CHAPTER 1

# Urgency to Adopt Sustainability



It has been about 50 years ago when we started to read books or articles about the environment with *Silent Spring* by Rachel Carson being one of the first important books published in 1962. Many other outstanding books have been written about the environment since then such as *The Ecology of Commerce* by Paul Hawken in 1993 and *Natural Capitalism* by Paul Hawken, Amory Lovins, and L. Hunter Lovins in 2008. The number and frequency of new books has increased as more and more people are concerned about the state of the environment.

Very few people question the decline in the state of our environment, only the degree to which it has deteriorated or the rate at which it is continuing to deteriorate. Regardless of the current status of our environment, it is important to put in perspective what has happened to our Earth since its creation. Historians estimate that the Earth is about 4.5 billion years old, but it is really difficult to understand exactly what this means. What does one billion really mean? Let's consider a situation where a 21-year-old girl is given one billion dollars as a gift, and she places the money in a noninterest-bearing account. She will be able to spend $60,000 every day of her life until she retires at the age of, say, 65 and still have $36 million left over for retirement. This gives someone a better understanding of what one billion dollars really means.

So how can we put 4.5 billion years in perspective so we can understand what has happened to the Earth since its creation. As suggested by David Brower [1], former executive director of the Sierra Club, let us compress the geological time, from the initial formation of the Earth until now, into the six days of biblical creation [2], from Monday through Saturday.

*Practical Sustainability Strategies: How to Gain a Competitive Advantage*, First Edition. Nikos Avlonas and George P. Nassos.

## CREATION OF THE ENVIRONMENT

Using the compressed time scale, the Earth was formed at midnight, the beginning of the first day, Monday. There is no life until Tuesday about 8:00 A.M., and millions of species begin to appear and disappear throughout the week. Photosynthesis begins and it gets into high gear by Thursday morning, just after midnight. By Saturday, the sixth and last day of creation, there is sufficient oxygen in the atmosphere that amphibians can come onto land and enough chlorophyll manufactured for the vegetation to begin to form coal deposits. The giant reptiles appear around 4:00 P.M. and primates show up at 10:00 P.M. on this last day, but *Homo sapiens* don't appear until 11:59:54—just six seconds ago. In other words, if we compress the age of the Earth to six days, or 144 hours, "man" is not created until the last six seconds. A quarter of a second to midnight, Jesus Christ appears. One-fortieth of a second is the beginning of the industrial age, and one-eightieth of a second ago, we discover oil, thus accelerating the carbon blowout started by the industrial revolution.

Scientists have predicted that this 4.5 billion-year-old Earth will be around for another "week." But look at the damage that has been done in just the past one-fortieth of a second. About 70% of the major fisheries have been depleted or are at their biological limit. It is estimated that the forest cover has been reduced by as much as 50% worldwide; 50% of the wetlands and more than 90% of the grasslands have been lost [3]. Currently, almost 40% of the world's population is experiencing serious water shortages. The big question now is how long will we last, another one-fortieth of a second—about five generations? Or will we be able to survive for another quarter of a second—about 2000 years? Or can we make a difference to extend a healthy world to some indefinite period of time? Or is it too late, and are we in the midst of a period of overshooting the carrying capacity of the Earth, followed by a rapid collapse?

God did not create the natural environment for the benefit of the people so they can use and misuse it. The environment *can* be used indefinitely as long as it is replenished. It has the capacity to support the needs of living creatures—plants and animals, including humans—but only a finite number. If this carrying capacity is exceeded to the degree that it cannot be replenished, the population that it is supporting will decrease significantly. This can be demonstrated by a real experiment conducted by scientists a number of years ago.

## EXCEEDING THE ECOLOGICAL FOOTPRINT

Near the end of World War II in 1944, the US Coast Guard placed 29 reindeer on St. Matthew Island in the Bering Sea as an emergency food supply for the US military. This island consisted primarily of vegetation and was void of any predators. Specialists had calculated that the island could support between 13 and 18 reindeer per square mile, or a total population of between 1600 and 2300 animals.

By 1957, the population was 1350; but just 6 years later in 1963, the population had exploded to 6000. Were the scientists wrong in their calculations of how many reindeer the island could support?

