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# ENVIRONMENTAL HEALTH

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From Global to Local

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## INTRODUCTION

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Howard Frumkin

Please stop reading.

That's right. Close this book, just for a moment. Lift your eyes and look around. Where are you? What do you see?

Perhaps you're in the campus library, surrounded by shelves of books, with carpeting underfoot and the heating or air-conditioning humming quietly in the background. Perhaps you're home—a dormitory room, a bedroom in a house, a suite in a garden apartment, maybe your kitchen. Perhaps you're outside, lying beneath a tree in the middle of campus, or perhaps you're on a subway or a bus or even an airplane. What is it like? How does it feel to be where you are?

Is the light adequate for reading? Is the temperature comfortable? Is there fresh air to breathe? Are there contaminants in the air—say, solvents off-gassing from newly laid carpet or a recently painted wall? Does the chair fit your body comfortably?

If you're inside, look outside. What do you see through the window? Are there trees? Buildings? Is the neighborhood noisy or tranquil? Are there other people? Are there busy streets, with passing trucks and busses snorting occasional clouds of diesel exhaust?

Now imagine that you can see even farther, to a restaurant down the block, to the nearby river, to the highway network around your city or town, to the factories and assembly plants in industrial parks, to the power plant in the distance

supplying electricity to the room you're in, to the agricultural lands some miles away. What would you see in the restaurant? Is the kitchen clean? Is the food stored safely? Are there cockroaches or rats in the back room? What about the river? Is your municipal sewage system dumping raw wastes into the river, or is there a sewage plant discharging treated, clean effluent? Are there chemicals in the river water? What about fish? Could you eat the fish? Could you swim in the river? Do you drink the water from the river?

As for the highways, factories, and power plant . . . are they polluting the air? Are the highways clogged with traffic? Are people routinely injured and killed on the roads? Are workers in the factories being exposed to hazardous chemicals or to noise or to machines that may injure them or to stress? Are trains pulling up to the power plant regularly, off-loading vast piles of coal? And what about the farms? Are they applying pesticides, or are they controlling insects in other ways? Are you confident that you're safe eating the vegetables that grow there? Drinking the milk? Are the farmlands shrinking as residential development from the city sprawls outward?

Finally, imagine that you have an even broader view. Floating miles above the earth, you look down. Do you notice the hundreds of millions of people living in wildly differing circumstances? Do you see vast megacities with millions and millions of people, and do you see isolated rural villages three days' walk from the nearest road? Do you see forests being cleared in some places, rivers and lakes drying up in others? Do you notice that the earth's surface temperature is slightly warmer than it was a century ago? Do you see cyclones forming in tropical regions, glaciers and icecaps melting near the poles?

OK, back to the book.

Everything you've just viewed, from the room you're in to the globe you're on, is part of your environment. And many, many aspects of that environment, from the air you breathe to the water you drink, from the roads you travel to the wastes you produce, may affect how you feel. They may determine your risk of being injured before today ends, your risk of coming down with diarrhea or shortness of breath or a sore back, your risk of developing a chronic disease in the next few decades, even the risk that your children or your grandchildren will suffer from developmental disabilities or asthma or cancer.

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## What Is Environmental Health?

*Merriam-Webster's Collegiate Dictionary* defines *environment*, first, in a straightforward manner as "the circumstances, objects, or conditions by which one is surrounded." The second definition it offers is more intriguing: "the complex of physical,

chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival." If our focus is on human health, we can consider the environment to be all the external (or nongenetic) factors—physical, nutritional, social, behavioral, and others—that act on humans.

A widely accepted definition of *health* comes from the constitution, crafted in 1948, of the World Health Organization (2005): "A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." This broad definition goes well beyond the rather mechanistic view that prevails in some medical settings to include many dimensions of comfort and well-being.

*Environmental health* has been defined in many ways (see Box I.1). Some definitions make reference to the relationship between people and the environment, evoking an ecosystem concept, and others focus more narrowly on addressing particular environmental conditions. Some focus on abating hazards, and others focus on promoting health-enhancing environments. Some focus on physical and chemical hazards, and others extend more broadly to aspects of the social and built environments. In the aggregate the definitions in Box I.1 make it clear that environmental health is many things: an interdisciplinary academic field, an area of research, and an arena of applied public health practice.

