Our environment: the sum total of our surroundings

Environment, Ecology

I. Ourenvironmentis the sum total of our surroundings A photograph of Earth reveals a great deal, but it does not convey the complexity of our environment. Our environment (a term that comes from the French environner, “ to surround”) is more than water, land, and air; it is the sum total of our surroundings. It includes all of the biotic factors, or living things, with which we interact. It also includes the abiotic factors, or nonliving things, with which we interact.

Our environment includes the continents, oceans, clouds, and ice caps you can see in thephotoof Earth from space, as well as the animals, plants, forests, and farms that comprise the landscapes around us. In a more inclusive sense, it also encompasses our built environment, the structures, urban centers, and living spaces humans have created. In its most inclusive sense, our environment also includes the complex webs of scientific, ethical, political, economic, and social relationships and institutions that shape our daily lives.

From day to day, people most commonly use the term environment in the first, narrow sense—of a nonhuman or “ natural” world apart from human society. This connotation is unfortunate, because it masks the very important fact that humans exist within the environment and are a part of nature. As one of many species of animals on Earth, we share with others the same dependence on a healthy functioning planet. The limitations of language make it all too easy to speak of “ people and nature,” or “ human society and the environment,” as though they are separate and do not interact.

However, the fundamental insight of environmentalscienceis that we are part of the natural world and that our interactions with other parts of it matter a

great deal. II. Environmental science explores interactions between humans and our environment Appreciating how we interact with our environment is crucial for a well-informed view of our place in the world and for a mature awareness that we are one species among many on a planet full of life.

Understanding our relationship with the environment is also vital because we are altering the very natural systems we need, in ways we do not yet fully comprehend. We depend utterly on our environment for air, water, food, shelter, and everything else essential for living. However, our actions modify our environment, whether we intend them to or not. Many of these actions have enriched our lives, bringing us longer life ps, betterhealth, and greater material wealth, mobility, and leisure time. However, these improvements have often degraded the natural systems that sustain us.

Impacts such as air andwater pollution, soil erosion, and species extinction can compromise human well-being, pose risks to human life, and threaten our ability to build a society that will survive and thrive in the long term. The elements of our environment were functioning long before the human species appeared, and we would be wise to realize that we need to keep these elements in place. Environmental science is the study of how the natural world works, how our environment affects us, and how we affect our environment.

We need to understand our interactions with our environment because such knowledge is the essential first step toward devising solutions to our most pressing environmental problems. Many environmental scientists are taking this next step, trying to apply their knowledge to develop solutions to the many environmental challenges we face. It can be daunting to reflect on the

sheer magnitude of environmental dilemmas that confront us today, but with these problems also come countless opportunities for devising creative solutions.

The topics studied by environmental scientists are the most centrally important issues to our world and its future. Right now, global conditions are changing more quickly than ever. Right now, through science, we as a civilization are gaining knowledge more rapidly than ever. And right now, the window of opportunity for acting to solve problems is still open. With such bountiful challenges and opportunities, this particular moment in history is indeed an exciting time to be studying environmental science. III. Natural resources are vital to our survival

An island by definition is finite and bounded, and its inhabitants must cope with limitations in the materials they need. On our island, Earth, human beings, like all living things, ultimately face environmental constraints. Specifically, there are limits to many of our natural resources, the various substances and energy sources we need to survive. Natural resources that are virtually unlimited or that are replenished over short periods are known as renewable natural resources. Some renewable resources, such as sunlight, wind, and wave energy, are perpetually available.

Others, such as timber, food crops, water, and soil, renew themselves over months, years, or decades, if we are careful not to use them up too quickly or destructively. In contrast, resources such as mineral ores and crude oil are in finite supply and are formed much more slowly than we use them. These are known as nonrenewable natural resources. Once we use them up, they are no longer available. We can view the renewability of natural resources as

a continuum (Figure 1. 1). Some renewable resources may turn nonrenewable if we overuse them.