Eventually, it was determined that the original calculations had been correct. The 6000 reindeer vastly exceeded the carrying capacity of the island, and they were soon decimated by disease, starvation, and extreme weather conditions. Such a drastic overshoot, however, did not lead to restabilization at a lower level, with some of the reindeer dying off. Instead, the entire habitat was so damaged by the overshoot of reindeer that the number of animals fell far short of the original carrying capacity. By 1966, just three years later, there were only 42 reindeer living on St. Matthew Island rather than the expected 1600 to 2300.

This is an example of what could happen to the Earth. In the case of St. Matthew Island, the resources used by the reindeer were grasses, trees, and shrubs, all renewable resources that can be replenished. Many of the resources necessary for human survival, however, are not renewable. There is only a finite source of resources such as minerals, oil, and coal. We must be cognizant of the overutilization of both renewable and nonrenewable resources.

To examine this overutilization of the Earth's resources, we must look at a concept called the ecological footprint. This is a tool for measuring and analyzing human natural resource consumption and waste output within the context of nature's renewable and regenerative capacity (or biocapacity). It represents a quantitative assessment of the biologically productive area required to produce the resources (food, energy, and materials) and to absorb the wastes of an individual or region. In terms of resources, it includes cropland, grazing land, forest, fishing grounds, and built-up land. The footprint to handle waste output includes the forests required to absorb all the carbon dioxide emissions resulting from the individual's energy consumption.

In order to be sure we don't exceed the carrying capacity of the Earth, the footprint for humanity must be within the annual regenerative capability of nature. Similarly, we must not exceed the absorptive capacity of the planet for handling of the waste that is produced. A *sustainable* environment will exist if we live within the Earth's regenerative and absorptive capacity. If we remove more from nature than can be provided indefinitely, we are on an unsustainable track.

An organization called Global Footprint Network [4] has been calculating and analyzing the ecological footprint of about 140 countries. The footprint refers to the amount of the Earth's carrying capacity it takes to sustain humanity's consumption of goods and services, basically the need for food, clothing, shelter, energy, and disposal of waste. According to its calculations, in the late 1970s, humanity's collective ecological footprint breached the sustainability

**TABLE 1.1 Ecological footprint for 2007**

| Country | Ecological footprint (acres) |
|---|---|
| United Arab Emirates | 26.4 |
| United States | 19.8 |
| Germany | 12.6 |
| Japan | 11.6 |
| Mexico | 7.4 |
| *World* | 6.7 |
| China | 5.4 |
| *Biocapacity* | 4.4 |
| India | 2.2 |
| Puerto Rico | 0.1 |

*Source*: Global Footprint Network.

mark for the first time, and it has remained unsustainable ever since. In fact, the deficit for maintaining sustainability has grown every year since then, and it appears that this deficit is on a path to grow further in the foreseeable future. Currently, it is estimated that we need 1.4 Earths to insure that future generations are as well off as we are today [5].

It is interesting to note the variation in the ecological footprint by region or nation as seen in Table 1.1 [4]. Not surprising, the largest footprint belongs to the United Arab Emirates where it is 26.4 acres per capita. This means that for each individual living in the United Arab Emirates, over 26 acres are necessary to provide the consumptive and disposal needs for that person. By comparison, the footprint for the United States is 19.8 acres. Two additional questions that might be asked are the following: (i) is the footprint increasing with time and (ii) how does this footprint compare to the available capacity? Growth in the ecological footprint can be attributed to an increase in population, an increase in consumption, or both. Of the Western European countries, Sweden, Belgium, Portugal, Spain, and Switzerland have increasing footprints, while Denmark and the Netherlands are making concerted efforts to reduce their footprints. The most striking result of this ecological footprint analysis is that if the entire world lived like the people of the United States, it would take over five planet Earths to support the present world population.

## THE LIMITS TO GROWTH

In 1972, a team of MIT experts wrote a report titled “The limits to growth” and presented it to scientists, journalists, and others and shortly published it as a book. It was the first time that computer modeling was used to answer the question as to whether the population would outgrow the planet and the resources available. The purpose of the study was to show the interrelationship between global growth factors like population, resources, persistent pollution, food production, and industrial activity. Based on this study, they predicted that if human beings continued to consume more than the environment was capable of providing, there would be an economic collapse and a sharp decline in population by 2030, which is not too far away.

