, which most people prefer over older outdated materials.

### **TRANSPORTATION SYSTEMS**

Transportation is one of the most important fixtures of industry. Industry needs to use a low-cost form of transportation yet ensure that products get to market relatively quickly. Transportation occurs throughout the industrial business process. Raw materials are transported to the production point. Finished products are transported to the wholesaler, perhaps traveling via several modes of transportation. Then the products are transported to the retailer, who sells them to you, and you take them home. Each of these steps in the industrial process may use different means of transportation.

When delivering products, time-space compression comes into play. **Time-space compression** is the effort to increase the efficiency of time in the delivery process by diminishing distance obstacles. One of the best ways to increase time efficiency is through the use of modern

technologies, such as the Internet. This has greatly increased the speed at which industry can deliver its products.

A general rule in transportation is the greater the distance traveled and the weight of the products, the greater the cost to transport them. As distance and weight decrease, so does the transportation cost.

Prior to the Internet—think back farther, prior to the telephone!—commerce had to be done through face-to-face contact. Sometimes, one of the parties had to travel a long distance to conduct a transaction. Today, you can email someone across the world and place orders within seconds. By reducing the time used in the communication process, the overall process becomes more efficient. Distance is still a factor in the transportation cost of finished products. Even this is continually decreasing, though, with the increased speed and efficiency of the five primary means of industrial transportation.

There are five primary forms of industrial transportation: truck, train, plane, pipeline, and ship. Each of these has advantages and disadvantages in terms of time and cost. Some are faster than others, some are more efficient than others, and some cost more than others.

### **TRUCKS**

The first means of transportation is the use of a **truck** or highway carrier. Trucks are a highly mobile and efficient form of transportation that can go almost anywhere there are roads. Trucks are the most-used method of industrial transportation. Companies order supplies, which are then hauled, usually by means of a semitrailer. Overland truck drivers can haul a fair amount of cargo for large distances relatively quickly. The efficiency of trucks means the products that you purchase in the store cost less. Most of the items that you purchase retail or even wholesale are delivered by truck.

There are some disadvantages to using trucks. One is delays due to weather. If a road is shut down, a truck cannot haul its payload over it. This loss of time means a loss of profits for the companies that depend upon truck delivery. Traffic delays can also diminish the efficiency of trucks. Many industrial areas are located in parts of town that experience high levels of traffic. Trucks themselves slow down traffic, because of their size and weight.

Another disadvantage of trucks is that they use fossil fuels. Most trucks run on diesel, which comes from the refining of petroleum products. Petroleum products cause environmental problems such as air pollution.

Trucks also have high maintenance costs. As their engines get older, they need more maintenance to keep running efficiently.

### TRAINS

Trains are one of the most efficient and most cost-effective forms of transportation available to industry. They can haul an immense amount of freight for long distances. In addition to their ability to haul huge loads, they are becoming increasingly fuel efficient.

Trains have some disadvantages. One is their lack of flexibility of routes. Train tracks don't go to every industrial location, and many trains must travel to a station, where the cargo must be unloaded from one form of transportation to another. These transfer points are called **break-of-bulk points**. Cargo is usually shifted from the train to a truck, which can then carry it the rest of the way. The bottom line is that almost all companies have roads leading to them, but not all businesses have train tracks leading to them.

Massive factories, like the huge automotive plants in Detroit, often have tracks built directly to their doorsteps to minimize transportation costs. Such factories do not have to use trucks to haul products to the train station, where the freight would have to be transferred.

An obvious disadvantage of trains is their inability to cross oceans. Trains are limited to land travel and cannot haul products to Asia from North America or vice versa. Also, the operating costs of a train can be high in relation to the land use of unused tracks compared to the other means of industrial transportation. In other words, the rails that the train companies built, at a considerable cost, are today used infrequently.

### AIRPLANES

Airplanes are the fastest way to get products to market. In many isolated areas, such as northern Alaska and the interior regions of Africa, planes are the only means of accessing the supplies needed for survival. Airplanes have a high degree of flexibility regarding their routes, but most freight hauled by airplane must go through a break-of-bulk point, usually to some type of truck.

Some of the produce consumed in the United States comes from Central and South American countries, and airplanes are used to haul fruit products to North America during the winter. Shipping the produce by other means would mean that the fruit would spoil; the only means of transport that is fast enough to do this is airplanes. Dozens of flights daily haul produce from tropical regions to other countries during the winter.

Although they are the fastest means of transportation, airplanes are also the most expensive to use. In addition, the fuel efficiency of airplanes is very low, and fuel costs can eat away at profits. Many



airlines in the United States have suffered economically because of increases in fuel prices. Airlines have tried to offset this cost by charging passengers and shippers more.

Also, airplanes experience weather delays. In icy conditions, many planes are grounded for safety reasons. Just as passengers experience delays at the airport, industrial producers and consumers suffer from delays in the shipment of products. Such delays reduce or eliminate profitability.

### **PIPELINES**

Pipelines are a highly efficient way of moving gas or liquid products from one region to another. Pipelines are also one of the safest means of hauling these products. However, pipelines are limited to gas and liquid products. Therefore, pipelines are generally limited to the transportation of natural resources from their extraction or mining points to production facilities, which may be hundreds or even thousands of miles away. The determining factor of whether pipeline transportation is feasible is the availability of pipelines between the point of extraction and the resource's destination.

One of the most famous pipelines in the world is the Alaskan Pipeline. The Alaskan Pipeline is an engineering marvel, extending over 800 miles through some of the highest mountains in North America. Its primary purpose is to get petroleum from the production point in the North Slope to the transportation point near Valdez, Alaska. This pipeline was built at an extreme cost with oil company money. These oil companies saw the building of the pipeline as an investment. The amount of oil in the North Slope of Alaska greatly eases the burden of importing foreign oil.

The safety record of pipelines in the United States is impeccable. There are very few incidents of pipeline failure. If maintained properly, a pipeline can last for many decades. However, as with all means of industrial transportation, pipelines have some drawbacks. As mentioned, pipelines can only haul gas or liquid products. Also, they're very expensive to build, and once a pipeline is built, moving any section of it is difficult. The line is usually built to cross the least distance possible to minimize construction costs.

As with the Alaskan Pipeline, environmental studies need to be done before construction can begin. These environmental studies are paid for by the primary user of the pipeline. The pipeline's environmental impact must be given a clean bill of health before any construction can take place.

### **SHIPS**

Anything from small barges on inland waterways to supertankers that can haul tons of crude oil around the globe are used for industrial transportation. There are thousands of ships on the world's oceans at any given time. All different types of products are shipped by water. Many are hauled in cargo containers and shipped from massive ports, such as Hong Kong and Singapore.

The Panama Canal, a major shipping route for goods en route from the east coasts of North and South America to the west coasts of each continent, is due for a major renovation project because many of its locks are too small for the largest ocean-going vessels.

Ships are the most energy-efficient means of transportation, even more so than trains. The average cost per distance traveled is the lowest among the five means of transportation.

However, using ships is also the slowest method of delivering industrial products to either production points or markets, so it works best for products where speed is not a necessity. Athletic shoes coming from China to the United States can be shipped by ship, because they won't spoil on the way. Transporting products by ship keeps down costs.

Another downside to using ships is that many industrial plants lack access to waterways, so a break-of-bulk point is needed to get products from the warehouse or production facility to the port, where the cargo must be loaded. This break-of-bulk point adds to shipping costs. Also, there is a high terminal cost associated with using port facilities.

A final disadvantage of using ships is that they are weather dependent. Barge traffic on northern rivers in Europe and North America ceases during the winter months. On the open seas, storms have forced ships hundreds of miles off course.

## LOCATION OF INDUSTRY

### AGGLOMERATION

**Agglomeration** is the centralization of features of an industry for the mutual benefit of the industry as a whole. The best way to think about agglomeration is to think of your local shopping mall. You go to the mall to purchase a new pair of jeans. While walking to the store to buy jeans, you see a shirt that you just have to get to go with your jeans. While walking out of the mall, you also purchase a new pair of shoes to go with the outfit. Your intention was to only buy jeans, but you leave with an entire outfit. The entire mall benefited from your intention to purchase the jeans. The stores are in competition with each other to a point, but they also help each other by drawing in more people, thereby increasing one another's customer bases.

The agglomeration principle worked for Detroit by creating a competent workforce for automotive plants. General Motors, Ford, and Daimler-Chrysler all benefited from being near each other.

Secondary industries, attracted by the industrial hub, provided products and services to all three. The unions provided the quality labor that was essential in the production of cars. Tires were made in nearby Ohio and sent to Detroit. When companies locate themselves around these major industrial centers, their production costs actually decrease, because raw materials don't have to be shipped as far to the assembly plants.

Much of **manufacturing** or **warehouse location** is based on the principle of agglomeration. Industrial parks can provide companies with tax breaks to locate their industrial plants at that particular location. Shared services, such as the construction of railroad tracks for train transportation, can greatly reduce costs.

**Cumulative causation** is continued growth due to the positive aspects of the principle itself. For example, if agglomeration is successful, more agglomeration occurs. Cumulative causation transpired in Detroit around the automotive industry. Cumulative causation can also lead to a disadvantage from the same agglomeration principle. The **deglomeration** of an economy can occur when the market has become saturated with a particular industry. This creates too much competition, forcing some of the businesses within that industry either to relocate or close down.

## INDUSTRIAL REVOLUTION

The Industrial Revolution started in the mid-1700s and was an extension of the Enlightenment period in Europe. One major invention of the Industrial Revolution was the steam engine, which enabled farther and faster travel than ever before in human history. The steam engine could be used for trains as well as ships. As a result, both agricultural and industrial products had access to a bigger market, and more products needed to be manufactured to meet the demand. Mass production methods and technologies allowed industry to take advantage of the new business environment.

In contrast to today's mass production principles, much of industry was characterized by specialization prior to the Industrial Revolution. One person produced an entire product, using tedious methods and inefficient means. The Industrial Revolution, which began in England, allowed for more mechanization, speeding up the production process and allowing the quantity and sometimes the quality of the product to improve.

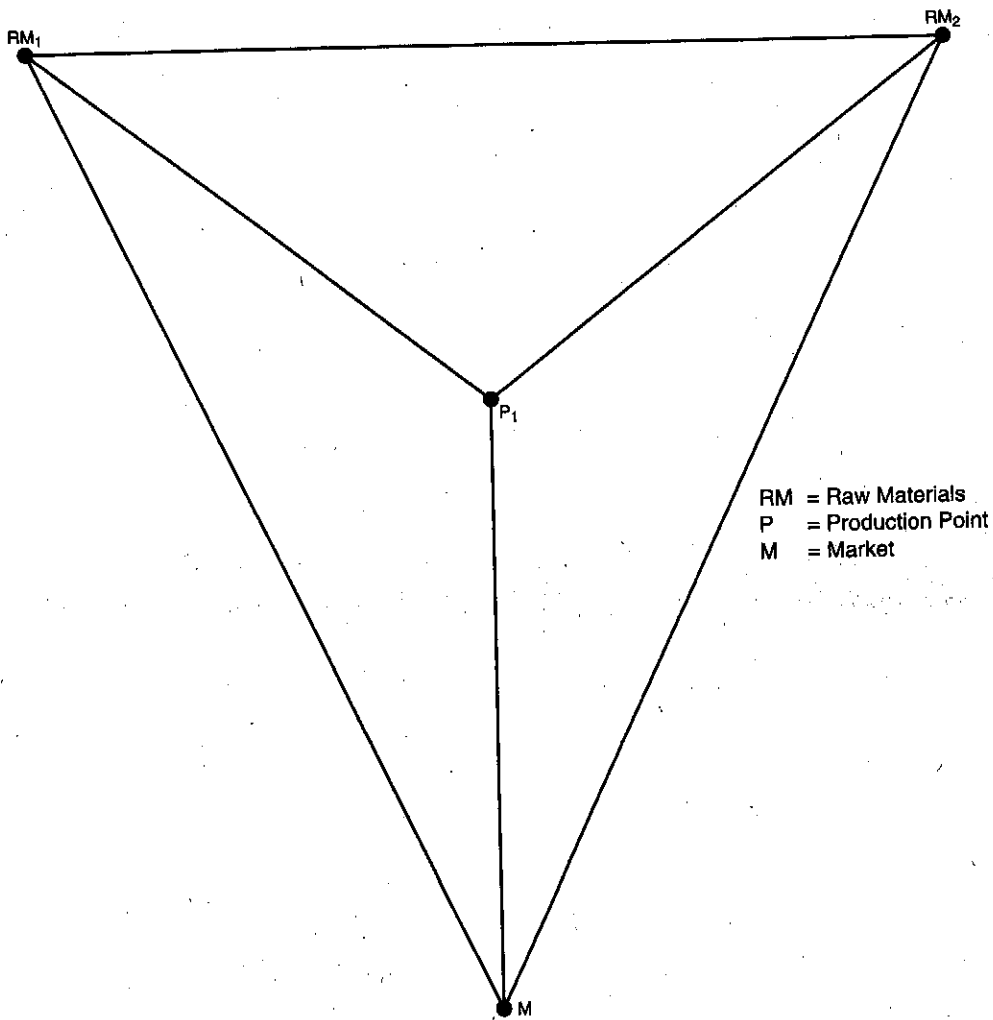


Figure 8.1: Weber's Least Cost Theory.

### WEBER'S LEAST COST THEORY

One of the preeminent economic geographers is a man by the name of Alfred Weber. Weber was a German economist and socialist who in the 20th century developed a theory to try to describe the **industrial location** of certain industries.

Weber's theory, shown in Figure 8.1, became known as the least cost theory. His theory suggests that a company building an industrial plant needs to take into consideration the source of raw materials and the market for the product. Thus, the weight of the raw materials and the finished product will determine the location of the production facility for that company.

The fundamental principle is triangular. The base of the triangle consists of the two raw materials necessary for the production of the product. If the product being produced is a **weight-gaining**

**industry** (an industry where the finished product weighs more than the raw materials), then the industrial production point will need to be located closer to the market to minimize the transportation costs associated with a relatively heavy product (see Figure 8.2). If the industry is a **weight-reducing industry** (an industry where the raw materials weigh more than the finished product), the industrial production point will need to be located closer to the raw materials (see Figure 8.3).

Many of the resource-oriented industries are weight-reducing industries. The weight-reducing industries try to minimize the costs of hauling heavy materials, such as ore, long distances by placing their industrial production points closer to where the resources are located, such as mines.

The production of potato chips is an example of a weight-reducing industry. For our purposes here, let's assume that there are two primary raw materials, salt and potatoes, in the production of Geochips. Because the potatoes and the salt are heavier than the finished product, a bag of potato chips, the production point should be located closer to the potato farms and the salt plant.