### Box I.1: Definitions of Environmental Health

"[Environmental health] [c]omprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations" (World Health Organization [WHO], 2004).

"Environmental health is the branch of public health that protects against the effects of environmental hazards that can adversely affect health or the ecological balances essential to human health and environmental quality" (Agency for Toxic Substances and Disease Registry, cited in U.S. Department of Health and Human Services [DHHS], 1998).

"Environmental health comprises those aspects of human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health. It includes both the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and well-being of the broad physical, psychological, social and aesthetic environment, which includes housing, urban developmental land use

and transport" (European Charter on Environment and Health; see WHO, Regional Office for Europe, 1990).

"Environmental health is the discipline that focuses on the interrelationships between people and their environment, promotes human health and well-being, and fosters a safe and healthful environment" (National Center for Environmental Health, cited in DHHS, 1998).

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## The Evolution of Environmental Health

Human concern for environmental health dates from ancient times, and it has evolved and expanded over the centuries.

### Ancient Origins

The notion that the environment could have an impact on comfort and well-being—the core idea of environmental health—must have been evident in the early days of human existence. The elements can be harsh, and we know that our ancestors sought shelter in caves or under trees or in crude shelters they built. The elements can still be harsh, both on a daily basis and during extraordinary events, as the tsunami of 2004 reminded us.

Our ancestors confronted other challenges that we would now identify with environmental health. One was food safety; there must have been procedures for preserving food, and people must have fallen ill and died from eating spoiled food. Dietary restrictions in ancient Jewish and Islamic law, such as bans on eating pork, presumably evolved from the recognition that certain foods could cause disease. Another challenge was clean water; we can assume that early peoples learned not to defecate near or otherwise soil their water sources. In the ruins of ancient civilizations from India to Rome, from Greece to Egypt to South America, archeologists have found the remains of water pipes, toilets, and sewage lines, some dating back more than 4,000 years (Rosen, [1958] 1993). Still another environmental hazard was polluted air; there is evidence in the sinus cavities of ancient cave dwellers of high levels of smoke in their caves (Brimblecombe, 1988), foreshadowing modern indoor air concerns in homes that burn biomass fuels or coal.

An intriguing passage in the biblical book of Leviticus (14:33–45) may refer to an environmental health problem well recognized today: mold in buildings. When a house has a "leprous disease" (as it is translated in the Revised Standard Version),

... then he who owns the house shall come and tell the priest, "There seems to me to be some sort of disease in my house." Then the priest shall command that they empty the house before the priest goes to examine the disease, lest all

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that is in the house be declared unclean; and afterward the priest shall go in to see the house. And he shall examine the disease; and if the disease is in the walls of the house with greenish or reddish spots, and if it appears to be deeper than the surface, then the priest shall go out of the house to the door of the house, and shut up the house seven days. And the priest shall come again on the seventh day, and look; and if the disease has spread in the walls of the house, then the priest shall command that they take out the stones in which is the disease and throw them into an unclean place outside the city; and he shall cause the inside of the house to be scraped round about, and the plaster that they scrape off they shall pour into an unclean place outside the city; then they shall take other stones and put them in the place of those stones, and he shall take other plaster and plaster the house. If the disease breaks out again in the house, after he has taken out the stones and scraped the house and plastered it, then the priest shall go and look; and if the disease has spread in the house, it is a malignant leprosy in the house; it is unclean. And he shall break down the house, its stones and timber and all the plaster of the house; and he shall carry them forth out of the city to an unclean place.”

As interesting as it is to speculate about whether ancient dwellings suffered mold overgrowth, it is also interesting to consider the “unclean place outside the city”—an early hazardous waste site. Who hauled the wastes there, and what did that work do to their health?

Still another ancient environmental health challenge, especially in cities, was rodents. European history was changed forever when infestations of rats in fourteenth century cities led to the Black Death (Zinsser, 1935; Herlihy and Cohn, 1997; Cantor, 2001; Kelly, 2005). Modern cities continue to struggle periodically with infestations of rats and other pests (Sullivan, 2004), whose control depends in large part on environmental modifications.