For example, overpumping groundwater can deplete underground aquifers and turn a lush landscape into a desert. Populations of animals and plants we harvest from the wild may be renewable if we do not overharvest them but may vanish if we do. In recent years, our consumption of natural resources has increased greatly, driven by rising affluence and the growth of the largest human population in history. IV. Human population growth has shaped our relationship with natural resources For nearly all of human history, only a few million people populated Earth at any one time.

Although past populations cannot be calculated precisely, Figure 1. 2 gives some idea of just how recently and suddenly our population has grown beyond 6 billion people. Two phenomena triggered remarkable increases in population size. The first was our transition from a hunter-gatherer lifestyle to an agricultural way of life. This change began to occur around 10, 000 years ago and is known as the agricultural revolution. As people began to grow their own crops, raise domestic animals, and live sedentary lives in villages, they found it easier to meet their nutritional needs.

As a result, they began to live longer and to produce more children who survived to adulthood. The second notable phenomenon, known as the industrial revolution, began in the mid-1700s. It entailed a shift from rural life, animal-powered agriculture, and manufacturing by craftsmen, to an urban society powered by fossil fuels (nonrenewable energy sources, such as oil, coal, and natural gas, produced by the decomposition and fossilization of ancient life). The industrial revolution introduced improvements in sanitation

and medicaltechnology, and it enhanced agricultural production with fossil-fuel-powered equipment and synthetic fertilizer.

Thomas Malthus and population growth At the outset of the industrial revolution in England, population growth was regarded as a good thing. For parents, high birth rates meant more children to support them in old age. For society, it meant a greater pool of labor for factory work. British economist Thomas Malthus (1766–1834) had a different opinion. Malthus claimed that unless population growth were controlled by laws or other social strictures, the number of people would outgrow the available food supply until starvation, war, or disease arose and reduced the population (Figure 1.). Malthus's most influential work, An Essay on the Principle of Population, published in 1798, argued that a growing population would eventually be checked either by limits on births or increases in deaths. If limits on births (such as abstinence and contraception) were not implemented soon enough, Malthus wrote, deaths would increase through famine, plague, and war. Malthus's thinking was shaped by the rapid urbanization and industrialization he witnessed during the early years of the industrial revolution, but debates over his views continue today.

As we will see in Chapter 8 and throughout this book, global population growth has indeed helped spawn famine, disease, and social and political conflict. However, increasing material prosperity has also helped bring down birth rates—something Malthus did not foresee. Paul Ehrlich and the " population bomb" In our day, biologist Paul Ehrlich of Stanford University has been called a " neo-Malthusian" because he too has warned that population growth will have disastrous effects on human welfare.

In his 1968 book, The Population Bomb, Ehrlich predicted that the rapidly increasing human population would unleash widespread famine and conflict that would consume civilization by the end of the 20th century. Like Malthus, Ehrlich argued that population was growing much faster than our ability to produce and distribute food, and he maintained that population control was the only way to prevent massive starvation and civil strife. Although human population nearly quadrupled in the past 100 years—the fastest it has ever grown (see Figure1. a)—Ehrlich's predictions have not materialized on the scale he predicted. This is due, in part, to agricultural advances made in recent decades. As a result, Ehrlich and other neo-Malthusians have revised their predictions accordingly and now warn of a postponed, but still impending, global crisis. V. Resource consumption exerts social and environmental impacts Population growth affects resource availability and is unquestionably at the root of many environmental problems. However, the growth in consumption is also to blame.

The industrial revolution enhanced the material affluence of many of the world's people by considerably increasing our consumption of natural resources and manufactured goods. Garrett Hardin and the " tragedy of the commons" The late Garrett Hardin of the University of California, Santa Barbara, disputed the economic theory that unfettered exercise of individual self-interest will serve the public interest. According to Hardin's best-known essay, " The Tragedy of the Commons," published in the journal Science in 1968, resources that are open to unregulated exploitation will eventually be depleted.