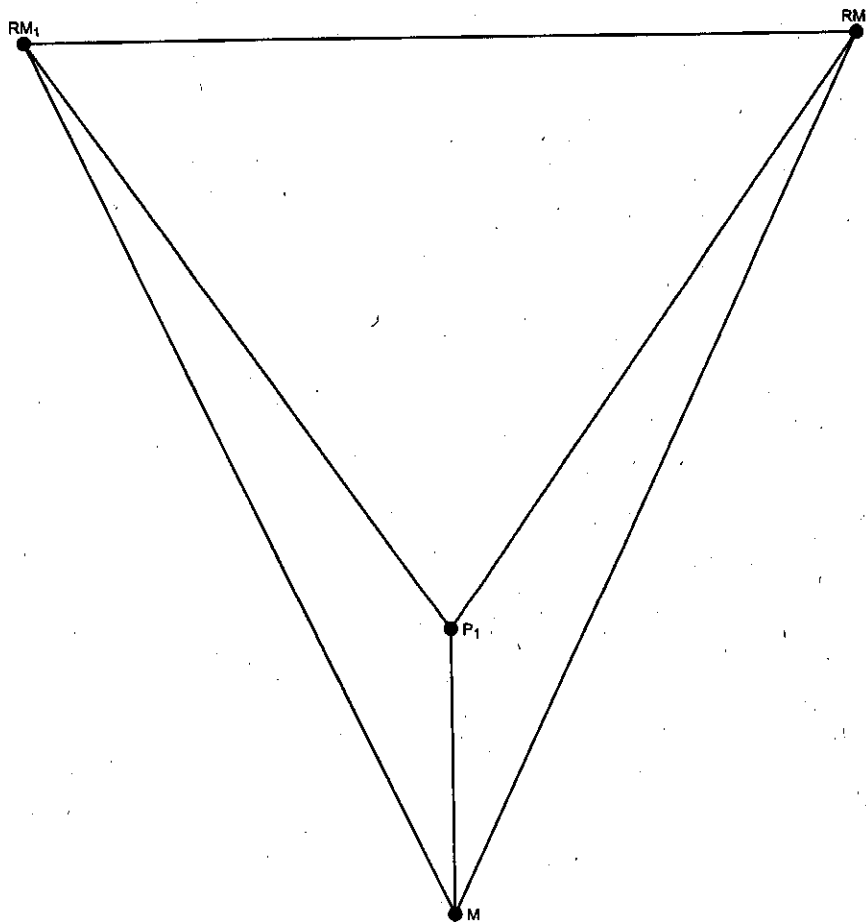
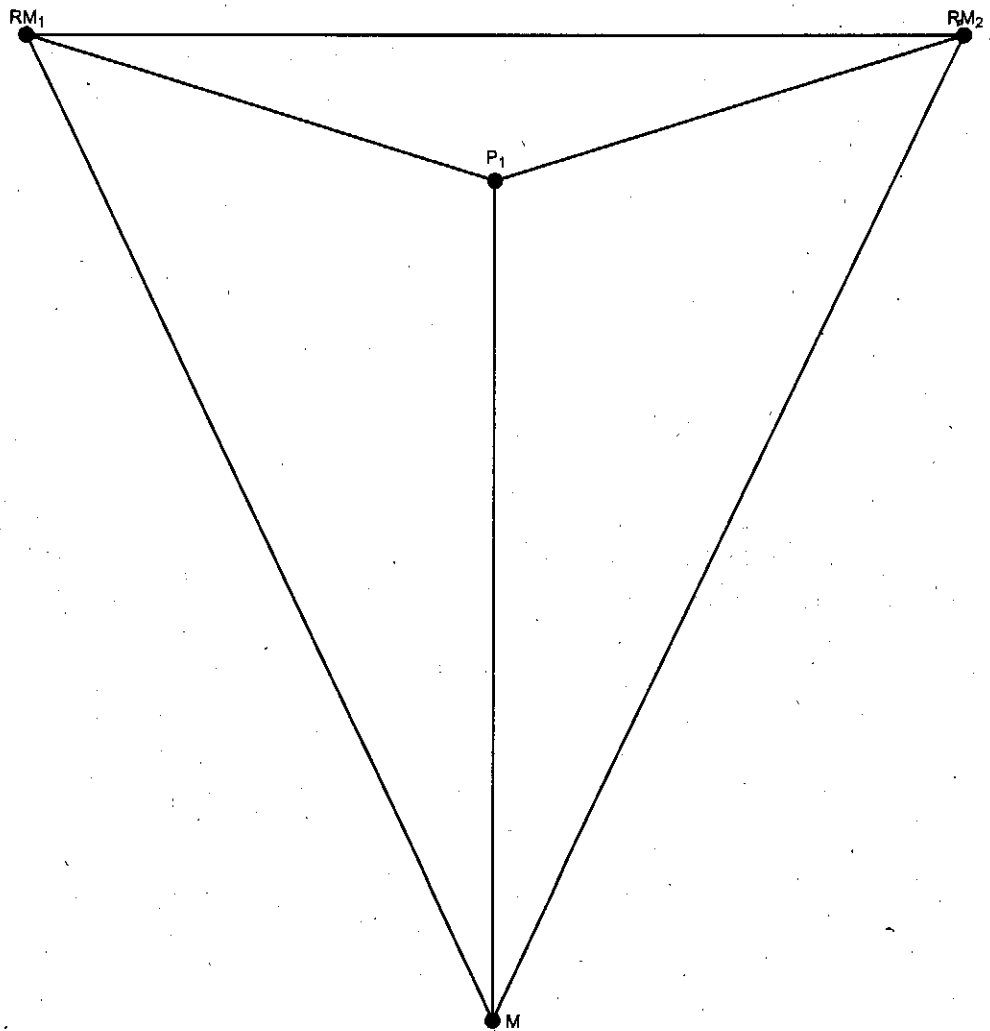


Figure 8.2: Weber's Least Cost Theory — Weight Gaining.



**Figure 8.3: Weber's Least Cost Theory — Weight Reducing.**

A weight-gaining industry, on the other hand, adds to the weight of the raw materials in making the finished product. Automobiles are an example of a weight-gaining industry. The plastic, rubber, and engines all add to the overall weight of the finished product. Weight-gaining industries want their production points located closer to their markets so as to reduce the transportation costs of the heavy finished product.

An example of a weight-gaining industry using the same raw materials as Geochips would be French fries. In our production of Geofries, the raw materials are the same—salt and potatoes—but now the finished product must be frozen when shipped to market. Refrigeration, or the cooling or freezing of the product, adds to the cost of the transportation by increasing the product's weight as well as by increasing the energy needed for the actual refrigeration. Because the Geofries

are a weight-gaining product, the manufacturer will want to move the production point closer to the market.

Another example of Weber's least cost theory is the fictional "brick bunny." The brick bunny is built with two primary products: bricks and feathers. Because the bricks weigh more than the feathers, the producer puts the production point closer to the bricks to minimize their transport cost. The production point is skewed toward the side of the triangle where the raw material that is the heaviest (bricks) comes from. This is shown in Figure 8.4.

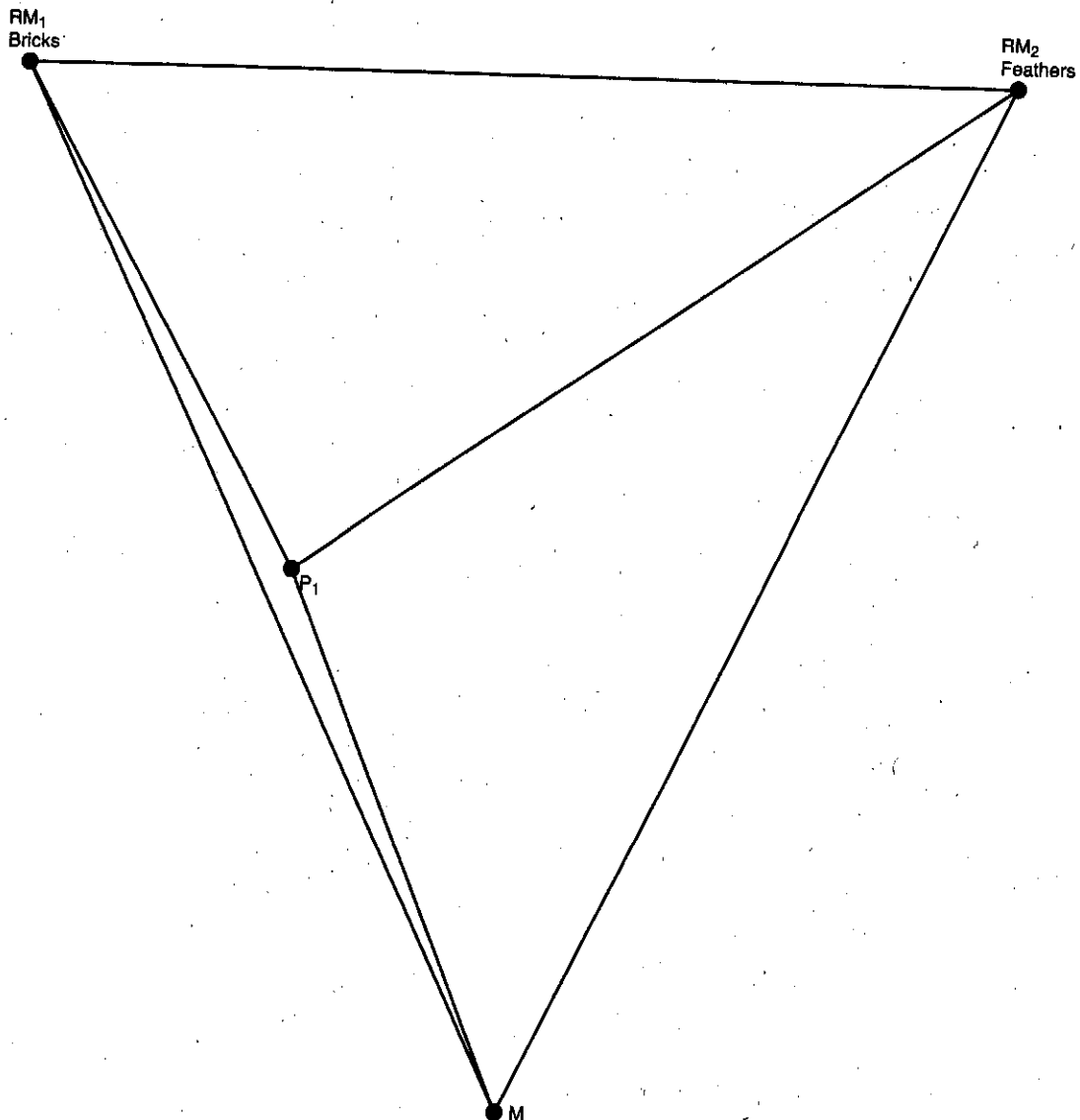


Figure 8.4: Weber's Least Cost Theory—Brick Bunny.

The three primary factors that Weber included in his model were raw materials, labor, and transportation. The most expensive is labor; however, transportation is the easiest item of the three to control through the location of the new industrial facility. Still, all three factors are vital in determining the success of a business or industry.

For Weber's theory to work, he had to make some assumptions. The industrial production point must be located somewhere within the triangle. Otherwise, excessive transportation costs will make the product too expensive, and the consumer will be able to purchase the same product more cheaply from another manufacturer who is located within the triangle.

Also, all parts of the triangle must be uniform in topography. Like von Thunen's agricultural land use model (also based on transportation), everything inside the triangle must have the same landscape characteristics so that transportation costs are the same everywhere in the triangle.

Another assumption is that the areas inside of the triangle have the same political, cultural, and economic values. Every person within the triangle must have the same opportunity to purchase the product and the same desire for it.

Weber also assumed that the availability of transportation is equal in all parts of the triangle. The items must be shipped via the shortest and/or cheapest available method.

Other important assumptions are that the minimum amount of raw materials needed to make the product is available and that a market is known to the producer when developing the product.

Yet another assumption is that labor is infinitely available to any production point located within the triangle. However, that labor force is immobile, unwilling to move with the industry if the industry relocates.

What happens when a variety of materials is needed for the production? Then the production point moves closer to the heaviest raw material to balance transportation costs.

Weber's theory can be used on different, typically macro-level scales, from national to state or city levels. Weber's assumptions suggest that all of the industry occurs within the same national boundaries. However, industrialization is becoming more global. With trade alliances, such as the North American Free Trade Agreement (NAFTA), the ability to produce goods in one country and sell them in another is becoming much more common.

### **FOREIGN PRODUCTION OF GOODS**

**Maquiladoras** are industrial plants located in Mexico that produce goods using relatively inexpensive labor and then sell the products in the United States for more profit than if the products were made in the U.S. A debate rages over the **outsourcing** of jobs from the United States to less developed countries, where companies can pay employees pennies on the dollar. Unions



and others are decrying the loss of American jobs to citizens in less developed countries. However, U.S. consumers benefit from buying products as cheaply as possible. This process is known as the **new international division of labor**. The new international division of labor, sometimes called the global division of labor, began in the 1960s and entails the outsourcing of jobs from more developed countries to less developed countries in order to take advantage of cheaper labor costs. The result has been a loss of manufacturing jobs in more developed countries and an increase of employment opportunities in less developed countries.

With the increased efficiency of transportation systems, companies can produce their goods around the world and ship them to the markets in the more developed countries with relative ease and lower cost expenses.

A **footloose industry** is a company with no allegiance or ties to a country or a location that, therefore, can move its primary locations at will. Many times, this is done for tax purposes. Companies will set up tax shelters in countries that have more favorable tax rates. Bermuda is a haven for international businesses because of its corporate tax advantages.

### **TRANSNATIONAL CORPORATIONS**

**Transnational corporations** are large companies that have offices or divisions around the world. Many times, this is done to reduce travel costs or to enter different markets. These companies live in a global culture. Profits of these transnational corporations are measured in billions of U.S. dollars. Coca-Cola is an example of a transnational corporation with offices on every continent except Antarctica. The brand name *Coca-Cola* is recognized around the world and is one of the most recognizable brands on earth. Thousands of Coke products are sold every second. Another example is 3M (Minnesota, Mining, and Manufacturing), which has offices in Europe and Asia as well as North America. Many transnational corporations had their start in the United States, but other companies, such as the Union Bank of Switzerland (UBS), one of the largest financial institutions in the world, had their beginning in Europe.

The point of transnational corporations is to be ubiquitous. Being **ubiquitous** means that a product is available to consumers at any time and at any location around the world. McDonald's is a good example of a ubiquitous company. A person can go to almost any major city around the world and get a Big Mac.

Transnational corporations employ millions of well-educated people around the world. Employees who work for transnational corporations are often transferred from continent to continent as they move up the corporate ladder. Some people claim that the allegiances of transnational corporations and footloose industries are not to a particular country but rather solely to their profit margins and shareholders.

### INTERNATIONAL DIVISION OF LABOR AND MASS PRODUCTION

The **international division of labor** says that when individuals can specialize in their individual production, their speed, efficiency, and quality increases, thereby reducing costs. Henry Ford applied this philosophy of labor to mass production, using the assembly line method to produce automobiles. Sometimes known as **Fordism**, this method involves each person on the assembly line doing a specific task to speed up the overall process of production. When workers specialized in individual areas of expertise, they were paid relatively well for their skill and could then afford to purchase the product that they were making. Prior to the assembly line method, most manufacturing was done by individuals making the entire product. This process was very slow and, therefore, relatively expensive.

The assembly line method became standard in almost every industry, increasing industrial profitability. The old way, of one person producing the entire product, is used today only for specialty products. People usually pay top dollar for this type of specialized product.

Some industries lend themselves better than others to mass production. In the automobile industry, new mechanization techniques have allowed many manual jobs to be taken over by machines. However, other industries, such as agriculture, are more **labor intensive**. Although items like grain can be mass-produced with the assistance of machines, like combines and tractors, other agricultural employment is very labor intensive.

Another example of a labor-intensive industry is the textile industry. Most of the clothes that you wear had to be handmade, often in a factory in a less developed country. Sometimes U.S. retail outlets have been accused of ordering clothes from factories called **sweatshops** owing to their poor working conditions. It can be argued that the people working in sweatshops are there voluntarily and are earning a promising wage in that country. In addition, these jobs create employment and a tax base for many less developed countries.

The growth of **manufacturing exports** has led to a global economy of commerce. As production costs have continued to increase in the United States and Europe, more products are being imported from Asia and less developed countries around the world.

### GLOBAL INDUSTRIAL ZONES

Where is industry located in the United States and the world today? Some areas have site and situation advantages that have contributed to various countries' economic success. All of these locations have found a large percentage of their employment sector involved in industry. There are four primary industrial zones in the world today: the northeastern portion of the United States

and the southeastern portion of Canada; Western Russia and the Ukraine; Central and Western Europe; and East Asia, including China and Japan.

## **NORTHEASTERN UNITED STATES AND SOUTHEASTERN CANADA**

### **NEW ENGLAND**

New England historically had some site and situation advantages that made it successful. New England benefited from the cheap labor provided by early immigrants who used Boston as their entry point into the United States. One of the largest industries in the Boston region was textiles. Much of this industry has moved to the South in recent decades because of the lack of unionized labor in the South, but New England used to be famous for its clothing manufacturing. Hydroelectric power from rivers provided much of the power needed to spin the belts and operate the machines to mass produce cloth. Much of the cloth was made from cotton, which was imported from the South.

Large factories were set up in towns such as Lowell, Massachusetts. Life for workers was difficult, but the pay was relatively good. Life in the factory was often strictly controlled by the owners. The owners of the factory set up bunks within the factory itself, and the workers stayed on the factory campus. Even religious worship was located in the factory, and the factory developed its own culture.

The large textile machines created a very loud, unhealthy working environment. Children were often used to clean the lint from the textile machines while they were still operating. Child labor laws in the United States arose from the textile operations in New England, along with the coal mining industry in West Virginia.

### **THE MIDDLE ATLANTIC**

The Middle Atlantic region of the United States is known today as "the megalopolis." This area includes the large urban areas of New York City; Philadelphia, Pennsylvania; Wilmington, Delaware; and Baltimore, Maryland. This region had a large pool of available labor to work in factories. It also had a large market to purchase manufactured products. This area also was known for its major ports. Today, New York City is still one of the largest and busiest ports in the United States.

### **THE EASTERN GREAT LAKES**

The Eastern Great Lakes region includes the southeastern portions of Canada, the city of Pittsburgh, and the upstate New York region. The majority of these areas received hydroelectric power from the Great Lakes and Niagara Falls. The situation of Pittsburgh was ideal for the

production of steel. Barges and ships hauled iron ore from the Great Lakes to the port of Erie, Pennsylvania. From there, the ore was put on trains and hauled to Pittsburgh. Steel was then hauled to market via barges on the Ohio River and by train.

The southeastern portion of Canada, which extends along the St. Lawrence Seaway and includes Hamilton, Toronto, and Montréal, is some of the most valuable land in Canada in terms of industrial production. The majority of the Canadian population lives in this area. Canada's largest city is Toronto, with a little over 4 million people. This area has a large workforce and market ability to support industrialization. Since NAFTA was enacted, goods can be shipped across the U.S. border relatively easily. The St. Lawrence Seaway can export products to the Atlantic Ocean for transport to markets around the world.