This topic of overshoot and collapse was addressed again in *The Limits to Growth: The 30-Year Update* [6], which stated that "overshoot can lead to two different outcomes. One is a crash of some kind. Another is a deliberate turnaround, a correction, a careful easing down. We explore these two possibilities as they apply to human society and the planet that supports it. We believe that a correction is possible and that it could lead to a desirable, sustainable, sufficient future for all the world's peoples. We also believe that if a profound correction is not made soon, a crash of some sort is certain. And it will occur within the lifetimes of many who are alive today."

Although the 1972 report seemed to focus on a very negative scenario, it looked at various changes that could avert a collapse. One positive variable was looking at technological changes that increased agricultural productivity, reduced pollution, and provided an increase in the available supply of natural resources. Technological advancements would have a positive impact, but this alone could not avert a collapse. Social and cultural changes would also be necessary to reduce consumption and stabilize population growth. Since it had been 40 years since the report, data were collected and compared with the predictions. To mark the 40th anniversary of the report, experts gathered to discuss the challenges ahead into a sustainable future. Their concern was depicted in Figure 1.1 [7], which shows that the world is following the predictions of the study.

You can see that with 30 years of data, pollution, industrial output, population, and services per capita are all increasing as expected. At the same time, the remaining nonrenewable resources are decreasing a little slower (good), but food per capita is increasing a little faster than expected (bad).

The study was also concerned with sustainable development, which was defined by the notion that the developed nations can keep what they have while the poor people try to catch up, or, perhaps, keep on doing what we are all doing, but through technological advances we can expect less pollution and use fewer resources. Unfortunately, we are not succeeding with this expectation. We are currently consuming 50% more than what the Earth is able to provide, as explained earlier by the ecological footprint.

What we are consuming can be described as the different forms of industrial capital. This capital really refers to the machines and factories that produce the manufactured goods. These products manufactured by the industrial

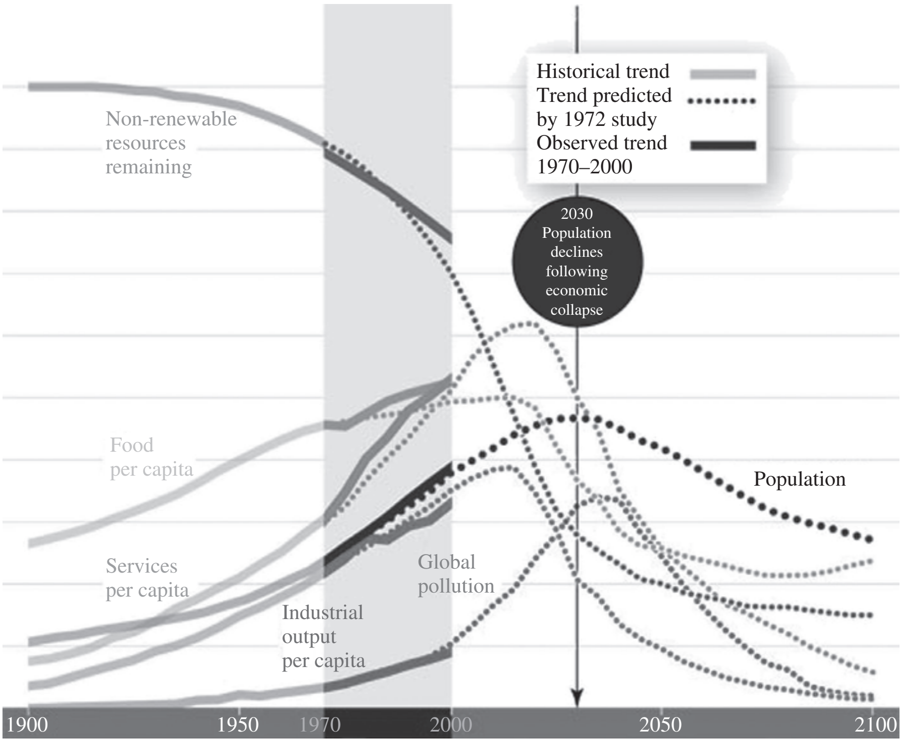


**FIGURE 1.1** Tracking predicted trends.

capital can be defined as industrial output. This industrial output derived from industrial capital can be used to generate service capital for the service industry, like banks, schools, and hospitals, which provides services for the people. Industrial capital is also converted to agricultural capital to generate agricultural output. Likewise, it is converted to resource-obtaining capital to generate resource output. In addition, industrial capital is used to manufacture consumer goods. As each of these industrial outputs continues to grow, there is a need for more capital to be invested in the factories and machines that serve each of the outputs. Consequently, there may be an exponentially growing requirement for industrial output to expand the capacity for production in the future. This leads to more and more consumption.