Hardin based his argument on a scenario described in a pamphlet published in 1833. In a public pasture, or “ common,” that is open to unregulated grazing, Hardin argued, each person who grazes animals will be motivated to increase the number of his or her animals in the pasture. Ultimately, overgrazing will cause the pasture’s food production to collapse (Figure 1. 4). Because no single person owns the pasture, no one has incentive to expend effort taking care of it, and everyone takes what he or she can until the resource is depleted.

Some have argued that private ownership can address this problem. Others point to cases in which people sharing a common resource have voluntarily organized and cooperated in enforcing its responsible use. Still others maintain that the dilemma justifies government regulation of the use of resources held in common by the public, from forests to clean air to clean water. Weighing the issues:| The Tragedy of the Commons| Imagine you make your living fishing for lobster. You are free to boat anywhere and set out as many traps as you like.

Your harvests have been good, and nothing is stopping you from increasing the number of your traps. However, all the other lobster fishers are thinking the same thing, and the fishing grounds are getting crowded. Catches decline year by year, until one year the fishery crashes, leaving you and all the others with catches too meager to support your families. Some of your fellow fishers call for dividing the waters and selling access to individuals plot-by-plot. Others urge the fishers to team up, set quotas among themselves, and prevent newcomers from entering the market.

Still others are imploring the government to get involved and pass laws regulating how much fishers can catch. What do you think is the best way to combat this tragedy of the commons and restore the fishery? Why? | Wackernagel, Rees, and the ecological footprint As global affluence has increased, human society has consumed more and more of the planet's limited resources. We can quantify resource consumption using the concept of the " ecological footprint," developed in the 1990s by environmental scientists Mathis Wackernagel and William Rees.

The ecological footprint expresses the environmental impact of an individual or population in terms of the cumulative amount of land and water required to provide the raw materials the person or population consumes and to dispose of or recycle the waste the person or population produces (Figure 1. 5). It measures the total amount of Earth's surface " used" by a given person or population, once all direct and indirect impacts are totaled up. For humanity as a whole, Wackernagel and Rees have calculated that our species is using 30% more resources than are available on a sustainable basis from all the land on the planet.

That is, we are depleting renewable resources 30% faster than they are being replenished—like drawing the principal out of a bank account rather than living off the interest. Furthermore, people from wealthy nations have much larger ecological footprints than do people from poorer nations. If all the world's people consumed resources at the rate of North Americans, these researchers concluded, we would need the equivalent of two additional planet Earths. VI.

Environmental science can help us avoid mistakes made by past civilizations It remains to be seen whether the direst predictions of Malthus, Ehrlich, and others will come to pass for today’s global society, but we already have historical evidence that civilizations can crumble when pressures from population and consumption overwhelm resource availability. Easter Island is the classic case (see “ The Science behind the Story”), but it is not the only example. Many great civilizations have fallen after depleting resources from their environments, and each has left devastated landscapes in its wake.

The Greek and Roman empires show evidence of such a trajectory, as do the Maya, the Anasazi, and other civilizations of the New World. Plato wrote of thedeforestationand environmental degradation accompanying ancient Greek cities, and today further evidence is accumulating from research by archaeologists, historians, and paleoecologists who study past societies and landscapes. The arid deserts of today’s Middle Eastern countries were far more vegetated when the great ancient civilizations thrived there; at that time these regions were lush enough to support the very origin of agriculture.

While deforestation created deserts in temperate regions, in more tropical climates, the ancient cities of fallen civilizations became overgrown by jungle. The gigantic stone monuments of the Angkor civilization in Southeast Asia, like those of the Maya in Mexico and Central America, remained unknown to Westerners until the 19th century, and most of these cities remain covered by rainforest. Researchers have learned enough by now, however, that scientist and author Jared Diamond in his 2005 book, Collapse,

could synthesize this information and formulate sets of reasons why civilizations succeed and persist, or fail and collapse.

Success and persistence, it turns out, depend largely on how societies interact with their environments. I. People vary in their perception of environmental problems Environmental science arose in the latter half of the 20th century as people sought to better understand environmental problems and their origins. An environmental problem, stated simply, is any undesirable change in the environment. However, the perception of what constitutes an undesirable change may vary from one person or group of people to another, or from one context or situation to another.