### **THE WESTERN GREAT LAKES**

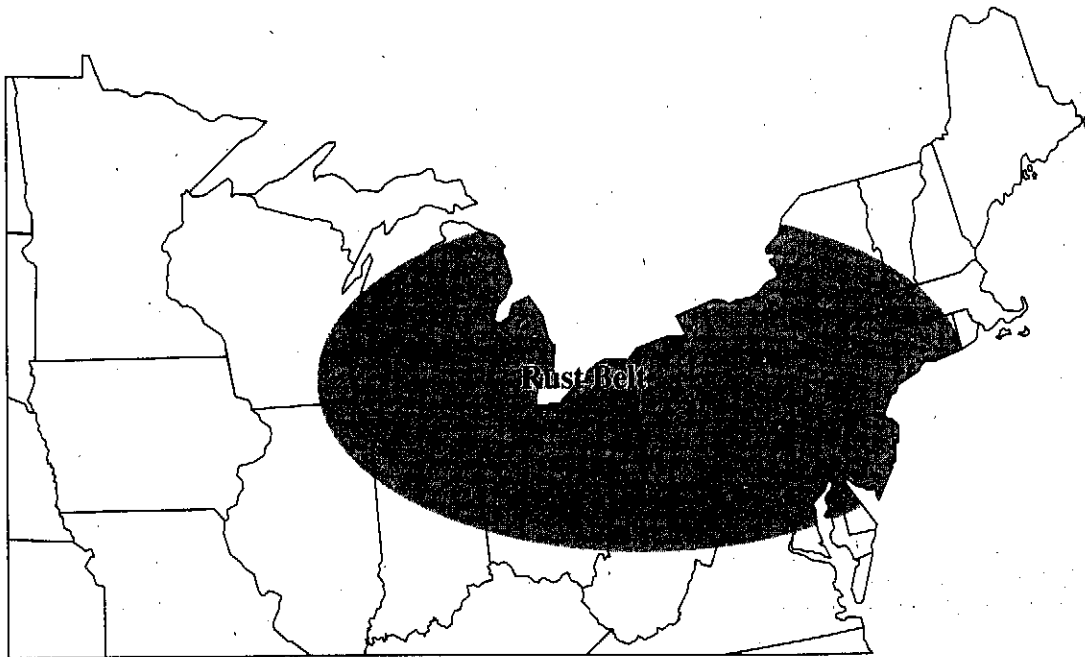
The Western Great Lakes region includes the cities of Detroit, Chicago, and Milwaukee. Chicago is a hub of transportation in the United States because it is in the middle of the country. It contains O'Hare airport, one of the busiest airports in the world and a hub for two of the largest airlines in the United States, American Airlines and United Airlines. In addition, Midway airport is a hub for Southwest Airlines. Dozens of railroad lines converge in Chicago, as do many interstate highways. Engineers actually reversed the flow of the Chicago River to allow river traffic between the Great Lakes and the Mississippi River. Chicago is the largest city between the East Coast (New York) and the West Coast (Los Angeles), and it provides a major market for the resale of products, as well as a labor source for factories.

As aforementioned, Detroit has become a major automobile manufacturing region. All of the major automobile makers in the United States have huge factories there. However, new automotive plants have opened in the South, including a BMW plant in the Greenville/Spartanburg area of South Carolina, a Honda assembly plant in Lincoln, Alabama, and a Toyota plant in San Antonio, Texas. Many of these newer automotive factories have located in the South to take advantage of relatively inexpensive, nonunion labor.

The Rust Belt, shown in Figure 8.5, contains the greatest amount of industrial area in the United States. It is called the Rust Belt because of the huge factories that have shut down within the past two or three decades. The result is a crumbling infrastructure that cities in this region have been trying to clean up.

### **THE SOUTH**

Today, there is a new industrial realm in the United States. Many Southern states are luring manufacturing industries to their cities to increase employment and tax revenues. Some cities even offer tax breaks or no taxes for several years to motivate companies to locate in their cities.



**Figure 8.5:** Rust Belt Area in the United States.

The changing face of industry in the United States is having a profound impact, both positive and negative, on different regions. Cities located in the Rust Belt have seen the loss of thousands of jobs in the manufacturing sectors of their economies, while other areas have seen an increase in the manufacturing sector. Many transnational corporations headquartered in foreign countries are building factories in the United States to minimize transportation costs. For example, the idea of a “foreign car” is becoming more and more foreign. Many “foreign” cars have parts that are produced and assembled in the United States. When these companies decide where to locate their factories, they often use Weber’s theory to minimize transportation costs, thereby minimizing costs and maximizing profits for their shareholders.

### **RUSSIA AND THE UKRAINE**

Russia and the Ukraine region have high levels of manufacturing due to the enormous amounts of natural resources located in the area.

#### **THE UKRAINE**

The Ukraine is one of the largest industrial areas in the former Soviet Union, because of its agricultural productivity and coal-mining activity. The Ukraine took away much of the Soviet Union’s industry and natural resources when it became independent. It still provides Russia with many of its produced goods. This is also one of the major wheat producing regions of the world.

The agricultural portions of Ukraine provide it with a solid economic base, along with raw materials for energy production.

### **RUSSIA**

Much of Russia's industrial base is in the west of the country, around Moscow and St. Petersburg. In addition to the major urban centers of Russia, the Siberian region contains a large amount of manufacturing due to its vast natural resources. In areas where forestry is practiced, the production of paper and packaging materials dominate the economy. The Siberian region has a very small population, and transportation, mostly by rail, is limited. The creation of the Trans-Siberian railroad, one of the great wonders of the transportation world, led to industrial cities growing up along its routes during the communist era.

Farther to the east, hydroelectric power on the Yenisei and Amur Rivers runs factories.

### **CENTRAL AND WESTERN EUROPE**

The Central and Western Europe region includes the countries of Great Britain and extends eastwards into northern France and Germany. This region initiated the Industrial Revolution and hasn't looked back since. The major coal-producing region of Europe is located around Belgium and northern France. Today, however, Europe uses much less coal and relies more on nuclear power. France uses nuclear power for upward of 70 percent of its energy needs.

### **GREAT BRITAIN**

Large industrial areas in Great Britain include London, Manchester, Leeds, and Newcastle. These areas depend largely on the coal industry. Great Britain has been blessed with large deposits of coal within its borders, which have been instrumental in developing the industrial base for many of Great Britain's large urban centers.

### **GERMANY**

In Germany, the steel industry depends on the coal that is mined within its borders. Germany has the other advantage of having two primary rivers to transport goods, the Rhine and the Ruhr. The area around Düsseldorf, even today, is considered heavily industrialized.

Because the population of Germany is spread out among many different cities, inland transportation via rivers and highways is very important. Today, Germany is the leader in industrial production in Europe. Abundant raw materials combined with an educated workforce and a close market with good transportation systems has enabled Germany to continue its industrial success.

## FRANCE

Today, many other portions of Europe have become more industrialized. The production of automobiles in France and Germany, as well as airplanes in France, has provided many jobs. Airbus, with its headquarters located in Toulouse, France, is competing with Seattle-based Boeing to be the world's largest manufacturer of airplanes. With the aircraft market in Asia growing, both Boeing and Airbus have completed projects on new airliners, which can haul people farther, faster, and for less cost by using less fossil fuels.

## IRELAND

Ireland has seen increasing economic prosperity due to industrial development. It has joined the European Union.

## EAST ASIA

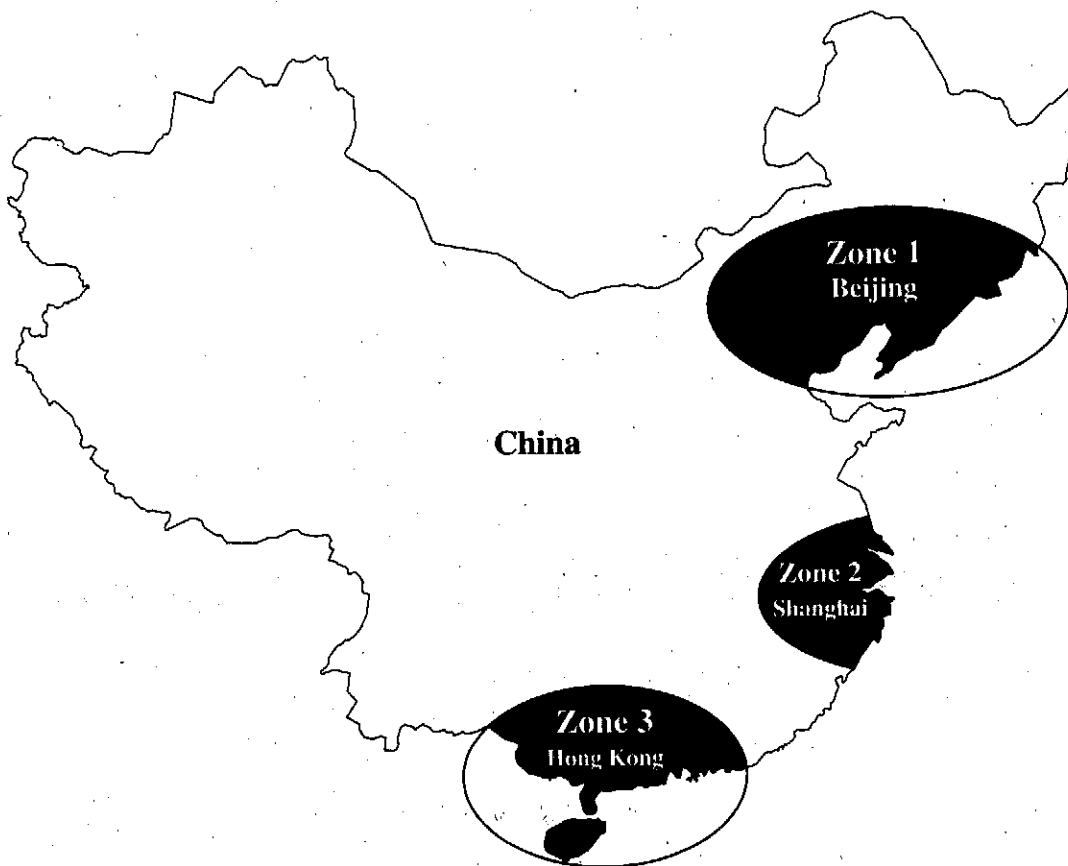
China, Hong Kong (now a part of the People's Republic of China), South Korea, Taiwan, and Singapore have also entered the global marketplace. Many of the ports in China, Japan, and Korea are designated treaty ports. **Treaty ports** are international ports that must be kept open for international trade because of the signing of a treaty. China has more than 80 treaty ports as the result of treaties from different wars. Many of the ports in eastern China are **export processing zones**. These zones are designed to export goods made in China efficiently. Most of these products go to Japan, Europe, and the United States.

The new rising star in industry is China. The Chinese market, which includes more than 1 billion people and a growing middle class, has global industries clamoring to meet its needs.

China's gross domestic product has increased around 10 to 12 percent annually in recent years. China's population is increasingly gaining education and is more than willing and able to compete in a global marketplace. China has had some growing pains as it struggles to keep up with the infrastructure requirements of such a rapid growth rate. Figure 8.6 shows China's industrial regions.

### CHINA: SHANGHAI

Probably no city represents the immense growth in industrialization and urban development in China better than Shanghai. Shanghai is the largest city in China in terms of population. Located at the mouth of the Yangtze River and on the Huangpu River, it has seen tremendous investment in its infrastructure and industrial zones in the past decade. The port of Shanghai, once a seldom-used facility, is now one of the busiest ports in the world. It has seen container volume increase by as much as 33 percent in one year. Goods made in China are produced relatively cheaply and then sent to more developed countries around the world. The textile industry in China employs tens of thousands of Chinese workers. Wal-Mart receives many of its products from Chinese manufacturers, which keep the cost of the products low.



**Figure 8.6:** China's Major Economic Zones.

Huge industrial parks are being established in and around the larger Chinese cities. Shanghai's industrial park is one of the largest in the world. The area known as Pudong has been one of the most successful economic initiatives in history. Pudong, which means "east of the river," has seen the development of a new international airport and a world-renowned convention center. The World Expo will be occurring in Shanghai in 2010, and China is building infrastructure for that event. The Maglev train, a new high-speed train, will haul passengers at speeds of over 300 miles per hour from the airport near the coast to the city center about 20 miles away.

The Chinese have set up **special economic zones (SEZs)**, designated specifically for foreign companies to locate their headquarters. Areas like Shanghai, also known as the Yangtze Delta region, have seen enormous investment from foreign companies trying to get into the Chinese market. Both Ford and General Motors have located plants near Shanghai, and Volkswagen just finished construction of a new plant aimed at producing more than 150,000 cars per year. Shanghai's population has grown as many rural farmers have moved into the area looking for work in manufacturing.



Driving around Shanghai, one notices the dominance of immense factories and industrial centers on the city's landscape. This industrial activity has come at a price. The air pollution in Shanghai and in other cities in China is some of the worst in the world. The skyline in Shanghai can rarely be seen owing to the smog and the amount of air pollution.

For the past half century, there has been competition in China between the government center in Beijing and the economic center in Shanghai. Historically, much investment was put into the government center, whereas Shanghai was viewed negatively. This has changed in the past decade as billions of U.S. dollars and euros have entered the economy. The Chinese government has invested in railroads, highways, and airports, as well as seaports. As a result, Shanghai is now one of the economic centers of East Asia and competes with areas like Hong Kong and Singapore for financial supremacy in all of Asia.

### **CHINA: NORTHEASTERN CHINA**

Northeastern China, or Manchuria, includes the city of Beijing and includes the majority of China's natural resources. Coal manufacturing has dominated industrial activity in the region. Because of the coal, steel is produced here. Much of the industrial activity in northeastern China has developed around the Huang He River. The Huang He River, sometimes called the Yellow River because of its color imparted by the soil in the area, is a major transportation route for manufactured materials. This region is akin to the northeastern United States. Steel, iron, agricultural equipment, and food processing have developed here. Like the U.S. Rust Belt, this area has experienced factories shutting down or leaving for other sections of the country.

### **CHINA: HONG KONG**

In 1997, Great Britain relinquished its control of the port of Hong Kong, which it had gained in the Opium War in the late 1800s. For most of the century, capitalist Hong Kong was a beacon of economic success amid the squalid conditions just across the border in China. That has changed. Hong Kong is still a major trading post for all of Asia and is considered one of the "Four Asian Tigers" (see the following section), but China is much more economically successful. Areas that neighbor Hong Kong have benefited from its reintegration into China. Cities along the border, such as Guangzhou, have begun to develop. Many of the factories in this region, including a Nike factory, specialize in textiles and other clothing and accessories.

Hong Kong has seen its economic growth continue despite being located in a communist country, in part because China has allowed free-market capitalism to take root. China also welcomes the foreign currencies Hong Kong pumps into its economy through trade. For many, in fact, Hong Kong represents what can be achieved with little to no government involvement in the economy. However, this means no safety net, and should a business fail, very few security systems are in place to help laid-off workers.

The port of Hong Kong is one of the busiest in the world. Hong Kong's main industry is the re-export of industrial products made primarily in mainland China. Its harbor is almost perfectly situated. Its site factors are questionable though. Rocky soil and mountainous or hilly terrain have made growth difficult. As a result, Hong Kong has one of the highest population densities in the world and has built up rather out. High-rise apartments dominate its busy skyline.

Hong Kong is known as a major entrepot. **Entrepots** are areas where trade goods are brought to be reloaded onto other forms of transportation. Many of the textiles that are manufactured in China are loaded onto ships and sent to Hong Kong, where they are reloaded onto other ships to go elsewhere for resale.

### THE FOUR ASIAN TIGERS

The **Four Asian Tigers**, sometimes called the Four Asian Dragons, are Hong Kong (see the previous section), South Korea, Taiwan, and Singapore (see Figure 8.7). Each is experiencing rapid economic growth due to its industrial base and the export of items to the United States and Europe. Each of the Four Asian Tigers has used the Asian model of economic success, namely trade. This model is based on the relatively inexpensive production of goods and their export to world markets. All of the Four Asian Tigers have access to a world-class port. They also have developed, educated workforces who are trained to do highly skilled labor. In almost all of the Four Tigers, manufacturing has consisted of low-quality textiles and toys. In recent years, however, the sector has shifted to include electronics and other higher-order goods.

Trade for the Four Asian Tigers is a **complementary** process, meaning that both sides benefit. The countries that manufacture products increase employment, and the countries that receive products satisfy their consumers. Thus, trade is a win-win situation.

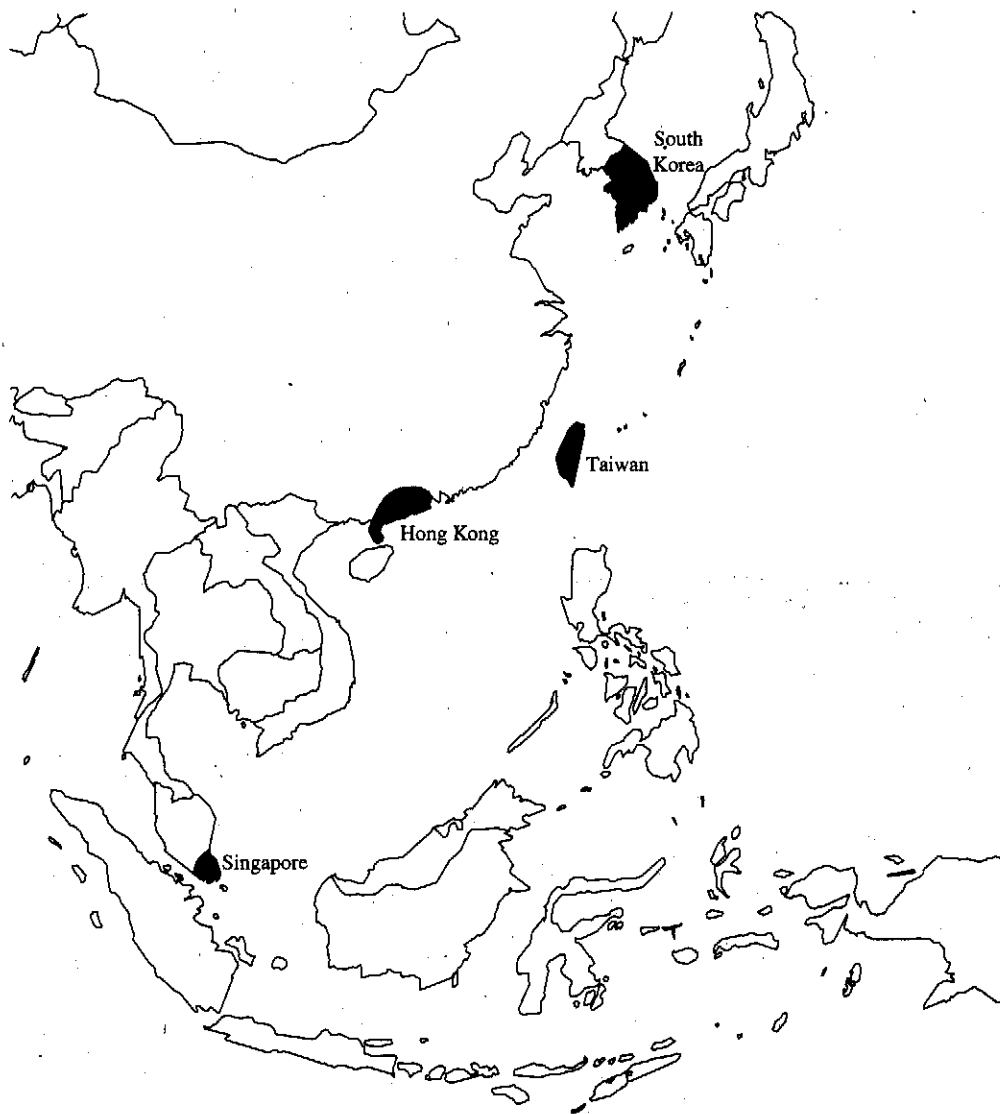
### ASIAN TIGER: SOUTH KOREA

South Korea is dominated by its capital city, Seoul. Seoul is the largest city in South Korea, with a population approaching 19 million people, a high-quality university and primary educational system, and a ready workforce. Seoul is truly a world-class city, even holding the summer Olympics in 1988 and hosting three World Cup soccer games in 2002.