**Industrial Awakenings**

Modern environmental health further took form during the age of industrialization. With the rapid growth of cities in the seventeenth and eighteenth centuries, “sanitarian” issues rose in importance. “The urban environment,” wrote one historian, “fostered the spread of diseases with crowded, dark, unventilated housing; unpaved streets mired in horse manure and littered with refuse; inadequate or nonexistent water supplies; privy vaults unemptied from one year to the next; stagnant pools of water; ill-functioning open sewers; stench beyond the twentieth-century imagination; and noises from clacking horse hooves, wooden wagon wheels, street railways, and unmuffled industrial machinery” (Leavitt, 1982, p. 22).

The provision of clean water became an ever more pressing need, as greater concentrations of people increased both the probability of water contamination and the impact of disease outbreaks. Regular outbreaks of cholera and yellow fever in the eighteenth and nineteenth centuries (Rosenberg, 1962) highlighted the need for water systems, including clean source water, treatment including filtration, and distribution through pipes. Similarly, sewage management became a pressing need, especially after the provision of piped water and the use of toilets created large volumes of contaminated liquid waste (Duffy, 1990; Melosi, 2000).

The industrial workplace—a place of danger and even horror—gave additional impetus to early environmental health. Technology advanced rapidly during the late eighteenth and nineteenth centuries, new and often dangerous machines were deployed in industry after industry, and mass production became common. Although the air, water, and soil near industrial sites could become badly contaminated, in ways that would be familiar to modern environmental professionals (Hurley, 1994; Tarr, 1996; Tarr, 2002), the most abominable conditions were usually found within the mines, mills, and factories.

Charles Turner Thackrah (1795–1833), a Yorkshire physician, developed an interest in the diseases he observed among the poor in the city of Leeds. In 1831, he described many work-related hazards in a short book with a long title: *The Effects of the Principal Arts, Trades and Professions, and of Civic States and Habits of Living, on Health and Longevity, with Suggestions for the Removal of many of the Agents which produce Disease and Shorten the Duration of Life*. In it he proposed guidelines for the prevention of certain diseases, such as the elimination of lead as a glaze in the pottery industry and the use of ventilation and respiratory protection to protect knife grinders. Public outcry, and the efforts of early Victorian reformers such as Thackrah, led to passage of the Factory Act in 1833 and the Mines Act in 1842. Occupational health did not blossom in the United States until the early twentieth century, pioneered by the remarkable Alice Hamilton (1869–1970). A keen firsthand observer of industrial conditions, she documented links between toxic exposures and illness among miners, tradesmen, and factory workers, first in Illinois (where she directed that state's Occupational Disease Commission from 1910 to 1919) and later from an academic position at Harvard. Her books, including *Industrial Poisons in the United States* (1925) and *Industrial Toxicology* (1934), helped establish that workplaces could be microenvironments that threatened worker health.

A key development in the seventeenth through nineteenth centuries was the quantitative observation of population health—the beginnings of epidemiology. With the tools of epidemiology, observers could systematically attribute certain diseases to certain environmental exposures. John Graunt (1620–1674), an English merchant and haberdasher, analyzed London's weekly death records—the *bills*

of mortality—and published his findings in 1662 as *Natural and Political Observations Upon the Bills of Mortality*. Graunt's work was one of the first formal analyses of this data source and a pioneering example of demography. Almost two centuries later, when the British Parliament created the Registrar-General's Office (now the Office of Population Censuses and Surveys) and William Farr (1807–1883) became its compiler of abstracts, the link between vital statistics and environmental health was forged. Farr made observations about fertility and mortality patterns, identifying rural-urban differences, variations between acute and chronic illnesses, and seasonal trends, and implicating certain environmental conditions in illness and death. Farr's 1843 analysis of mortality in Liverpool led Parliament to pass the Liverpool Sanitary Act of 1846, which created a sanitary code for Liverpool and a public health infrastructure to enforce it.