## CONSUMPTION FACTOR

Another way of looking at overuse of the Earth's resources is to talk about consumption. There is a great variation today in consumption of many nations in the world. Consumption is defined as the needs of people for survival in terms of food, energy, materials, and the disposal of waste. The disparity in the consumption rate is that it is 32 times greater in the United States, Canada, Western Europe, Japan, and Australia than in the developing countries [8].

Today, the world population is estimated to be around seven billion people, of whom only about one billion live in the fully developed countries listed earlier. By the middle of this century, it is estimated that the world population could grow to nine billion people, and there are questions as to whether the Earth can support this number of people, or will it collapse. It is not really a question of how many people are on this Earth, but what is the consumption rate of these people?

People in third-world countries are aware of a major difference in the consumption rate per capita, although they probably don't know the magnitude of the difference. In general, their goal is to catch up to the developed countries, but if they believe their chances of catching up are hopeless, they could get frustrated, angry, or even participate in terrorist activities. Another option is to emigrate to a first-world country like the United States and Western Europe, but then they would contribute to the consumption rate of that country.

If one considers the fastest growing economy in China, these people are already aspiring to increase their consumption rate to the 32 factor. If the Chinese were to succeed, it would be equivalent of doubling the world's consumption rate. If India were to do the same thing, the consumption rate would then triple. If the entire world had the same consumption rate as these first-world countries, it would be the same as having 72 billion people on this planet at the current consumption rates—and there is no way the Earth could handle this.

Since we are in no position to restrict the rest of world from improving their quality of life, the only answer is that the high-consuming countries mentioned earlier must lower their consumption rate. But will they do it for the benefit of the rest of the world? Whether they want to or not, they must reduce their consumption rate because what they are doing today is not sustainable.

If these countries reluctantly agree to reduce their consumption rate, does it mean that they will have to reduce their quality of life? Definitely not! For example, the people in Western Europe consume half as much oil (gasoline) per capita than the people in the United States. But the Western European standard of living is considered higher than that in the United States in terms of life expectancy, healthcare, infant mortality, vacation time, quality of public schools, and several other criteria. Does a large gas-guzzling automobile really contribute positively to any of these quality of life factors? Probably not!

The current state of the environment can also be presented by looking at four major environmental issues: (i) water scarcity, (ii) energy sources, (iii) climate change, and (iv) population growth.

## CONSERVATION OF WATER

Water is a natural resource with a finite quantity. The amount of water on this planet 2000 years ago is the same as it is today, but the population during this time interval has gone from approximately 150 million to over 7 billion. But of all the water on the Earth, how much is readily available to all of the living creatures? Figure 1.2 [9] provides a summary of the current situation.

The Earth's surface is about 71% water; however, 97% of all the water on Earth is saline. Of the remaining 3%, 68.7% is in the form of ice caps and glaciers, 30.1% is groundwater, and 0.9% is in some other unavailable form. This leaves only 0.3% of the freshwater on Earth available to us on the surface, with 87% in lakes, 11% in swamps, and 2% in rivers. This means that only 0.1% of all the water on the Earth is available for industrial, agricultural, and human use. And of these three general uses, 70% is for agricultural use, 20% for industrial use, and only 10% for human consumption. Going further with the calculations results, only 0.01% of all the water on the Earth is being consumed by humans, and as the population grows, that leaves less for everyone.