South Korea exports automobiles and electronics. Port facilities are available in cities such as Pusan and Kwangju, allowing access to worldwide markets.

### ASIAN TIGER: TAIWAN

Another of the four Asian Tigers is Taiwan. After Mao Zedong took control of China in 1949, nationalist forces, led by Chiang Kai-shek, retreated to the island of Taiwan. A heated topic today is whether Taiwan is an independent country or a territory of the People's Republic of China. The United States has chosen to recognize Taiwan as an independent state because of its capitalistic economy and economic and military ties to the United States. However, China still believes Taiwan is part of China.



**Figure 8.7:** Four Asian Tigers Map.

Taiwan has seen a rapid economic growth in response to exports. In Taiwan, the main port of Kaohsiung facilitates the majority of exports.

#### **ASIAN TIGER: SINGAPORE**

Singapore is a city-state located at the tip of the Malay Peninsula. Singapore's government estimated the country's growth rate in 2006 at 7.9 percent, comparing favorably with that of China and the other Asian Tigers. Singapore, like Hong Kong, is a classic example of an entrepot. It takes

in goods and reexports them to the rest of the world. The port in Singapore is the busiest in the world. Massive cargo containers put dozens of freight boxes onto ocean liners for export to Japan, Europe, and the United States.

Singapore is also known for its tough policies against crime. The government has outlawed "bad habits," such as littering. As a result, many people are hesitant to visit as tourists for fear of punishment, which can include lashing. The opposite is true of business. International companies love to locate in Singapore, and businesspeople love working there, because it is one of the safest and cleanest places in the world.

There is a saying in Singapore that all of its citizens aspire to the five Cs: car, credit card, condominium, country club, and cash. Although the government is trying to sway people from an obsession with materialism, Western culture is exerting a strong influence. High-end automobiles and luxury clothing stores pervade the city.

### **THE "BABY TIGERS"**

Areas like Kuala Lumpur in Malaysia, Vietnam, the Philippines, and Thailand are all growing their economies and following the model of the Four Asian Tigers. India is gaining status in the industrial sector. Many U.S. companies have located their call centers in India.

### **JAPAN**

Japan's economic success can be traced back to World War II; the treaty that ended that war forbade Japan to build up its military. Without an army, Japan's government could invest in industrial development. Japan has very few natural resources yet is one of the world leaders in industry. Japan has used the world trade model to increase its share of world industry.

Japan's influence on the world has been especially pronounced in the automotive and electronics industries. Japan's workforce is extremely loyal to its companies, and workers equate personal and professional value with how the company performs. A highly skilled and educated workforce has been instrumental in the rise of Japanese industry. Areas around Tokyo, Yokohama, and Osaka have seen enormous increases in industrial productivity with major ports readily available. The transportation systems, including highways and rail transport, are world renowned, and Japan produced one of the highest-speed trains in the world—it moves at over 300 miles per hour.

### **TRADE IMBALANCES**

The United States has decried its trade imbalances with Japan and China and other Asian countries. Manufactured goods are coming into the United States at a greater rate than U.S. goods are entering Asian markets. Many Americans believe that this trade imbalance is hurting the American worker and the overall U.S. economy. However, some Asian companies have built

manufacturing plants in the United States, and some U.S. companies have opened offices and set up manufacturing centers in Asia.

### **OTHER AREAS OF INDUSTRIALIZATION**

Other areas of the world are experiencing rapid industrialization and, hence, rapid development in their economies. Mexico and Chile have greatly increased their exports in the past decade. In Africa and the Middle East region, Morocco, Turkey, and Saudi Arabia have increased their trade by a minimum of 5,000 percent since 1970. Much of this trade has been based on the exportation of natural resources.

## **TWO VIEWS OF ECONOMIC DEVELOPMENT**

When discussing economic development, a primary issue is that of the haves and the have-nots. These issues, based on the unequal distribution of resources, continue to plague geographers, who classify these groups into two primary categories: the more developed countries (MDCs) and the less developed countries (LDCs), also labeled "third-world countries." LDCs continually lag in economic development, and the majority of their populations are mired in poverty.

### **OPTIMISTIC VIEWPOINT**

The optimistic viewpoint of economic development is based on the principle that an abundance of resources is available in the form of both fossil fuels and alternative energy sources. Energy and other resources are distributed unevenly among countries. However, if humans work together, they can solve this problem of inequitable distribution. The **optimistic viewpoint** proposes allowing capitalistic forces the ability to enter countries and get resources to the areas that need them, at the same time profiting from their investment.

### **PESSIMISTIC VIEWPOINT**

The **pessimistic viewpoint** views the inaccessibility of resources as a serious challenge and addresses three primary concerns vis-à-vis economic development.

The first of these concerns is that the distribution of resources does not correspond to demand for them. The demand for resources will continue to increase as the world's population grows, and their supply will decrease.

Another concern is that LDCs may not be able to achieve critical mass to start a cycle of economic growth. Usually, when there is a need for a product, the market fills that need. However, what happens when no market exists for a product? Going back to the discussion of Weber's least cost theory, the market may not be ready for the production of a particular product. In this case,

industry trying to produce and sell products to LDCs may not be able to succeed because there is no demand.

The last concern is that investment is not allocated equally around the globe but rather is concentrated in only a few locations. A lack of investment seriously limits some areas' opportunities for growth. In some areas, such as in much of Africa, the potential gains are not worth the high risk of investing. African investment has been minimal. Aid from more developed countries has not been able to offset the environmental, population, medical, and political disasters in the continent. Africa is often deemed the poorest of all of the continents.

**Foreign direct investment** occurs when a company located in one country enters the economy of another country. The investor has a direct relationship with the product of the investment. In many Asian countries, foreigners invest by way of a stock market. In less developed countries, if there is any investment at all, it is usually in the form of direct ownership of a production facility or a plantation.

Much investment in recent years has been focused on Asia. The Four Asian Tigers have seen much investment in recent years, because such investments are usually safe and, of late, profitable. Although little investment has been made in certain areas in Africa and Latin America, development is better in some parts. For example, Americans looking for an idyllic location to retire have been purchasing land in Costa Rica and Panama.

Together, these three concerns of the pessimistic viewpoint mean that all sections of the globe will probably not see the same levels of progress in the upcoming decades.

## WAYS TO DESCRIBE DEVELOPMENT

There are different ways to address development. Development does not necessarily mean wealth. In fact, it's much more than individual wealth. A society may even deem wealth as an adverse condition to development, where a few have gained personal wealth at the expense of general social welfare.

So what is development? **Development** is the continued progress of a society in all areas, ranging from demographics to economics to social factors.

### HUMAN DEVELOPMENT INDEX

Economists and geographers agree that certain characteristics of development affect all members of the human race regardless of culture: life expectancy, literacy rate, average years of education, and GDP/capita. Together, these four characteristics comprise the **Human Development Index (HDI)**, developed by Pakistani economist Mahbub ul Haq in 1990. By applying a formula to these characteristics, one can determine the development of a country on a scale of zero to one. The HDI is the most often used measure of development and is utilized by the United Nations.

## LIFE EXPECTANCY

Countries with a relatively high **life expectancy** can expect their citizens to live approximately 60 or 70 years. According to the Centers for Disease Control and Prevention (CDC), U.S. life expectancy averages 77.9 years. Women, on average, live longer than men. The average life expectancy for women in the United States is 80.4 years; for men, 75.2 years. There are two theories as to why this is the case.

One is that women are biologically stronger than men, because they must be able to give birth. Also, in many cultures, young men engage in high-risk behaviors, for example dangerous feats, which in some cases can lead to death.

Another theory, increasingly outdated in many cultures, is that men have to experience the stress of everyday work life, while women stay at home with the children. According to this theory, the stress of raising children does not compare with what the man experiences at work outside the home. Also, men are often involved in more dangerous professions, including fishing, drilling, and firefighting, which cause male death rates to be higher.

In more developed countries, people can expect to live longer thanks to better access to medical facilities and personnel. The sanitary conditions in more developed countries are much higher than in less developed countries. Life expectancy may only be as high as 50 years in some African countries.

## LITERACY

**Literacy** is the percentage of a population that can fluently read and write. However, literacy goes beyond this. In essence, it's an ability to use a language to communicate. Literacy directly reflects the educational system of a country. The more people who can read and write, the greater a society's potential to succeed in the world economy. In more developed countries, the literacy rate may be as high as 99.9 percent. (The rate will never reach 100 percent, because in any society, some people will be unable to process language and writing.)

In many African countries, the literacy rate is below 30 percent, which means that over two-thirds of the country is unable to communicate effectively through writing and reading. The burden this puts on the governments of these countries is enormous. When more than 70 percent of a labor force cannot read or write, they can only perform low-skill labor, which inhibits economic growth.

The education system is the key to raising literacy rates. The problem stems from what the economic development pessimists claim is the lack of investment in these areas. The lack of investment means no money for schools, and a lack of employment means no tax base to fund schools. Many African countries are in a self-perpetuating cycle: they need education to get out of poverty, but poverty prevents them from funding education.

**EDUCATION**

Education itself is a measure of economic development. Being educated means that workers are more productive in their jobs, increasing the productivity of the society as a whole. In addition to having few educational facilities or teachers, many less developed countries are experiencing **brain drain**. Talented youth who receive scholarships to schools outside the country do not come back to initiate development in the area. Trained professionals, such as nurses and doctors, also leave for better living conditions in more developed countries.

**STANDARD OF LIVING**

The **standard of living** is the measure of wealth or enjoyment that one experiences. Much of this is culturally determined. As in Singapore with its five Cs (cash, credit cards, condominiums, car, and country club), many people around the world seek such markers of well-being. To a nomadic tribe, however, standard of living may be measured by the number of animals someone owns. To someone in a developing country, it might be the ownership of a washer and dryer.

**PHYSICAL QUALITY OF LIFE INDEX**

David Morris developed the Physical Quality of Life Index (PQLI) as an alternative to using gross domestic product. The **Physical Quality of Life Index** puts the factors of the Human Development Index on a scale from 0 to 100. To calculate the PQLI, economic geographers use the following steps:

1. Determine the *literacy rate* for the country.
2. Subtract the infant mortality rate from 166 and multiply the result by 0.625. This is the *indexed infant mortality rate*.
3. Subtract 42 from the life expectancy and multiply the result by 2.7. This is the *indexed life expectancy rate*.
4. Add together the literacy rate, the indexed infant mortality rate, and the life expectancy rate and divide that sum by 3.

Let's examine the United States using the PQLI:

1. Literacy rate is about 99.5 percent.
2. Infant mortality rate is 6.7.
 
$$166 - 6.7 = 159.3$$

$$159.3 \times 0.625 = 99.6$$
3. Life expectancy is 78.
 
$$78 - 42 = 36$$

$$36 \times 2.7 = 97.2$$



4. Add together the results of steps 1–3, then divide by 3:

$$99.5 + 99.6 + 97.2 = 296.3$$

$$296.3 \div 3 = 98.8$$

The PQLI of the United States is 98.8, putting the United States at the high end of the development spectrum.

## ECONOMIC DATA INDICATORS

Another way to measure the development of a society is by analyzing its economic data. Economic factors of development include a country's gross domestic product and gross national product, as well as the economic structure of the society as whole. Another measure of economic development is what people can afford to purchase with their expendable income. Finally, the availability of raw materials is an important economic measure of development.

### GNP AND GDP

Gross national product (GNP) and gross domestic product (GDP) are two separate statistics.

**Gross domestic product** is the selling value, or market price, of all the goods and services produced within a particular country's borders, typically in a given year. **Gross national product** is the value of the goods and services produced by that country's companies, usually within one year. This can include sales from transnational corporations in other countries.

For example, Coca-Cola has a production plant in Argentina. However, because Coca-Cola is an American company, its sales of Coke products from the plant in Argentina apply to the U.S. gross national product. In addition, because the Coke product was sold in an Argentinean grocery store, the transaction would count towards Argentina's gross domestic product.

### GROSS DOMESTIC PRODUCT PER CAPITA

**Gross domestic product per capita** is the total amount of goods and services produced in a country divided by the total population of that country. The end result is the value of the average person's production in their country for a particular year.

As of 2005, the gross domestic product for the United States was over \$12.4 trillion. The United States has just under three times the gross domestic product of the second-nearest competitor, Japan, which is followed by Germany and then China. Looking at the per capita statistics tells a much different story, however. In terms of gross domestic product per capita, the leading country in the world is Luxembourg, at almost \$70,000. Luxembourg is followed by Norway and then the United States, at just over \$41,000.

Countries on the lower end of the scale tend to be located in sub-Saharan Africa as well as parts of Asia. These countries' total gross domestic products may not even exceed \$100 million. Looking at the gross domestic product per capita puts the inequity into further detail. More than a dozen countries produce less per capita than many U.S. high school students working part-time jobs.

### ECONOMIC SECTORS

Another way to analyze economic factors of development is by looking at where the majority of people work in their economy. Going back to the demographic transition model, when the majority of the people in a society are employed in the agricultural sectors of an economy, it is less developed. As more people begin to be employed in the industrial sectors, the development of the society increases. As a society continues to progress into the tertiary and quaternary sectors of an economy, both its level of development and standard of living generally rise.

In a slight departure from the demographic transition model, economists classify the different **economic sectors** of an economy into primary, secondary, and tertiary activities.

- **Primary economic sectors** are involved in the basic activities, such as farming. Primary industries extract resources from the Earth, such as timber, fish, minerals, and soil.
- **Secondary economic sectors** use the materials from primary industries to manufacture a product for purchase. An example of a secondary industry would be furniture making. These companies use wood to produce furniture that a consumer then purchases.
- **Tertiary economic sectors** sell the products from the secondary economic sectors and provide services.

In the United States, many more people are employed selling and repairing automobiles than in their actual production, while less than 2 percent of the population is involved with agriculture. In less developed countries, most people are employed in the primary economic sectors.

### EXPENDABLE INCOME

Another economic measure of development is **expendable income**. Expendable income is the amount of money left over after all of the bills have been paid. In the United States, the amount of expendable income is high. For example, some people spend thousands of dollars to purchase a cutting-edge television, and some households have more television sets than people to watch them. In many areas of the world, an automobile is considered a luxury item, but in the United States, it is considered a necessity.

### TECHNOLOGY

The use of technology in a society is very indicative of its level of development. The **technology gap** describes the fact that some people have more technology than others; as well as the fact that

some people know how to use it while others do not. For example, most students today know how to use technology better than their parents.

More developed countries have a faster technology transfer process. The **technology transfer process** is the amount of time that it takes a new technology to leave the laboratory and arrive on shelves for citizens to purchase. The ability of companies to move from the design phase to the production and distribution phase is important in determining their profits. Less developed countries have some research facilities but have great difficulty moving towards the production or marketing of a new technology.

### **RAW MATERIALS**

The more raw materials that a country possesses the more developed that country is, right? Not necessarily. The answer to that question depends upon who owns the rights to and the profit from the raw materials.

For example, many Middle Eastern countries have immense wealth due to oil. However, this wealth is often concentrated in the hands of a small elite, hindering the overall development of these countries' economies. Other countries have access to raw materials but are still mired in poverty due to neocolonialism. Companies located in the more developed countries extract the natural resources and take the profits.

The majority of the more developed countries have adequate access to the raw materials needed for industrial production. However, countries can succeed without access to raw materials. Going back to the Four Asian Tigers, each of these countries has succeeded economically by using the trade model. They trade manufactured goods in exchange for many raw materials. Likewise, Japan has very few natural resources but has become one of the richest and most productive economies in the world.

### **DEMOGRAPHIC STATISTICS**

Using demographic statistics and models, such as the demographic transition model, a geographer can determine whether a country is in the more developed or the less developed category.