A person’s age, gender, class, race, nationality, employment, and educational background can all affect whether he or she considers a given environmental change to be a “ problem. ” For instance, today’s industrial societies are more likely to view the spraying of the pesticide DDT as a problem than those societies viewed it in the 1950s, because today more is known about the health risks of pesticides (Figure 1. 6). At the same time, a person living today in a malaria-infested village in Africa or India may welcome the use of DDT if it kills mosquitoes that transmit malaria, because malaria is viewed as a more immediate health threat.

Thus an African and an American who have each knowledgeably assessed the pros and cons may, because of differences in their circumstances, differ in their judgment of DDT’s severity as an environmental problem. | Different types of people may also vary in their awareness of problems. For example, in many cultures women are responsible for collecting water and fuelwood. As a result, they are often the first to perceive environmental degradation

affecting these resources, whereas men in the same area simply might not “ see” the problem.

As another example, in most societies information about environmental health risks tends to reach wealthy people more readily than poor people. Thus, who you are, where you live, and what you do can have a huge effect on how you perceive your environment, how you perceive and react to change, and what impact those changes may have on how you live your life. In Chapter 2, we will examine the diversity of human values and philosophies and consider their effects on how we define environmental problems.

II. Environmental science provides interdisciplinary solutions Studying and addressing environmental problems is a complex endeavor that requires expertise from many disciplines, including ecology, earth science, chemistry, biology, economics, political science, demography, ethics, and others. Environmental science is thus an interdisciplinary field—one that borrows techniques from numerous disciplines and brings research results from these disciplines together into a broad synthesis (Figure 1. 7).

Traditional established disciplines are valuable because their scholars delve deeply into topics, uncovering new knowledge and developing expertise in particular areas. Interdisciplinary fields are valuable because their practitioners take specialized knowledge from different disciplines, consolidate it, synthesize it, and make sense of it in a broad context to better serve the multifaceted interests of society. Environmental science is especially broad because it encompasses not only the natural sciences (disciplines that study the natural world), but also the social sciences (disciplines that study human interactions and institutions).

The natural sciences provide us the means to gain accurate information about our environment and to interpret it reasonably. Addressing environmental problems, however, also involves weighing values and understanding human behavior, and this requires the social sciences. Most environmental science programs focus predominantly on the natural sciences as they pertain to environmental issues. In contrast, programs incorporating the social sciences heavily often prefer using the term environmental studies to describe theiracademicumbrella. Whichever approach one takes, these fields reflect many diverse perspectives and sources of knowledge.

Just as an interdisciplinary approach to studying issues can help us better understand them, an integrated approach to addressing problems can produce effective and lasting solutions. One example is the dramatic improvement in one aspect of air quality in the United States over the past few decades. Ever since automobiles were invented, lead had been added to gasoline to make cars run more smoothly, even though medical professionals knew that lead emissions from tailpipes could cause health problems, including brain damage and premature death.

In 1970air pollutionwas severe, and motor vehicles accounted for 78% of U. S. lead emissions. But over the following years, engineers, physicians, atmospheric scientists, and politicians all merged their knowledge and skills into a process that eventually resulted in a ban on leaded gasoline. By 1996 all gasoline sold in the United States was unleaded, and the nation’s largest source of atmospheric lead emissions had been completely eliminated. III.

Environmental science is not the same as environmentalism Although many environmental scientists are interested in solving problems, it would be incorrect to confuse environmental science with environmentalism, or environmental activism. They are not the same. Environmental science is the pursuit of knowledge about the workings of the environment and our interactions with it. Environmentalism is a social movement dedicated to protecting the natural world—and, by extension, humans—from undesirable changes brought about by human choices (Figure 1.). Although environmental scientists may study many of the same issues environmentalists care about, as scientists they attempt to maintain an objective approach in their work. Remaining free from personal or ideological bias, and open to whatever conclusions the data demand, is a hallmark of the effective scientist. We will now proceed with a brief overview of how science works and how scientists go about this enterprise that brings our society so much valuable knowledge.