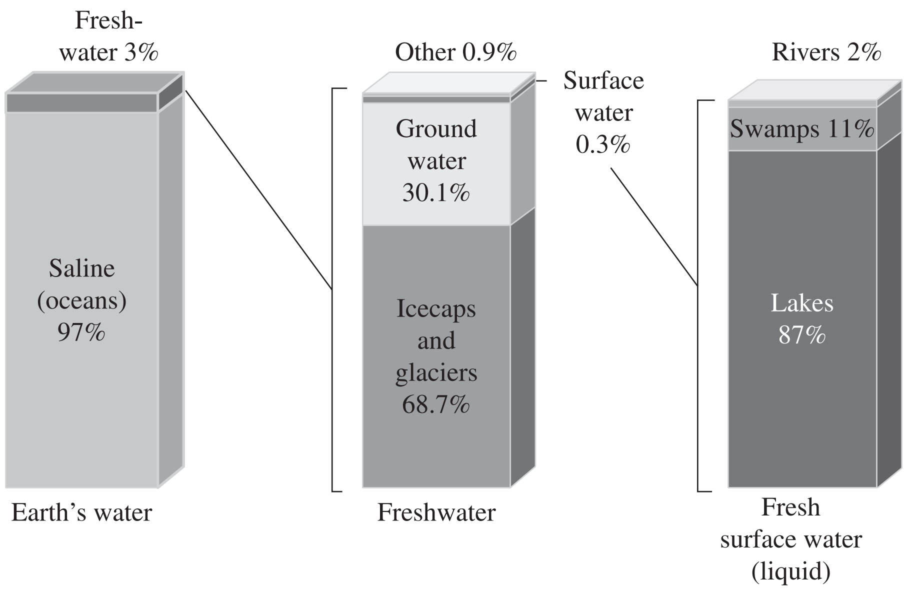


**FIGURE 1.2** Distribution of Earth's water.

According to the United Nations, two-thirds of the world's population is projected to face water scarcity by 2025. In the United States, a federal report shows that 36 states are anticipating water shortages by 2013. In 2008, the state of Georgia tried, unsuccessfully, to move the state's border north in order to claim part of the Tennessee River.

The concern for this water shortage is partly due to the companies that require so much for their processes. It takes roughly 20 gallons of water to make a pint of beer, about 130 gallons of water to make a 2 liter bottle of pop, and 500 gallons of water to make a pair of Levi's stonewashed jeans. Why so much? For the pop, it includes the water used to grow the ingredients such as sugarcane. For the jeans, it includes the water used to grow, dye, and process the cotton.

Companies are now calculating the "water footprint" in order to manage better the water consumption. This is not dissimilar to the carbon footprint that organizations and individuals have been calculating for some years. The water-footprint concept was first developed in 2002 by A.Y. Hoekstra at the University of Twente in the Netherlands [10]. Following the water-footprint concept, studies were conducted to calculate the embedded, or virtual, water required for a product, which was then added to what is consumed directly. Embedded water includes everything from raising beef in South America, growing oranges in Spain, or growing cotton in Asia. By calculating the embedded water, you would learn that a typical hamburger takes 630 gallons of water to produce. Most of the water is used to grow the grain to feed the cattle. This represents more than three times the amount the average American uses every day for drinking, bathing, washing dishes, and flushing toilets.

At first glance, these large numbers representing water footprints for certain products seem very alarming. However, they are not necessarily bad if there is available water and it is well managed. Since most of the water is used for crops, it becomes part of the water cycle where it is eventually evaporated or it is run off. This water becomes temporarily unavailable for other uses, but that is not really a problem in an area that has plentiful water. If it doesn't return to the same aquifer or it returns as rainfall in another region, this could be a problem.

## THE DEPLETION OF FOSSIL FUELS

In 1956, M. King Hubbert, a scientist with Shell Oil, proposed that fossil fuel production in a given region over time would follow a roughly bell-shaped curve without giving a precise formula [11]. Hubbert assumed that after fossil fuel reserves are discovered, production at first increases

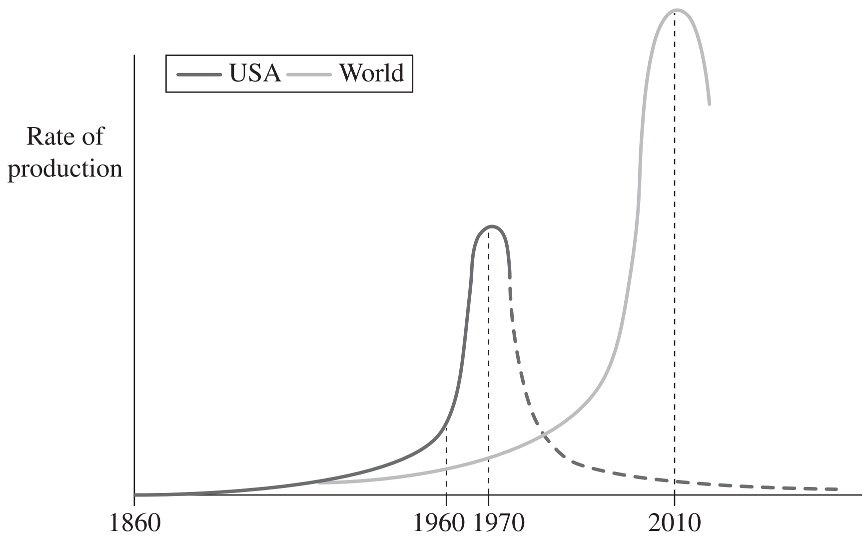


**FIGURE 1.3** Hubbert's peak.

approximately exponentially, as more extraction commences and more efficient facilities are installed. At some point, a peak output is reached, and production begins declining until it approximates an exponential decline as shown in Figure 1.3.