**Gender balance** relates to both economic and demographic factors of development. Gender balance does not necessarily mean more of one sex than the other but rather the equal opportunity for women and men to succeed. For example, gender inequities are prevalent in many Middle Eastern countries, even today, where there are separate doors for entrances into public buildings for men and women. Women are discouraged from gaining education or participating in the workforce. During the First Gulf War, the U.S. military was faced with a quandary. Women are an essential part of the U.S. military. But upon arrival in Saudi Arabia, the women in the armed forces were not allowed to drive a motor vehicle. It was against the law.

Another key demographic factor of development is **birth rate**. Less developed countries tend to have much higher birth rates than more developed countries. This is due in part to the economic structure of a society (primary, secondary, tertiary, quaternary, and quinary). As a country moves from one economic structure to a higher level, more and more women participate in the workforce and fewer children are born. However, in less developed countries that are still involved in primary economic activities, children are seen as an economic asset, providing labor on the farm and providing security for the elderly.

Together, the crude birthrate and crude death rate make up the natural increase rate. A country with a higher natural increase rate is considered a less developed country; one with a lower natural increase rate is considered a more developed country.

## ADDITIONAL DEVELOPMENT THEORIES

### WORLD SYSTEMS THEORY

Geographers have tried to put world development into spatial terms. Immanuel Wallerstein did this with his **world systems analysis**. Wallerstein was the first person to coin the terms *core* and *periphery*. The **core areas** are the more developed countries, which use the resources of the periphery to continue their success. These are located primarily in North America and Europe and also include Japan and Australia. The **periphery areas** are the less developed countries. The lack of investment by the more developed countries continues to keep these countries in poverty. Also, the ownership of many of the natural resources, or at least the means of extracting them, benefits the more developed countries. Figure 8.8 shows the core and periphery countries.

In recent years, the **semi-periphery** has been added to the model. The semi-periphery are the countries, such as the Four Asian Tigers, that are gaining in development and have some of the benchmarks of success but are still lacking the political importance associated with the core countries.

Also, major urban centers serve the core area. New York, Tokyo, and London are considered **world cities** based upon their financial and cultural importance in their areas. In the semi-periphery are cities such as Chicago, Paris, and Shanghai. These cities serve as regional hubs for their respective regions but are not on a world scale. Other cities are in the periphery regions and serve the needs of the major core areas.

The **dependency theory** suggests that some countries are allowing themselves to remain in poverty as a whole to obtain some other type of economic power, usually for an elite class. In many cases, the less developed country's leadership is hoarding economic resources for itself, while the majority of the population is struggling to feed itself.

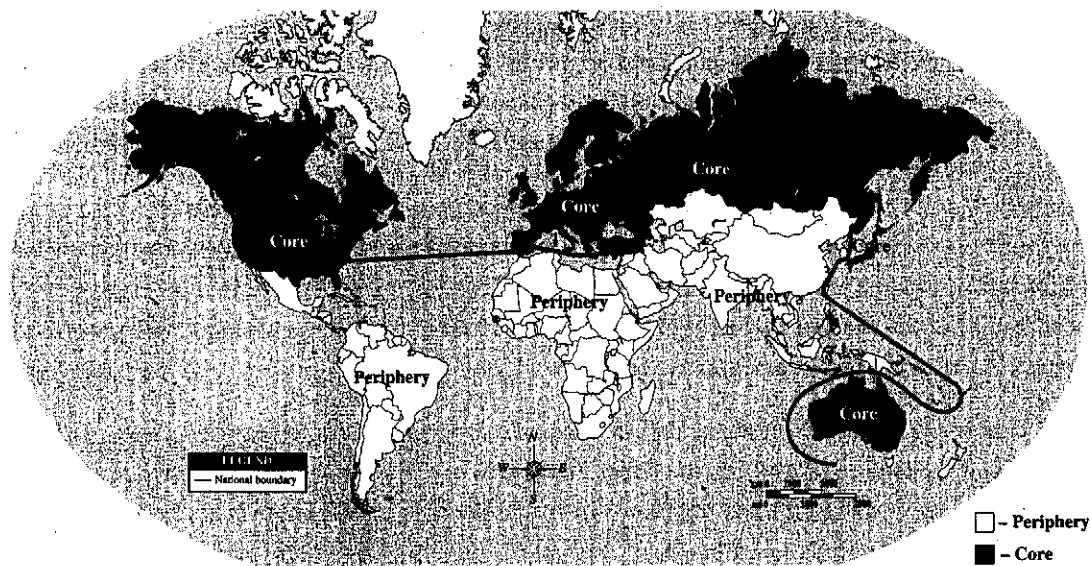


Figure 8.8: Core vs. Periphery Map.

### THE CORE-PERIPHERY MODEL

Another way to look at the **core-periphery model** of development is by looking at the concept through four primary factors: industrial core, upward transition, downward transition, and resource frontier. Each of these can be seen on a global scale down to a national or even urban scale.

The **industrial core** is where the majority of the manufacturing or industrial activities of a nation or a city are located. These areas usually contain large urban centers, which both provide the market for the products and the workforce to produce them. In the United States, the industrial core is the northeast, extending from New England to the western shores of Lake Michigan, including the cities of Milwaukee and Chicago. In Canada, the industrial core is located in the southeastern sections of Ontario and includes Hamilton, Toronto, Ottawa, and Montréal.

The next major area in the core-periphery model is the **upward transition** area. Upward transition means gaining jobs and attracting industry. Business incentives may include tax breaks and agglomeration. The tax base continues to expand in these areas, allowing more services (better schools, nicer parks; improved transportation) in a self-perpetuating cycle.

In the United States, the upward transition area is in the South. This area is experiencing rapid population growth due to the relocation of industrial activities from the northeast. The Sun Belt area extends from North Carolina to Georgia. Cities in this region, such as Charlotte, North Carolina, and Atlanta, Georgia, have experienced a renaissance of population and economic activities in the past decade. Another Sun Belt area is the central and coastal region of Texas, which includes the cities of San Antonio and Houston. The last major area of the Sun Belt is southern California and Arizona, including San Diego and Phoenix respectively.

In Canada, the upward transition area is in the western portion of the country around the Rocky Mountains. Cities such as Vancouver, Calgary, and Edmonton have all seen growth. The region is dominated by the crude petroleum coming from the western plains region. Tourism is also a major factor. The Vancouver area hosted the Winter Olympics in 2010, and Calgary held the Winter Olympics in 1988.

The third area in the core-periphery model is the **downward transition** area. Downward transition means that companies are leaving, and unemployment rates are high. As people leave an area, the tax base is reduced, and just as the upward transition area is in a self-perpetuating cycle upward, the downward transition area is in a downward cycle.

In the United States, the Great Plains region is experiencing a downward transition cycle. At the beginning of the twentieth century, the Great Plains area was in an upward transition due to the rich farmland and immigrants settling there. Today, companies are moving out of the Great Plains owing to the lack of population; because of the scarcity of good jobs, young people leave home to go to school and do not return, reducing the population further.

The downward transition area of Canada is the Atlantic Maritime Provinces. Nova Scotia and Newfoundland are struggling to find another means of economic success now that the fishing industry in the region has declined so much. Unemployment is at record levels in some areas, causing people to leave in increasing numbers.

The last section of the core-periphery model is the **resource frontier**. The resource frontier areas provide the majority of the resources for the industrial core. Many of these resources are used for energy production or are the base materials in manufacturing. Transportation systems need to be developed to get the materials from the resource frontier to the industrial core. The main forms of transportation used for this purpose are trains and pipelines. The incredible growth that occurs once a resource is found often ends once the resource has dried up, leaving rotting infrastructure and ghost towns behind.

In the early part of the 20th century, much of the western United States was a resource frontier section. Gold as well as other resources in the desert regions of Arizona, New Mexico, and California spurred growth. Today, the remote northern sections of Alaska, with crude oil resources, are the largest resource frontier in the United States. The Alaska Pipeline was built to get the crude petroleum from the northern part of the state to the transportation systems in the southern part of the state.

✓ In Canada, the resource frontier is in the same region as the United States. The newly created territory of Nunavut has an abundance of raw materials that industries need. The Northwest Territories and the Yukon Territory are also rich in natural resources. However, the northern sections of Canada have the same problem as the northern sections of Alaska—transportation. Because of the incredibly cold temperatures, it is almost impossible to build roads and railroad

tracks into the remote regions of Canada. Pipelines can be built. However, they are not flexible in their routes, needing to go directly from the source to the transportation hub, and they only work with liquids and gases.

On a city scale, different zones in the city may occupy different places in the core-periphery model. For example, certain areas of each large urban center are devoted to industrial output. Other areas, where people want to move, could be classified as upward transition areas. In contrast, certain neighborhoods experience higher unemployment rates and are less attractive; these are downward transition areas. The resource frontier is where natural resources are located. For example, sand and gravel, a base product used in many roads and driveways, is often found near large urban areas.

## GROWTH MODELS OF DEVELOPMENT

As societies move from the primary economic sectors to quaternary and quinary sectors, these countries go through different stages in their development.

### ROSTOW'S MODEL OF DEVELOPMENT

Walt Whitman Rostow created a model of development (also known as the **take-off model**) to show the five stages that a country progresses through in its development. These are: 1) the traditional society, 2) the preconditions for takeoff, or the transitional stage, 3) the takeoff, 4) the drive to maturity, and 5) the age of mass consumption.

In the **traditional society**, the majority of the workforce is involved in the primary sector of the economy. Most people practice subsistence farming. Any trade involves farmers and their agricultural products. Mass production is not yet developed.

The second phase of Rostow's model is **the preconditions for takeoff**, sometimes called **the transitional phase**. In this phase, material conditions, such as transportation or other infrastructure, improve. Entrepreneurs are beginning to see money-making opportunities, and the economy shifts from primary to secondary activities. During this phase, expendable income begins to rise, and more people can invest in entrepreneurial activities.

During the **takeoff stage**, more companies become involved in the manufacturing sectors of the economy. The remaining farmers become less reliant on subsistence farming and sell more of their produce. Food is now largely being processed for resale. The primary regions where growth is taking place are usually around large urban centers. However, in this stage, growth is only taking place in a few industries.

During **the drive to maturity**, the technology that was available to only a few companies during the takeoff stage is now being diffused and integrated into all areas of the manufacturing sector.

The final phase of Rostow's model is **the age of mass consumption**. Workers have become highly skilled in their professions and are using their strengths for the overall benefit of the economy. Productivity, earnings, and savings are at all-time highs. The society as a whole has shifted from secondary sectors to more of a tertiary or service-based economy. Manufacturing is still occurring but has shifted from traditional sectors to consumer goods.

Rostow's model is based on the principle that consumers will save and invest personal wealth to improve their economic status. Industry needs this capital to grow and then generates a return on investment to shareholders.

Critics of Rostow with optimistic economic viewpoints cite the sub-Saharan countries' level of development as examples where his model does not apply. Critics with pessimistic viewpoints point to the inequities of resource distribution around the world and the lack of capital to invest in some areas.

### **RICHARD NOLAN'S STAGES OF GROWTH MODEL**

Another model of development that has fused into economic geography is Richard Nolan's stages of growth model. This model describes individual companies' adaptation of technology to be competitive in the economy.

This model is similar to Rostow's but has six stages: 1) initiation, 2) contagion, 3) control, 4) integration, 5) data administration, and 6) maturity. Also, Nolan's model deals more with the integration of technology into a society, whereas Rostow's deals more with the fundamental principles of capitalism, such as investing and savings.

During the **initiation stage**, technology is used sparingly and primarily for data processing. The few users of technology do so to reduce the cost of human processing of data.

In the **contagion stage**, like a disease in a contagious diffusion pattern, technology begins to spread. There are more and more uses for technology, and often, the bugs need to be worked out of the system before people will purchase the product.

In the **control stage**, management is becoming more frustrated with the use of technology because employees don't necessarily have the training or the hardware to maximize their productivity with new software. People are confused and frustrated, but they also see the possibilities of technology. A micro example of this phase is a person buying a new computer and then, instead of using the computer for work or school, he or she simply uses it to play solitaire all day.

During the **integration stage**, users have come to terms with technology and have found practical uses for it.



In the **data administration stage**, technology is used mostly in the collection and the storage of data. Less work is done by computer programs, while more use is made of computers' ability to store data.

The last phase is the **maturity stage**. During the maturity stage, new uses for technology are being integrated into the workplace. During this stage, the organization is looking for ways to use technology to advance beyond its competitors.

Nolan's model pertains more to individual organizations than to countries as a whole. But as companies begin to get more adept with technology, they are usually at the forefront of the infusion of technology to the daily lives of their workers. Companies usually initiate technological development because they possess the resources to purchase new technology when it is still relatively expensive. Cost decreases as the technology ages.

Development is a difficult thing to quantify. In the past two decades, new means of measuring development, such as the Human Development Index and the Physical Quality of Life Index, have tried to quantify the different levels of development for countries around the world.

Many of the countries that are less developed are still in a colonial mentality. They depended upon their colonial powers for defense and in exchange gave up many of their economic raw materials. According to many economic geographers, **neocolonialism**, by which the less developed countries are still economically dependent upon the more developed countries, is still in effect today. Less developed countries depend on the more developed countries for investment.

## **SUSTAINABLE DEVELOPMENT**

Sustainable development is a general term that means different things to different people. The most commonly accepted and used definition of sustainable development comes from the United Nations Brundtland Report in 1987, which defined sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development takes into consideration economic development, social development, and the environment. It has been relatively successful on a small scale in a variety of settings throughout the world. Proponents of sustainable development have experimented with innovative projects that often focus on micro-loans, alternative energy projects, and women in development.

## **WOMEN IN DEVELOPMENT (GDI)**

The main drawback to the Human Development Index is the fact that it only takes into consideration four factors of development—longevity, health, education, and standard-of-living. There is so much more to understanding a society's level of wealth and well-being than four statistics. Most importantly, regional and gender differences exist within a country that do not show up in the HDI. The Gender Development Index (GDI) was created to give a clearer picture

of what life is like for women throughout the world. The GDI uses the same statistics as the HDI but analyzes the data with an eye to gender differences. Its most significant finding is that women are not equal to men in any country in the world in terms of material wealth. Western European and North American women are the most nearly equal, whereas in sub-Saharan Africa women are the worst off, that is, that region has the lowest GDI.

## LAND USE AND RESOURCES

### LAND USE ISSUES

Each city, town, and hamlet must decide how it would like to use the land and resources of the area. Some areas have gained revenue through tourism. **Ecotourism** is using the natural beauty of an area as a selling point to promote tourism and generate funds to preserve the ecological community. The ecotourism industry tries to protect the areas that tourists are traveling to see, and the human community often becomes a focal point of preservation efforts. The ecotourism industry wants to preserve not only the natural landscape but also the local economy; when the local inhabitants are relatively prosperous, they will be more inclined to protect the natural landscape.

One dilemma that these communities face is the oversaturation of tourists. The more tourists that a town brings in, the more revenue comes in, but at a price; the more people that the town brings in, the less natural the area becomes. National parks are facing this dilemma. Yosemite National Park in California experiences traffic jams in the summer months. Parks located close to large urban centers on the East Coast of the United States face the same problems of overuse. Smokey Mountains National Park has faced such an increase in usage that pollution is now affecting the trees and animals. In addition, the experience of visiting these places is becoming less authentic because of the sheer numbers of people in the parks at any given time.

Less developed countries face a dilemma among the land use decision-making models. Many of the less developed countries labor under enormous debt, usually to more developed countries. As a result, there is pressure either to repay the debt or enact policies to protect the environment. A **debt-for-nature swap** is the forgiveness of debts in exchange for the setting aside of land for conservation or preservation.

Many African, Latin American, and South Asian countries are in a unique predicament. The choice for individual workers is either to farm the land and destroy the natural habitat or protect the land through conservation techniques. Usually, this is not a difficult decision; farmers will choose to feed their families at the expense of the land.

The governments of these less developed countries are in a tough position. Do they conserve the land, as more developed countries are pressuring them to do, or do they allow their citizens the freedom to farm or engage in other activities to develop their economies? Often, the governments are too weak to change or enforce policies.

William Forster Lloyd conceived an idea in 1833 that Garrett Hardin then modernized, labeling this problem the **tragedy of the commons**. This theory suggests that humans will inevitably do what is best for them despite what is the best for the public good. When the best use of limited resources in a community comes up for debate, society must dictate the best uses of those natural resources. The political pressure on both sides of the spectrum makes choices difficult, and often one's position in the debate depends on which land use model one believes in.

## RESOURCES

There are two distinct types of resources found in the world. **Renewable resources** can be used again. They grow or replenish themselves in nature relatively quickly, as with trees for lumber or corn or sugarcane for biofuel, or they are a constant asset, such as sunlight.

**Nonrenewable resources** are the opposite of renewable resources. These resources took tens of thousands of years to produce, and they do not replenish themselves within a human life span or even several human life spans. Once these resources are used up, they are gone forever.

When discussing fossil fuels, it is important to note that there are different kinds of reserves. A **proven reserve** is a reserve of a fossil fuel that has already been discovered. Proven reserves are generally very large and offer great energy potential. A **potential reserve** is a reserve that has yet to be discovered, but geology suggests it may exist in a particular location.

## FOSSIL FUELS

**Fossil fuels**, including coal, oil, and natural gas, are examples of nonrenewable resources. These resources come from the breakdown of carbon-based sediment over long periods of time under great pressure. **Reserves** are the amount of the resource left in the ground yet to be used. **Production** is the removal of the resource.