If Farr was a pioneer in applying demography to public health, his contemporary Edwin Chadwick (1800–1890) was a pioneer in combining social epidemiology with environmental health. At the age of thirty-two, Chadwick was appointed to the newly formed Royal Commission of Enquiry on the Poor Laws, and helped reform Britain's Poor Laws. Five years later, following epidemics of typhoid fever and influenza, he was asked by the British government to investigate sanitation. His classic report, *Sanitary Conditions of the Labouring Population* (1842), drew a clear link between living conditions—in particular overcrowded, filthy homes, open cesspools and privies, impure water, and miasmas—and health, and made a strong case for public health reform. The resulting Public Health Act of 1848 created the Central Board of Health, with power to empanel local boards that would oversee street cleaning, trash collection, and water and sewer systems. As sanitation commissioner, Chadwick advocated such innovations as urban water systems, toilets in every house, and transfer of sewage to outlying farms where it could be used as fertilizer (Hamlin, 1998). Chadwick's work helped establish the role of public works—essentially applications of sanitary engineering—to protecting public health. As eloquently pointed out by Thomas McKeown (1979) more than a century later, these interventions were to do far more than medical care to improve public health and well-being during the industrial era.

The physician John Snow (1813–1858) was, like William Farr, a founding member of the London Epidemiological Society. Snow gained immortality in the history of public health for what was essentially an environmental epidemiology study. During an 1854 outbreak of cholera in London, he observed a far higher incidence of disease among people who lived near or drank from the Broad Street pump than among people with other sources of water. He persuaded local authorities to remove the pump handle, and the epidemic in that part of the city soon abated. (There is some evidence that it may have been ending anyway, but this does not diminish the soundness of Snow's approach.) Environmental

epidemiology was to blossom during the twentieth century (see Chapter Three) and provide some of the most important evidence needed to support effective preventive measures.

Finally, the industrial era led to a powerful reaction in the worlds of literature, art, and design. In the first half of the nineteenth century, Romantic painters, poets, and philosophers celebrated the divine and inspiring forms of nature. In Germany painters such as Caspar David Friedrich (1774–1840) created meticulous images of the trees, hills, misty valleys, and mercurial light of northern Germany, based on a close observation of nature, and in England Samuel Palmer (1805–1881) painted landscapes that combined straightforward representation of nature with religious vision. His countryman John Constable (1776–1837) worked in the open air, painting deeply evocative English landscapes. In the United States, Hudson River School painters such as Thomas Cole (1801–1848) took their inspiration from the soaring peaks and crags, stately waterfalls, and primeval forests of the northeast. At the same time, the New England transcendentalists celebrated the wonders of nature. “Nature never wears a mean appearance,” wrote Ralph Waldo Emerson (1803–1882) in his 1836 paean, *Nature*. “Neither does the wisest man extort her secret, and lose his curiosity by finding out all her perfection. Nature never became a toy to a wise spirit. The flowers, the animals, the mountains, reflected the wisdom of his best hour, as much as they had delighted the simplicity of his childhood.” Henry David Thoreau (1817–1862), like Emerson a native of Concord, Massachusetts, rambled from Maine to Cape Cod and famously lived in a small cabin at Walden Pond for two years, experiences that cemented his belief in the “tonic of wildness.” And America’s greatest landscape architect, Frederick Law Olmsted (1822–1903), championed bringing nature into cities. He designed parks that offered pastoral vistas and graceful tree-lined streets and paths, intending to offer tranquility to harried people and to promote feelings of community. These and other strands of cultural life reflected yet another sense of “environmental health,” forged in response to industrialization: the idea that pristine environments were wholesome, healthful, and restorative to the human spirit.

### The Modern Era

The modern field of environmental health dates from the mid-twentieth century, and perhaps no landmark better marks its launch than the 1962 publication of Rachel Carson’s *Silent Spring*. *Silent Spring* focused on DDT, an organochlorine pesticide that had seen increasingly wide use since the Second World War. Carson had become alarmed at the ecosystem effects of DDT; she described how it entered the food chain and accumulated in the fatty tissues of animals, how it