The Hubbert curve suggests that the oil production rate increases as more reserves are discovered, and the rate peaks when half the estimated ultimately recoverable oil is produced. This is followed by a falling production rate, all along a classic bell curve. This same analysis has shown that it took 110 years to produce about 225 billion barrels of crude oil in the United States, but half of that oil was produced in the first 100 years and the second half in the next 10 years. In the United States, Hubbert predicted that this production rate peak would be achieved in 1970, the year when half of the estimated ultimately recoverable oil was utilized, and then production would start its steady decline. That, in fact, is what happened when the United States lost its preeminence as the world's leading producer of oil and caused a spike in gasoline prices and long lines at the pumps. On a global basis, this milestone was expected to occur around the year 2010, but Hubbert was not far off as US gasoline prices were highest during the summer of 2008.

According to this analysis, the current supply of fossil fuels, and oil in particular, is not only finite but decreasing rapidly. There may, however, be undiscovered reserves that could have an impact on this analysis. In any event, the quantities of oil, gas, and coal in the Earth's subsurface are finite, and their rate of consumption must be reduced.

## CLIMATE CHANGE

A report from the United Nations Intergovernmental Panel on Climate Change (IPCC) stated that the Earth cannot tolerate more than a 3−5 °F increase in temperature. In order not to exceed this level, the carbon dioxide emissions must be reduced 60–80% of the 1990 levels by the year 2050. If you take into account the increase in population by 2050 and the corresponding increase in energy demand, to achieve this reduction is almost incomprehensible.

In 1988, the United Nations General Assembly created the IPCC with the task of reviewing and assessing the most recent scientific, technical, and socioeconomic information produced worldwide relevant to the understanding of climate change. Further, it would provide the world with a clear scientific view on the then current state of climate change and its potential environmental and socioeconomic consequences, notably the risk of climate change caused by human activity.

The first assessment report of the IPCC was presented in 1990 and along with subsequent reports led scientists to conclude that the Earth cannot tolerate more than a 3−5 °F increase in temperature. In order not to exceed this level, the carbon dioxide emissions must be reduced 60–80% of the 1990 levels by the year 2050. The first in a series of international meetings took place in 1992 in Rio de Janeiro, Brazil, called the Rio Earth Summit. As a result of that meeting, five years later, the Kyoto Protocol was adopted. It recognized that climate change was a result of greenhouse gases (GHG) created by human industrial activity. The idea was that rich nations, which had already benefited from industrialization, would reduce their GHG emissions in the first part of the treaty and developing nations would join in later. Milestones were created in various intervals through the year 2050. One of the milestones was to reduce GHG by 5% below 1990 levels by 2012. Instead, the world increased GHG by 58% above 1990 levels as the Kyoto Protocol came to an end.

At the next international meeting, which took place in Doha, Qatar, at the end of 2012, the developing countries once again demanded, as they did in Kyoto in 1997, for the rich countries to make a commitment to set real targets for reducing their GHG output. The rich nations then agreed to make some commitment toward a stronger legal agreement by 2015.

There are some scientists, while in the minority, who believe that global warming may exist and/or it is not anthropological. Regardless, reducing carbon dioxide emissions is like an insurance policy. If one assumes that global warming does exist and therefore takes the necessary action, the downside risk is minimal. If we learn in 20 years that global warming never really existed, it would have resulted in unnecessary development of renewable energy sources and possible introduction of a carbon tax. If, on the other hand, one assumes that global warming does not exist and therefore takes no action at all, what would happen if this assumption is eventually determined to be incorrect? The result on the world population could be catastrophic, with rising sea levels leading to flooding and droughts leading to dwindling food production.