Fossil fuels have been the subject of great debate in recent decades. The estimates of how long fossil fuels will last at current usage are anywhere from 10 to over 100 years. In any case, fossil fuels are finite and will eventually run out. Those who perceive the landscape in terms of environmental or preservationist viewpoints warn of the likelihood of fossil fuels running out fairly soon. They feel that we must invest in alternative fuel sources. Sustainability and economic land use believers have a more optimistic perspective on using fossil fuels into the next century. They perceive the landscape in terms of monetary gains. From their point of view, alternative fuels should be considered but, at least for today, they aren't efficient enough to replace fossil fuels.

The **resource crisis** is the eventual depletion of fossil fuels and a resulting collapse of energy-dependent societies. The world depends on these resources for its industrial base. Billions of people use fossil fuels. In addition, a multibillion-dollar industry has built the Alaska pipeline, supertankers, and other products necessary to extract and transport these resources around the

globe. Fossil fuels provide hundreds of thousands of jobs in more developed countries, from drilling or mining to the transportation and sales.

The purpose of these **extractive industries** is to find the most efficient way to remove resources from the earth with minimal disruption to the natural environment. The need for money versus the need for space and place go head to head in this debate. **Space** is the actual location of the resource, and place is the description and the attributes that make the space valuable to some people.

As the debate continues, what is not in question is how dependent the world has become on fossil fuels. The developed countries around the world run on fossil fuels. The discovery of fossil fuels means more energy production. Also known as **mineral fuels**, they include gas, oil, coal, natural gas, and others. Fossil fuels are usually burned to produce electricity for communities. The locations of these resources are important to both local economies in terms of employment and national economies in terms of energy production.

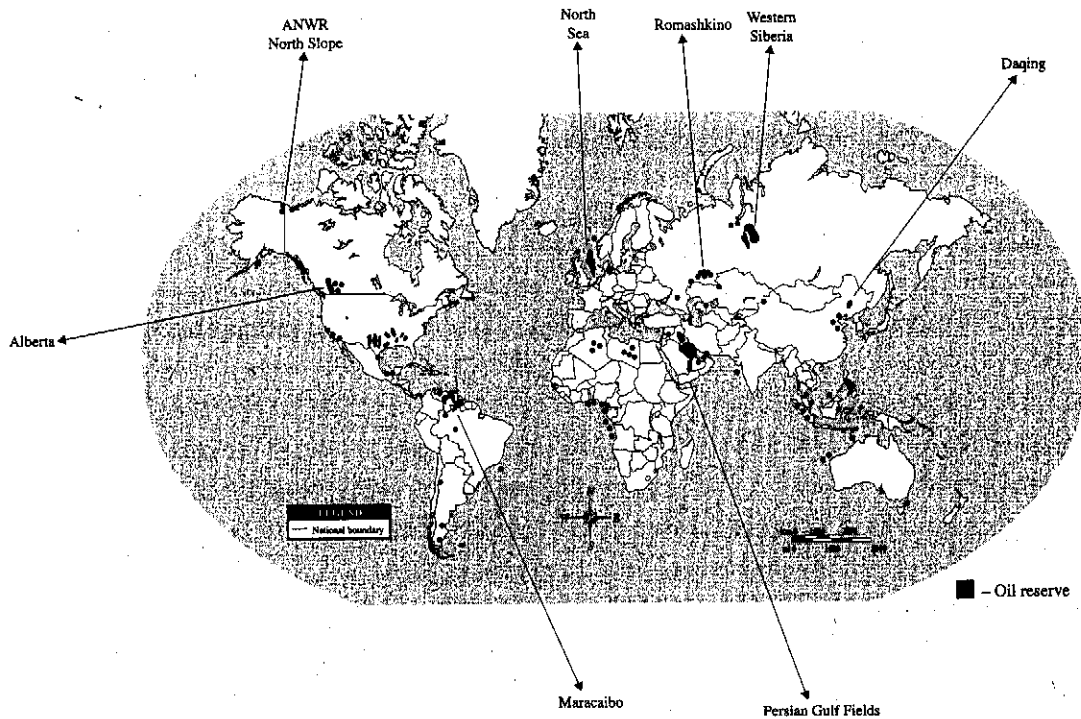
The world is seeking alternatives to fossil fuels before they are completely depleted. During the energy crisis of the 1970s, the U.S. government formed the Department of Energy to assist in the development of alternative fuels to avoid future energy crises.

## OIL

Many societies feel that the greatest of the world's natural resources is oil, or petroleum. Oil is the lifeline of modern industrialized societies and is fundamental to many Western countries' economies. Europe and North America both rely heavily on the production and consumption of oil. People in the United States use oil on a daily basis. If you have an automobile, you are not only using gasoline for your car, but you are also using motor oil to lubricate the engine, and much of the car's interior is probably made of plastic, also a petroleum-based product.

Today, the oil industry in the United States is alive and well. The majority of the oil in the United States comes from three major sources: states on the Gulf of Mexico, including Texas and Louisiana; Alaska; and, the third-largest area of production, the state of California. Huge oil refineries located on the Gulf of Mexico produce the gasoline, motor oil, and other products that are necessary for U.S. industry and society to run.

Oil comes from deep inside the Earth. Many times, these oil reserves are located beneath the ocean, and oil rig platforms are used for their extraction. Miles of pipes tunnel deep under the Earth's surface to extract the oil located there. The different products that are made from oil come from the refining process. These include gasoline, methane, propane, butane, kerosene, diesel fuels, and jet fuel. Oil refineries produce these different products by extracting the resource at different points during the heating process.



**Figure 8.9: Oil Reserves of the World.**

Most of the easily recoverable oil in the world has already been discovered. The increasing difficulty in finding and extracting the remaining deposits has increased the price of crude oil to some of its highest levels in history. Any break in the chain from extraction to production to delivery adds to the cost of the oil that we use in our daily lives.

The United States is the third-largest oil producer, with over 7.6 million barrels per day, behind Saudi Arabia, producing just under 9.5 million barrels per day, and Russia, a close second with 9.4 million barrels per day. Figure 8.9 shows the distribution of oil around the world.

The United States uses approximately 20.7 million barrels of oil every day. The imbalance between U.S. production and consumption means the United States must import a large percentage of its oil. However, most U.S. oil comes from its domestic reserves as well as from other countries in the Western Hemisphere, including Canada, Mexico, and Venezuela. Another area that provides the United States with oil is the Middle East.

Huge oil companies have developed in the Gulf of Mexico. They are a large part of the economies of such cities as Houston, Texas. There is a saying that as the oil industry goes, so goes Houston. Houston has tried to diversify its economic base and reduce its reliance on the oil industry, but this industry still provides employment to a large percentage of the area's workforce.

Other countries in the world with large areas of proven oil reserves are Saudi Arabia, Venezuela, Mexico, Iran, and Iraq. Most of these countries have amassed great wealth from exporting oil to more developed countries whose production levels have not been meeting consumption levels. The majority of the world's oil reserves are located in the Middle East. Dubai, in the United Arab Emirates, is one of the wealthiest cities in the world owing to its oil reserves. Manual labor in this city is supplied by immigrants from Africa and India.

The up-and-coming giant of China is using more and more oil-based products, which further strains global supplies. As China continues to grow and its middle class continues to expand, so will its use of oil. Streets and highways are already clogged in China, and the desire to purchase and use automobiles is growing, particularly among the middle class. The higher the demand for a resource, the higher its price. Since oil is an essential component of manufacturing, this means that consumers will pay more for clothes, toys, and other products because the cost per barrel of oil is rising.

### **OPEC**

The countries in the world that have large reserves of petroleum have organized themselves into a cartel, the **Organization of Petroleum Exporting Countries**, known as **OPEC**. This cartel was initiated in 1960, primarily with Middle East member countries. However, in recent years, countries from Africa and South America have been included. OPEC determines the price of crude petroleum by setting the numbers of barrels each member country will produce. The more barrels that are pumped, the lower the price and vice versa. Swings in oil prices are partially offset when the governments of consuming countries, like the United States, subsidize the cost of oil.

#### **OPEC COUNTRIES**

Algeria	Nigeria
Indonesia	Qatar
Iran	Saudi Arabia
Iraq	United Arab Emirates
Kuwait	Venezuela
Libya	

OPEC's relationship with the United States has sometimes been rocky. During the 1970s, OPEC decided to refuse to sell petroleum to the United States. Gasoline prices in the United States skyrocketed almost overnight. The price of gas more than doubled, and long gas lines were common. Many gas stations sold out within hours and then shut down until they could get more gasoline. The

U.S. government determined the amount of gasoline that each station could sell. The price of a barrel of crude oil rose more than 1,000 percent in a matter of months. As a result of this crisis, the United States set up the U.S. Petroleum Reserve. This reserve could be tapped if the U.S. oil supply is at risk, ensuring the supply and keeping the price down, thus controlling price inflation.

Consensus has not always come easily for OPEC. Conflicts among its members have led some countries to "cheat," producing more than the allowed oil to gain more income at the expense of other OPEC countries. Sometimes, OPEC members have used oil revenues for military purposes, such as when Iran and Iraq were at war in the 1980s.

#### ***THE ARCTIC NATIONAL WILDLIFE REFUGE***

Prices for a barrel of oil in recent years have ranged from around \$40 per barrel to a high in July 2008 of almost \$150 per barrel. Prices for a gallon of gasoline in the United States approached \$4 a gallon in some parts of the country. The imbalance between supply and demand complicates U.S. foreign relations, and again, the land use debate arises. Should the United States develop a domestic supply of oil in the Arctic National Wildlife Refuge, or should we protect this wilderness area? As our consumption of oil increases and our desire for cheap gasoline continues, the debate will only intensify.

Most people agree that the U.S. needs to decrease its dependence upon foreign oil. The debate is over how to get the energy to drive the economy if not from foreign oil. Environmentalists and preservationists believe that the U.S. needs to increase its alternative energy capacity. Economic land use supporters suggest that the U.S. should further develop its natural oil reserves located in Alaska and the Gulf of Mexico. Most sources suggest that there is enough oil in the Arctic National Wildlife Refuge to supply the U.S. need for at least several decades. Opponents to drilling in the region suggest that the oil industry will disturb the natural ecosystem, threatening caribou, wolves, bears, birds, and other polar animals. Proponents of drilling suggest that only 1.5 million acres of the refuge's 19.2 million acres would be touched in exchange for significant recoverable oil deposits.

The Arctic National Wildlife Refuge encompasses over 19.2 million acres of land in northern Alaska. Oil abounds in the region. There are no roads within the Arctic National Wildlife Refuge. There is only one road on the edge of the refuge, and that is used to provide limited access to visitors, who can observe over 45 species of animals. The U.S. Fish and Wildlife Service runs the refuge. This is a different agency from either the National Park Service or the National Forest Service, which have different viewpoints on how the land should be used.

In the early 1900s, the area was already showing its promise as an oil reserve. It was labeled Naval Petroleum Reserve #4 in 1923, to ensure that oil would be available to the American consumer if needed. During the 1940s and 1950s, the American government sponsored oil exploration. During the latter half of the 19th century, the environmental movement has been more politically active, and in 1953, the Sierra Club designated it a wilderness area.

Scenarios such as the one playing out around the Arctic National Wildlife Refuge can be found all around the world. For example, how much development should be allowed in the fragile ecosystem of Antarctica is debated. Africa and Asia are dealing with similar dilemmas. The less developed countries generally prefer to develop their land to ensure their economic security. The more developed countries tend to devote more land to conservation, because their economies are already developed and they can afford to sacrifice some potential resources.

### COAL

The United States has abundant reserves of coal. For this reason, the U.S. burns coal more than any other resource to produce electricity. There are other uses for coal, including residential heating, but they are becoming more rare. Many states have coalfields within their boundaries.

Coal must be burned to produce energy. There are different forms of coal. The majority of the coal in the western states is lignite, which needs to be burned in greater quantities to produce the same amount of energy as the Appalachian coals, such as bituminous and anthracite. Because so much lignite needs to be burned to produce heat, it is not often used in blast furnaces to make steel; rather, the majority of this type of coal is used to produce electricity in power plants. Anthracite coal has the highest value of any coal because of its high heat output. This is the type of coal used most often to heat homes. Subbituminous and bituminous coal also generate high heat outputs. Each of these forms of coal is useful in creating electricity.

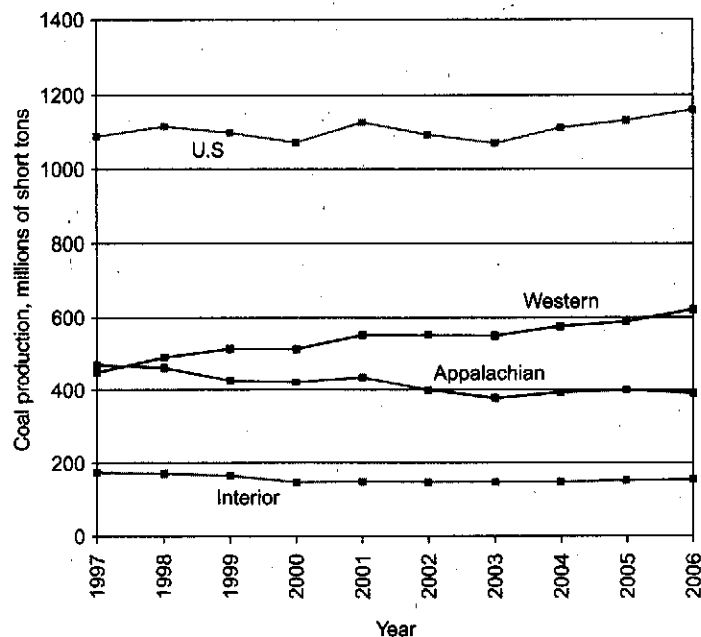


Figure 8.10: Coal Extraction Chart.



In 2005, the United States extracted more than 1.3 billion short tons of coal from its soil. As shown in Figure 8.10, this was the largest amount in history. The majority of this coal came from the western states; Montana, North Dakota, Wyoming, Colorado, New Mexico, and Utah all possess large amounts of coal. Most subbituminous coal is found in Alaska and some other western states. The majority of coal found in Texas, Montana, and North Dakota is the lignite form. The largest coal mine in the world, the Black Thunder coal mine, is located outside of Gillette, Wyoming.

The next major source of coal in the United States is the Appalachian region, followed by the interior regions of the country, including Illinois, Iowa, Missouri, Oklahoma, and Texas. West Virginia, Kentucky, and parts of Pennsylvania have based their economies on the extraction of coal from the Appalachian Mountains. The majority of the coal found in the Appalachian region is bituminous coal. However, the purest form of coal, anthracite, is found in large quantities in Pennsylvania.

For most of the past 150 years, much of the coal found was shipped to Pittsburgh for the blast furnaces to produce steel. This steel provided the foundation for many of the buildings that still stand today. This transportation of coal has posed some problems. Much of it is shipped by means of truck and train. These transportation options use petroleum as their primary means of power. Using one fossil fuel to deliver another means the U.S. is using two separate power sources in the steel production chain.

Coal is a vital aspect of overall energy production in the United States. Because the United States is loaded with coal reserves, it can produce large amounts of energy, and therefore it has been more reluctant to use alternative forms of energy than if coal were scarce. Transitioning to alternative energy would, at least temporarily, mean larger monthly energy bills.

As for worldwide coal production, China is the leader with the United States in second place. Other large producers of coal include Australia, Russia, and India. The safety records of Chinese coal mines have come under increased scrutiny. Recently, a number of coal mines have exploded or caved in due to poor safety standards. The industry will be subjected to even more pressure from safety watchdogs as the demand for coal continues to increase in China. China is also one of the leaders in coal consumption, which is causing air pollution in many urban areas.

In Europe, Great Britain has seen the greatest impact from coal. The coal industry is one of the reasons for the rise of the Industrial Revolution, which began in Great Britain. Europe has seen a downturn in its coal mining industry since the 1970s due to continued expansion of alternative energy uses, such as nuclear power. Europe gets much more of its power from alternative energy sources than the United States does.

Russia's coal mining industry has seen tremendous changes, which accompanied the political changes in the former Soviet Union. The privatization of the coal mining industry has brought about an improvement in safety standards. The majority of coal mining is taking place in Siberia.

In Africa, South Africa possesses a large amount of coal reserves. The area around the Vaal River is known for its industrial complexes and serves as a major consumer of the coal mined in the region.

### NATURAL GAS

Another important fossil fuel is natural gas. Natural gas is an odorless, colorless gas from inside the Earth. When burned, it provides abundant heat to homes and businesses around the United States and the world. The majority of the homes in the United States are heated with natural gas.

The south central region of the United States produces the most natural gas. Texas produced over 5 billion cubic feet in 2005, and Oklahoma, Louisiana, Wyoming, New Mexico, and Colorado each produced over 1 million cubic feet that year. Natural gas is mined and distributed throughout the United States by means of underground pipelines.

In terms of world production, no other country comes close to Russia in regards to its reserves of natural gas. Russia contains one-third of all of the natural gas reserves in the world. Iran has the second-largest reserves, with about 16 percent of the total, and the United States has about 10 percent of the world's natural gas. These three countries together possess just under 60 percent of all of the natural gas in the world.

### METALS

#### GOLD

Gold has always offered immediate wealth, so people have migrated to look for it. In the United States, gold reserves have been found in western states. Nevada is the largest gold-producing state, followed by Alaska and California. Various migrations have been initiated because people assumed gold could be found at their destination. The California gold rush of 1849 led thousands of settlers to the mountains of California in search of their dream. The Yukon region of Canada saw a gold rush in the late 1800s to early 1900s. Very few found the success that they were looking for, but some did find immediate wealth. Much of the gold that has been found in the United States was found by these pioneers during the late 1800s and early 1900s. Gold prospecting increased during the Great Depression, because of desperate economic conditions; people who had lost their jobs in the East traveled west as prospectors seeking instant wealth.

The majority of gold is mined, which involves either an **open pit mine**, where the land is removed and the resources are extracted in the open air, or a **shaft mine**, where tunnels are dug deep into the earth and extend for miles horizontally. Mines are also termed surface mines or underground mines. **Surface mines (strip mines)** are similar to open pit mines, because they dig up the earth and then replace the soil when the digging or drilling is completed. **Underground mines** use the

shaft and tunnel systems. The majority of the gold in the United States is found through open pit mines.

California, Arizona, Colorado, South Dakota, and Oregon all have large areas devoted to gold mining. Gold mining today is done much differently than the pan mining of the past. Remote sensing devices search the earth for large deposits of gold. When a vein is found, much of the top layers of earth are removed in an open pit mining process.

In the past, gold was used for coins and as a backup to the U.S. monetary system. Gold is accepted worldwide as a measurement of wealth. It lasts for a long time and has traditionally been very stable in its value. The United States has since left the gold standard of monetary policy because of the continued fluctuation of gold prices. Much of the gold mined in the United States today is used for jewelry. Gold is also used in various industries.

South Africa leads the world in gold production, producing one-fifth of the world's total. In recent years, the United States has passed Australia, becoming the second-greatest producer with over 14 percent of the world's output. Australia produces another 14 percent. Together, these three countries produce almost half of the world's gold.

Recent discoveries of small amounts of gold in the Amazonian basin in central Brazil have led to a major migration into that country's interior regions. Poverty in the urban areas of São Paulo and Rio de Janeiro has inspired a massive surge of prospectors hoping for wealth.

### **IRON ORE**

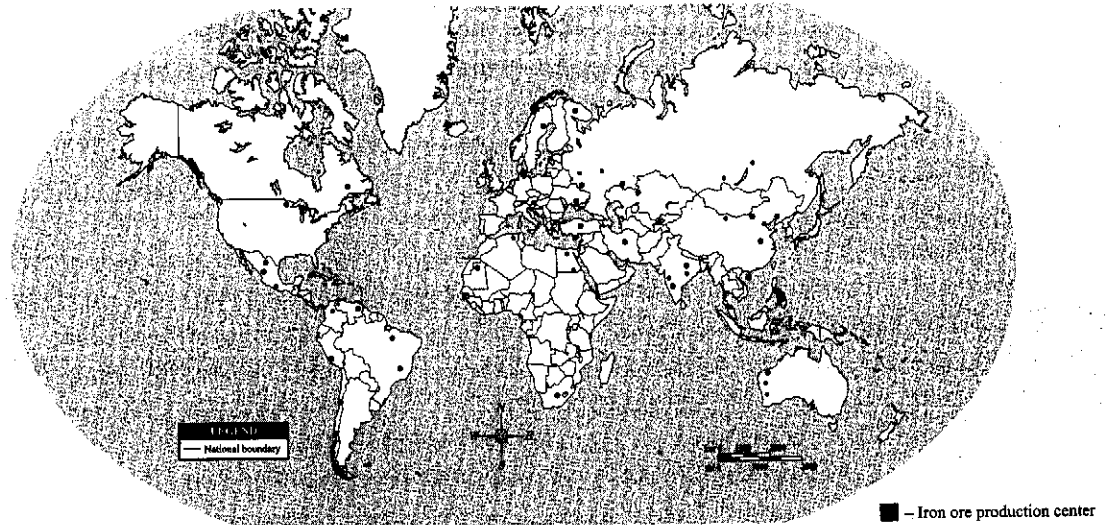
Another resource vital to the development of the United States and other developed countries is iron ore. Iron ore is a rock from which iron can be extracted. The most important use of iron ore is in the production of steel. The iron is used in huge blast furnaces that subject it to extreme heat.

The three main rocks that are used for iron production are hematite, magnetite, and taconite. Taconite is a hard ore. The taconite first must be crushed, and then operators must separate the magnetite to produce a pellet with a certain amount of iron in it. If the iron content is too low, it can't be used in the steel production process.

The largest iron ore mines in the United States are in the Upper Great Lakes region. Northern Minnesota, Wisconsin, and Michigan each have large areas devoted to the mining of iron ore. Northern Minnesota and northern Michigan have huge taconite mines. Figure 8.11 shows iron ore production in the United States and the world.

Towns such as Virginia and Hibbing in northern Minnesota saw their heydays in the early 1900s with the rise of the steel industry, which required coal for its furnaces and iron for production. Large ships hauled iron ore from the Great Lakes. Coal was sent by train northward from mines in West Virginia. Pittsburgh was perfectly sited to use iron ore and coal in the production of steel.

Iron ore production in the United States has been slipping in recent decades, as the United States depends less on steel. The U.S. now depends more on plastics, which are a product of the petroleum industry. As steel production continues to wane in the United States, so will the iron ore industry. As a result, the areas in northern Minnesota and northern Michigan have fallen upon hard economic times.



**Figure 8.11: World Iron Ore Production Centers.**

The future of iron ore mines is in doubt. However, although the demand for steel has decreased in the United States, around the world steel is still a fundamental component in the construction of cities and transportation systems. A Chinese company recently purchased a mine in northern Minnesota. The Chinese dependence on steel is at an all-time high, and continued economic development in China ensures that steel will remain in high demand for a while. Iron ore can now be shipped from the Great Lakes through Canada and hauled by ship to China. Due to China's consumption of steel, there is a worldwide shortage of the metal. In fact, demand is so high that companies are sometimes forced to wait weeks for the steel they need to complete projects.

China's steel industry has grown exponentially during the previous two decades, now accounting for over 400 million metric tons of steel production. In comparison, Japan is second at 112 million metric tons, and the United States is third at 94 million metric tons. This demand for steel increases demand for coal and iron ore. As China's economy continues to grow at double-digit rates, its steel industry will only continue to grow.

China currently leads the world in iron ore production, with 280 million tons produced in 2004. Australia and Brazil were tied for second place with 220 million tons, followed by Brazil, India, Russia, Ukraine, and then the United States. The United States produced 54 million tons of iron

ore in 2004. The company Companhia Vale do Rio Doce (CVRD), based in Brazil, is the world's largest producer of iron ore.

## FORESTRY AND FISHING

### FORESTRY

The forest industry in North America is a unique industry in relation to the land use models. The U.S. Forest Service is under the direction of the U.S. Department of Agriculture, which supports the harvesting of timber in national forests. The National Park Service, which is under the direction of the U.S. Department of the Interior, does not support chopping down trees. Sometimes Forest Service lands and Park Service lands abut each other, leading to a situation where on one side of the road you can harvest timber and on the other side you cannot, despite the fact that both sides of the road are owned by the federal government.

Forestry is a huge industry in North America. Forests are some of the most treasured national resources in the United States. The redwood forests in California are older than the first European settlements in the United States, and some trees have been alive for many centuries. Despite this, society needs the products that can be made from these trees. Products from the timber industry are used in everything from milkshakes to chewing gum to home construction. Furthermore, the efficiency of the timber industry has generated significant profits. According to the U.S. government, the number of forested acres is projected to increase 0.1 to 0.2 percent within the next two decades.

Often, a timber company owns a certain parcel of land, harvests the wood, and then replaces the trees that it cut down. Once the land has been replanted, it is left alone for several decades so that the trees can mature and then be cut down again. Sometimes, the timber companies contract out with local and state governments to harvest timber on government-controlled land. This may be done for profit for the local governments or to provide fire protection for human structures nearby.

North America, with its large areas of virgin forest, is the world leader in the production of timber. Billions of trees have been harvested on the continent since humans have lived there.

In the United States, the three major areas of timber production are the Pacific Northwest, the Great North Woods of the Upper Midwest, and the Southeast. Most of the wood harvested from these regions is used in the construction of homes. This includes anything from the framing of houses to furniture and cabinetry. In the Pacific Northwest, in states such as Oregon and Washington, land use management has become a major point of contention between the forest industry and forest service. Sustainable practices ensure the profitability and productivity of the industry for both the near and distant future.

An area with bright prospects for development is Brazil; but again, the debate over land use has arisen. Many environmentalists and preservationists feel that the virgin timberland of Brazil, much

of it located in the interior of the country, should be preserved. However, Brazil needs resources and employment opportunities. A balance must be struck between the need for residential construction and jobs and the need to preserve the environment. The future of the forested areas in Brazil is in doubt, according to many environmentalists.

People who favor sustainability feel that Brazil is an example of effective sustainability programs, pointing out the amount of land that has already been replanted and is being used for tree plantations. This issue goes back to the debate over farming as well. Shifting agriculture means that settlers are cutting down forests or otherwise clearing areas, usually through burning, to plant crops. This bares the thin soil of the tropics, which washes away in the moist climate. Environmentalists fear that replanting trees may not happen quickly enough, if the soil has already eroded into the nearby streams and rivers.

Because of its location and climate, Brazil possesses many different species of trees. Some of the trees that grow in tropical areas are highly prized around the world. Key woods, such as mahogany and rubber, have their sources in Brazil. Other trees, with which Americans might be more familiar, grow in the more temperate southern regions of South America.

Other areas in the world, including many parts of Asia, must import their wood from North American countries like the United States and Canada, or from South America. China's demand for wood, for example, has been outpacing its ability to produce new trees.

Russia has a big forestry industry. Its large expanses of coniferous and deciduous forests allow Russia to produce 20 percent of all the world's forest resources. Upwards of 40 percent of the land in the eastern sections of the country is covered with forests.

The future of forestry as a whole remains very strong owing to sustainable practices used to harvest this renewable resource.

### **THE FISHING INDUSTRY**

The good news for the fishing industry is that there continues to be a high demand for fish products, including crustaceans. The opportunity for high profits exists, but only a few brave souls undertake what some consider to be one of the most dangerous jobs in the world.

Fishing, in terms of how it deals with a natural resource, is different from the aquaculture discussed in chapter 7. Fishing entails the capture of fish from the wild, whereas aquaculture is the breeding and raising of fish and fish products, usually in fish ponds built by the farmer. Fishing is done in either large lakes, such as the Great Lakes, or in the ocean.

In the United States, one of the largest fished areas is off of the coast of New England. Cool waters from Canada and warm waters from the Gulf Stream produce ideal conditions for the capture of fish. However, the overfishing of these areas has contributed to what some now consider a

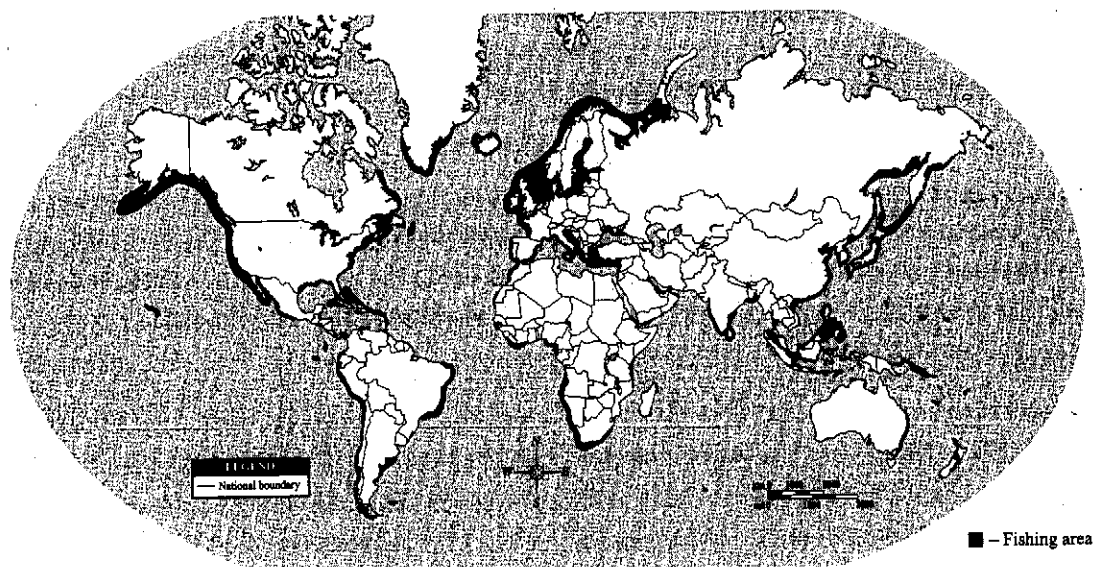
biological crisis. The cod off the coast of New England and the maritime provinces of Canada have been severely depleted.

Fishing is one of the largest industries in Iceland. The icy waters are the perfect habitat for many species of fish, which congregate around the island country. The fish are kept on ice to retain their freshness, then sold in the nearby towns of Keflavik and Reykjavik.

Another area known for its fishing production is the Pacific Northwest region, including the coasts of Oregon and Washington. Unfortunately, the salmon for which the region is famous have been depleted. In addition, Alaska is one of the leading sources in the United States for crab and fish harvests.

Figure 8.12 shows the fishing areas of the world.

Advances in technology have increased the fishing industry's yield, hence the large profits. Much of the industry, however, is at the mercy of the number of fish in the ocean. Fish, like trees, are a renewable resource. However, recent studies of world fish production have shown decreases in fish stocks. Environmentalists feel that the harvest of the fish has outpaced the ability of the fish to reproduce, leading to dramatic decreases in much of the world's fish population. Environmentalists predict that in the next half century, the world's fish production will cease owing to overharvesting. According to environmentalists, much of this overharvesting is being done by the more developed countries of the world. Others feel that such assertions are only scare tactics, pointing out the success of aquaculture in sustainably producing fish and seafood.



**Figure 8.12: Key Fishing Areas of the World.**

## ALTERNATIVE ENERGY

Alternative energy sources are not as extensive as one would hope at this time. They cannot provide enough power to repay the work and money invested in them on a large scale. However, as technology advances, the industry attracts more investment. And, as the need for alternative energy increases, the reliability and the output of alternative energy sources will improve as well.

Currently, there are six primary forms of alternative energy: hydroelectric, solar, wind, nuclear, biomass, and geothermal energy sources. Each of these holds promise and poses challenges regarding future development.

### HYDROELECTRIC POWER

**Hydroelectric power** is the use of water to create electricity. The power of falling water has been used in industry for thousands of years. People dug holes in the earth and diverted rivers into the holes; the falling water spun water wheels, which then spun turbines or belts in factories. Before electricity was distributed on a mass scale, factories had to rely on water as their primary source of power.

Huge dams have been built around the world to harness the power of moving water. The largest dam in the world is currently being built in China. At more than a mile wide, the Three Gorges Dam is the largest public works project that China, or the world, has ever attempted. It will harness water from the Yangtze River to provide power for the population centers in the eastern portions of the country. The dam was scheduled to be finished in 2009, but all of the structural work was completed in 2006. Officials debate the true cost of the dam, which ranges anywhere from \$25 billion to \$100 billion in U.S. dollars. The dam is thought to be capable of meeting upwards of 10 percent of China's future power needs.

Other large dams in the world include the Aswan Dam in Egypt, which harnesses the power of the Nile River; the Sayano-Shushenskaya Dam in the Yenisei River in Russia, which provides power for that country's aluminum industry; and the Itaipu Dam, located on the Paraná River which provides power to both Brazil and Paraguay. The largest dam in the United States is the Grand Coulee Dam, which produces its power from the Columbia River in Washington state.

The Works Project Administration (WPA) initially established in 1935 as the Works Progress Administration and renamed in 1939, was created under the leadership of President F. D. Roosevelt. His New Deal policies were initiated to ease the high unemployment rate due to the Great Depression. The WPA built dams throughout the western sections of the United States as well as roads in previously isolated areas. During the 1930s and 1940s, dam construction in the United States was at its apex; thousands of dams were built on little creeks and across great rivers. Most dams were built in the West, because the government owned a lot of land there.



There are some major downsides to hydroelectric power. Dams can create a lot of energy, but they are expensive to build and must be on a waterway that can provide the necessary power to produce large amounts of energy. Major rivers are prime sites for dams, but damming the river affects many people, both upstream and downstream. By blocking the river, a reservoir is created behind the dam, flooding that area. The Three Gorges Dam in China has flooded villages and forced the relocation of upwards of 1 million Chinese citizens.

The United States uses many of these reservoirs as recreation areas. The Lake Mead area near Las Vegas was turned into a National Recreational Area when the Hoover Dam was completed. The damming of the Columbia River by the Grand Coulee Dam formed Franklin D. Roosevelt Lake.

Many dams are built on rivers that fish, such as salmon, use to migrate upstream. By blocking the rivers, dams create a barrier for the fish, halting their reproductive cycle. Newer dams are built with diversions that allow the fish to bypass the dam and complete their reproductive cycle.

Dams have also been known to break. The 1889 Johnstown flood, which killed over 2,200 people in Pennsylvania, was caused by the failure of the South Fork Dam. In Idaho, the Teton Dam broke in 1976, killing 14 people and causing over \$1 billion in property damage. As recently as 1999 in Seville, Spain, the Los Frailes Tailings Dam flooded a large area with toxic waste, posing numerous environmental problems for fish and other wildlife.

### **SOLAR ENERGY**

Another major source of alternative energy is solar energy. **Solar energy** uses the power of the sun to produce heat that can then be used to create electricity. Solar energy is one of the best renewable energy sources available. The sun will continue to exist for millions of years, and solar power is one of the cleanest sources of energy.