## POPULATION GROWTH

Each of the environmental issues described earlier, consumption, fossil fuel reserves, water scarcity, and climate change, are all related to the world population. Figure 1.4 [12] provides a summary of the historical as well as the projected growth in population.

The world population reached one billion people in 1804, two billion in 1927, five billion in 1987, six billion in 1999, and seven billion in 2011 [13]. As can be seen, the growth in population has been accelerating and is currently at an addition of 10 million people every six weeks. Most of this growth is in the developing countries, which may not be a major problem because of the lower consumption rate. However, as indicated earlier, some of these economies are increasing as are their consumption rates. China and India are examples of such growing economies.

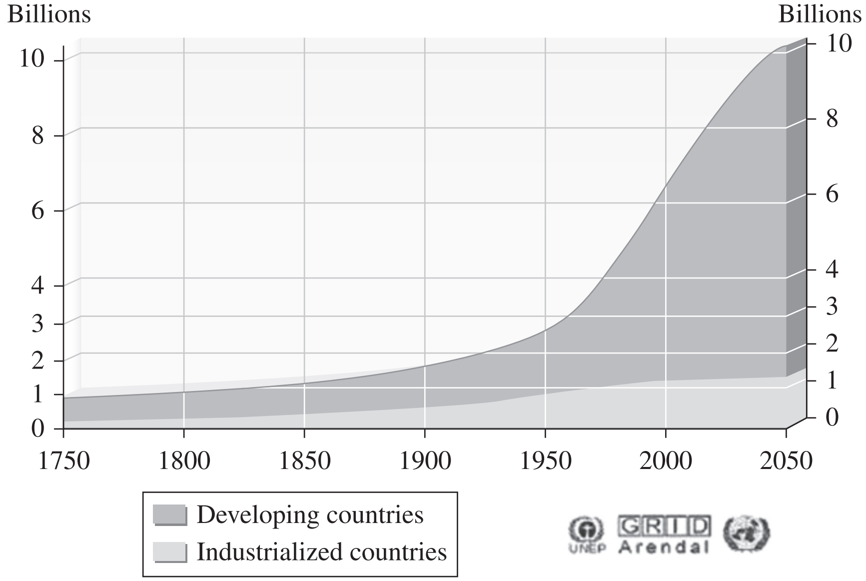


**FIGURE 1.4** World population development.

## THE ENVIRONMENT'S BIG FOUR

Today, these are the four major environmental concerns in the world, specifically:

- Water quality and quantity
- Depletion of fossil fuels
- Climate change resulting primarily from fossil fuels
- Population growth—eventually exceeding the Earth's capacity

Mitigating the impact of these four major environmental issues leads to an urgency for sustainable development.

## REFERENCES

1. Brower D. *Let the Mountains Talk, Let the Rivers Run: A Call to Those Who Would Save the Earth*. San Francisco, CA: HarperCollins; 1995.
2. The Holy Bible, *Genesis* 1: 1–31.
3. Moyers B. *Earth on Edge*. Washington, DC: World Resources Institute and Public Affairs Television, Inc.; 2002.
4. Global Footprint Network. 2011. National Footprint Accounts. Available at www.footprintnetwork.org. Accessed 2013 Jul 19.
5. Venetoulis J, Talberth J. *Ecological Footprint of Nations 2005 Update*. Oakland, CA: Redefining Progress.
6. Meadows D, Randers J, Meadows D. *The Limits to Growth: The 30-Year Update*. White River Junction, VT: Chelsea Green Publishing Company; 2004.
7. Strauss M. Got corn? *Smithsonian Magazine*, p. 25, April 2012.
8. Diamond J. What's your consumption factor? *New York Times*, January 2, 2008.
9. US Geological Survey. Available at http://en.wikipedia.org/wiki/Water_distribution_on_Earth. Accessed 2013 Jul 19.
10. Hoekstra AY, editor. Virtual water trade. Proceedings of the International Expert Meeting on Virtual Water Trade; 2003 Feb; The Netherlands: IHE Delft.
11. Hubbert MK. Nuclear energy and the fossil fuels. Presented before the Spring Meeting of the Southern District, American Petroleum Institute, San Antonio, TX; 1956 Mar 7–9.
12. GRID-Arendal. Available at http://www.grida.no/graphicslib/detail/world-population-development_29db. Accessed 2013 Jun 28.
13. US Census Bureau. Available at http://www.worldometers.info/world-population/. Accessed 2013 Jul 19.