Passive solar energy systems use darker objects to absorb the heat of the sun and store it. Your latitude determines where your windows should be located in your home. In the Northern Hemisphere, the windows should face the south to receive direct sun exposure. In the Southern Hemisphere, the opposite is true. With the windows in your home, you can capture the sun's heat, minimizing the fossil fuels needed to heat your home. You will also need something to absorb the heat and store it. Once stored, the heat can be released to heat water and air.

What are the problems with solar energy? It cannot effectively power massive power plants or entire cities. Most people who have solar power in their homes use it just to heat water for their personal use. Solar or **photovoltaic cells**, panels that are used to convert light into electrical energy, are expensive to install, so not many people use them. Also, many people consider these panels outside their homes to be eyesores. The panels are relatively small, but when enough are placed together to create a significant amount of electricity, they can stand out.

Another potential downside is that in areas without direct sunlight during certain times of the year, solar panels cannot capture enough energy to heat a home. Higher latitudes do not receive as much direct sunlight as tropical areas. For example, in the winter, solar power is more productive in the Desert Southwest than in Alaska, simply because of the position of the sun in the sky.

However, newer technology has enabled solar panels to become smaller and more efficient. No longer do massive storage units need to be located on the outside of houses. New solar technology has enabled solar panels to be put directly on the roof. When people use these panels, they are using an active solar energy system. An active solar energy system soaks up light and converts it through photovoltaic cells to produce electricity.

Also, proponents of solar power feel that it will become more cost-effective in the future because of the absence of fossil fuels. Customers will pay more for fossil fuels as they become scarcer. Solar power, however, will not necessarily increase in price because of competition to create more efficient, more productive systems. Conversion costs for existing homes are somewhat prohibitive, but some new homes will have a solar energy system built in. Once the system is installed, the monthly costs of running it are minimal.

Even optimists about solar energy suggest that only 40 to 80 percent of a home's total heat can come from active solar energy. During extended periods of cloudy weather, the system cannot produce enough energy to heat a residence. Local government building codes are requiring that solar-powered buildings include a backup plan.

### **WIND ENERGY**

One of the cleanest methods of producing energy is the use of wind. Huge wind turbines are located in windmill parks, also called **wind farms**. As air gets warmer, it rises, and as it cools, it falls. This movement turns the blades of large windmills, which then spin turbines that produce electricity. **Wind energy** is the movement of wind to create power.

Different areas heat up and cool down at different rates. Water heats up and cools down more slowly than land. Also, some land changes temperature faster than other land; deserts heat up and cool down faster than areas with darker, richer soil. As air gets warmer, it rises, and as it cools, it falls.

Wind energy is one of the alternative energy sources with the most promising future because it is one of the cleanest sources of energy. Wind energy is related to solar energy in the sense that most wind is a direct result of the sun's heating of the Earth. The Earth spins, and the rotation causes air to move from high-pressure to low-pressure areas.

Along with hydroelectric power, wind is one of the oldest sources of alternative power. Farmers have been using windmills for over a century. Prior to the electricity boom in the 1930s and 1940s, many rural areas in the United States did not have power. In fact, some areas were not connected

to the country's power grid until the 1960s and 1970s. Such people had their own power sources, usually from the wind. They also used the wind to pump water for irrigation.

Wind farms are usually located in areas that experience more wind than other areas. All areas of the Earth experience the movement of air upon the surface of the Earth, but some are more windy than others. The Great Plains is a good example of an area that is windy because of a lack of natural windbreaks. Large areas of the Great Plains are being used to produce power from wind. Many farmers are building large windmills on their farms and selling their excess power to utility companies in larger urban areas, like Chicago. In fact, some farmers in the Great Plains have ceased to produce crops because of the low prices of agricultural commodities and instead have found a new source of wealth in producing wind energy.

The worldwide use of wind energy has seen exponential growth during the last decade. This growth is expected to continue, as many countries have mandated that larger percentages of total energy production come from wind energy in the coming decades. Currently, the United States is third in the world in using wind power. Only Germany and Spain produce more power from wind sources than the United States.

Wind power presents some challenges. Wind is not that productive yet. A lot of windmills are required to produce enough power to meet the electricity needs of cities. A nuclear power plant can generate more power while using a fraction of the space of a wind park.

Also, during overly windy conditions, windmills must be shut down. If the windmills are running in high winds, they may tip over. Wind speed needs to be an average of 6 to 20 miles per hour. Anything under that, and there is not enough wind to spin the turbines to create electricity. Anything over 20 miles per hour, and production drops because the windmills need to be turned off.

Critics of wind power also cite as an adverse effect that birds fly into the turbines and are killed. Another concern about wind energy is the blight on the landscape that wind farms create. Dozens of large wind turbines are needed to produce significant energy. Some people find them unattractive, and the noise can be a nuisance for those who live near them.

There are costs associated with wind power as well. A turbine that can generate one megawatt of power can cost upwards of \$2 million. This investment may be prohibitive for many small farmers who would otherwise invest in wind power. Once established, though, wind power's costs are minimal and the profits high.

### **NUCLEAR POWER**

Another form of alternative energy comes from nuclear power. **Nuclear power** is one of the most controversial yet productive power sources in the world. Some people suggest that nuclear power shouldn't even be considered as an alternative energy source, because it needs uranium or plutonium (nonrenewable resources) for its production.

The power of nuclear energy cannot be overstated. The amount of energy produced from nuclear energy far outweighs the amount of energy from any other power source, including fossil fuels. Currently, the United States receives about 15 percent of its total power from nuclear energy. Some countries in Europe, such as France, receive over 70 percent of their power from nuclear energy.

There are two types of nuclear power: fission nuclear power and fusion nuclear power. When people are discussing nuclear power, they are describing fission power. **Fission nuclear power** involves the splitting of a uranium atom and harvesting the energy from the splitting process. This reaction is controlled through the use of water and supercontainers of concrete that can be upwards of ten feet thick. Splitting a uranium atom produces heat, causing the water to boil. The steam is then used to generate electricity.

**Fusion nuclear power** is the joining of two hydrogen atoms to create a helium atom. This reaction takes place in the sun, a giant fusion reactor that produces an incredible amount of heat. Fusion occurs at millions of degrees Fahrenheit. Humans have not yet used fusion to generate power. The fusion process produces the power of a hydrogen bomb. It is an enormous source of power but one with serious consequences.

One of the biggest drawbacks to nuclear energy is plant safety and the potential for nuclear meltdowns. The largest accident in the history of nuclear power occurred in the Ukraine with the meltdown of Chernobyl in 1986. It was the result of inadequate safety measures and poor supervision of the nuclear fission process.

The Chernobyl accident sent clouds of radioactive dust throughout northern Ukraine. Exposure to a radioactive cloud can have severe health impacts. The Chernobyl incident exposed people to radiation at rates far higher than medically recommended. Following the disaster, rates of cancer and birth defects have been high. More than 20 years later, radioactivity is still high in the Chernobyl region.

The closest thing to a disaster in the United States occurred at the Three Mile Island nuclear power plant in Pennsylvania in 1979. A partial meltdown of one of the reactors started to happen. The reaction was brought under control within a few days, but the potential disaster has had a profound impact on the U.S. perception of nuclear power ever since.

The other major drawback to nuclear power is the storage of waste. The spent rods of uranium are radioactive. These radioactive rods must be disposed of somewhere. The question is where? Nobody wants to have radioactive waste near their homes. An acronym, NIMBY, has been coined; it stands for Not In My Back Yard. Currently, the United States sends its radioactive waste to a storage facility in Nevada. However, this is intended to be only a temporary solution.

Countries around the world could use nuclear technology to attack another country with great devastation. The United States used hydrogen bombs on Nagasaki and Hiroshima to end World

War II. Those bombs caused incredible damage, yet they were small compared to nuclear bombs today.

By using breeder reactors, scientists can convert a nonrenewable resource (uranium) to a renewable resource (plutonium). The potential for this is both promising and problematic. Uranium is a very scarce resource and will run out within a few decades. Plutonium, while a renewable resource, is much more dangerous to humans than uranium.

### **BIOMASS**

Another form of alternative energy in use today is biomass. The biomass industry is one of the fastest-growing industries in the United States. **Biomass** is the use of agricultural products, natural vegetation, or urban waste to produce a type of fuel that automobiles or other engines can use. The most common crops used to make fuel are sugarcane, as in Brazil, and corn, as in the United States. These agricultural products are used to make biodiesel and ethanol-blended fuels.

Many states provide subsidies for farmers to produce corn, which is then sold to produce ethanol. Ethanol can be added to gasoline to make it burn cleaner. Ethanol plants are dotted throughout the Midwest, corresponding to the Corn Belt. However, ethanol is too unstable to transport well, and it must be transported by train. Trucks cannot haul enough of it to supply refineries, and ethanol deteriorates if pumped through pipelines.

Responding to government mandates, many major automobile manufacturers have developed automobiles that will run on what is called E-85 gasoline, which is composed of 85 percent ethanol and 15 percent gasoline from petroleum. This fuel is much cleaner than pure gasoline. When ethanol is burned in the combustion engine, the by-product is carbon dioxide, which plants can use for photosynthesis. A by-product of the combustion of normal gasoline is carbon monoxide, which is dangerous to plants and humans.

Much of the gas that is currently used in automobiles may be as high as 10 to 15 percent ethanol. The new ethanol-based fuels will flip-flop the ratios, making the burning process cleaner in the cars that can use the new fuel. To use ethanol, a car must be fitted with an engine that can burn it. Putting an ethanol blend into an automobile that is not designed to burn it will cause serious engine problems. Ethanol-based engines can also burn regular gasoline. In addition to E-85, there are other ethanol-based fuels, such as E-70.

As the United States becomes more concerned with its environmental impact on the world, the use of ethanol-based automobiles will only increase. At least, the manufacturers of such cars hope that will be the case.

As with the other alternative energy sources, there are some problems with using biomass. Ethanol is acidic and rapidly corrodes fuel pumps. Also, gas mileage is much less for vehicles that run on ethanol fuels. Even though the cost of ethanol-based fuels is 50 to 70 cents less per gallon, mileage

is almost cut in half. The initial cost of the vehicle and the cost of filling it up more often may come to more than purchasing and operating a vehicle that runs on regular gasoline.

In addition, ethanol-based fuels have a tendency to freeze in cold weather, an issue of particular concern in some states, where temperatures can get well below zero in the winter. This can make starting the vehicle nearly impossible. A way to heat the gas tank is required on all such vehicles to start them in subfreezing temperatures.

## POLLUTION

Because fossil fuels must be burned to make energy, the result is a relatively large amount of air pollution. **Air pollution** is the occurrence of unnatural products in the atmosphere as a result of human activities. Some fossil fuels produce more air pollution than others when they are mined and/or burned to create energy.

There are different kinds of pollution. Carbon monoxide is one of the more common causes of air pollution. When the furnace in your house burns natural gas incorrectly, the by-product is carbon monoxide. When carbon monoxide levels get too high in your house, the gas reduces the amount of oxygen, causing sleepiness and ultimately death. Carbon monoxide is in the atmosphere as well. When too much carbon monoxide is introduced into the atmosphere, the same result occurs.

Another kind of air pollution is caused by hydrocarbons. In recent decades, hydrocarbons have been implicated in the depletion of the ozone layer over the polar regions. Hydrocarbons also contribute to the urban haze when prevailing winds can't diffuse the pollution in the atmosphere over a city. Hydrocarbons are released from aerosol cans, among other sources.

Mexico City is notorious for its air pollution. The haze surrounding Mexico City has caused numerous health issues for its citizens. The city itself has a poor site. Mountains on all sides do not allow adequate ventilation and diffusion of air pollution. If you drive a car in Mexico City, you have a certain color on your license plate, which indicates on which days you are allowed to drive. This regulation is designed to reduce the pollution from cars as well as to reduce some of the traffic congestion in the world's second-largest city.

Mexico City isn't the only city in the world with air pollution. Cities in China are also known for their air pollution. Shanghai is one of the world's great economic cities; however, if you go to the top of some of its highest buildings, you cannot see the horizon because of the amount of smog. Beijing is no different. In many cities, government standards have either not been enforced consistently or are nonexistent. Urban residents in the United States and Europe live in some of the cleanest cities in the world. The Environmental Protection Agency in the United States and government environmental agencies in European countries have set strict standards on the burning of fossil fuels to ensure clean air in large urban areas.

Coal is one of the biggest air polluters. In recent decades, however, the coal industry has greatly reduced the amount of air pollution caused by burning it. The Environmental Protection Agency has worked alongside the major coal producers to reduce the emissions of coal-burning plants. In the early 1900s, steel-producing cities, such as Pittsburgh, were covered in soot. Streetlights were turned on in the middle of the day to offset the dark conditions caused by air pollution.

Air pollution has also resulted in acid rain. **Acid rain** is the term used for any form of precipitation with an unusually low pH value. It is the result of pollutants, such as sulfur dioxide and nitrogen oxide, that chemically alter water droplets. The burning of fossil fuels into the atmosphere causes acid rain. The Rust Belt in the United States has a lot of heavy industry, with smokestacks billowing pollutants out into the air. Due to the prevailing winds of North America, which blow weather from west to east, the pollution formed acid rain in many sections of New England and southeastern Canada. High quantities of sulfur dioxide and nitrogen oxide have been found in lakes and buildings in these regions. Some of the regions with the highest amounts of acid rain have already been listed; other areas include the Great Plains, Rocky Mountains, and Pacific Northwest.

Acid rain has expedited the process of decay on buildings and other structures exposed to the rain. Forested areas have seen increases in soil acidity levels, creating unhealthy conditions for the native tree species. Acid levels have risen in lakes, destroying native fish species, sometimes to the economic detriment of people who depend on fishing tourism for their survival.

Ozone depletion is another result of pollution. A debate has risen over the emission of the pollutants that are causing the breakdown of the ozone layer. Ozone is a naturally occurring gas that is produced from a chemical reaction when sunlight hits the Earth's surface. Chlorofluorocarbons are released into the environment when an aerosol can is used. The chlorofluorocarbons break up the ozone layer, which is the Earth's main protection against the sun's ultraviolet rays. Ozone depletion has been especially severe over the polar regions. If the ozone layer breaks down further, many more cases of skin cancer will result from unprotected exposure to the sun's rays.

Critics of the theory that manmade pollutants are depleting the ozone layer suggest that the polar regions do not produce ozone because they are dark for several months of the year, resulting in ozone holes over the poles.

Debate continues over the use of chlorofluorocarbons, and the aerosol industry has changed many of their containers to meet environmental guidelines. Environmentalists ask: Is it too late? Has too much of the ozone layer already been depleted?

For consumers, picking a side in the debate often comes down to a choice of products. You may purchase a product that you have trusted and used for years. You know this product works and have depended on it for a long time. But one day, you learn that the product is not friendly to the

environment. You now have a choice to make. You compare the benefits of the familiar product with a new, environmentally friendly product, and you may make a switch. This transition to a more environmentally friendly product is known as the **substitution principle**. Many aerosol cans no longer use chlorofluorocarbons in their products, but some still do. Switching from aerosol products that issue pollution to cans without chlorofluorocarbons is an example of the substitution principle.

Another major issue that has gained worldwide attention in recent years is the greenhouse effect. The **greenhouse effect** is the gradual warming of the Earth due to pollutants, which come primarily from more developed countries. Greenhouse gases, in effect, keep warm air closer to the surface of the Earth, causing a warming of the Earth's surface. A warming of the Earth's surface would have profound effects on life everywhere.

Scientists who support the concept of global climate change point out the retreating glaciers in both the Arctic and the Antarctic. Some glaciers that were once huge have been reduced to relatively small chunks of ice. The melting of the polar ice caps would result in massive flooding of coastal regions around the world.

Although many scientists recognize global climate change, some are critics of the global warming theory. Criticism primarily suggests that there is a lack of research supporting the concept that the Earth is heating. Global temperatures have only been recorded for the past 150 years. Doubters suggest that one cannot conclude that the Earth is heating up as a result of manmade pollutants, simply because of the lack of scientific study and data available. Scientists who are skeptical of the claims of global climate change also point out that the oceans have not been warming and, in some cases, have actually been cooling. To make a logical leap and suggest that the entire earth is warming would not be scientifically sound, according to the anti-global-warming scientists.

As stated, the warming and cooling of the oceans would have drastic effects on global weather patterns. Areas that were once prone to flooding may experience drought-like conditions, while arid areas may experience wetter conditions. The warming of the Pacific Ocean is called El Niño, and its cooling is called La Niña. Both of these phenomena can have profound impacts on weather throughout the United States.

Countries from around the world have gotten together and written protocols for the more developed countries to reduce the use of greenhouse gases. The process began in 1985 with the Vienna Convention for the Protection of the Ozone Layer. This conference, held in Austria, tried to establish a time frame to eliminate the use of some of these gases and halt the destruction of the ozone layer.

In 1987, the Montreal Protocol was signed by over 100 countries. Its primary target was to reduce the use of chlorofluorocarbons by one-half by the year 1999. Several other meetings, including



conferences in Denmark and Brazil in the 21st century, have further tried to curtail the use of fossil fuels, which put more carbon monoxide into the atmosphere.

Critics of these protocols suggest that this is simply a game of politics and political envy. Trying to curtail the use of greenhouse gases in the more developed countries is difficult. Hearing less developed countries tell more developed countries to curtail the use of these gases didn't make sense to countries like the United States. In negotiating many of these protocols, China was allowed not to participate in the decision and was excluded from the requirements. Excluding the country with one of the fastest-growing economies in the world and one of the worst pollution rates from the convention's requirements showed some of the political implications and hidden agendas of the meetings, according to the critics of these conferences.