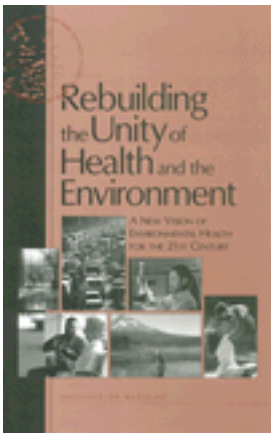

Rebuilding the Unity of Health and the Environment: A New Vision of Environmental Health for the 21st Century

Kathi Hanna and Christine Coussens, A Workshop Summary for the Roundtable on Environmental Health Sciences, Research, and Medicine, Division of Health Sciences Policy

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A NEW VISION OF ENVIRONMENTAL HEALTH FOR THE 21ST CENTURY

Kathi Hanna and Christine Coussens

A Workshop Summary for the
Roundtable on Environmental Health Sciences, Research, and Medicine
Division of Health Sciences Policy
INSTITUTE OF MEDICINE

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—Goethe

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Preface

It has been 3 months since the workshop on *Rebuilding the Unity of Health and the Environment: A New Vision of Environmental Health for the 21st Century,* and the quality of discussions by both the speakers and the participants still impresses me. It is only appropriate that at the dawn of the new millennium, we stop and examine environmental health. Current environmental health concerns are conveying a sense of urgency. The time to act is now before further damage threatens our physical and emotional well-being.

The science of environmental health is a broad topic and suffers from the lack of a precise definition; it has different meanings depending on an individual's perspective. Environmental health has many facets encompassing the natural, the social, and the built environments. The visual images of the different communities and individuals shown by the speakers were powerful and conveyed the essence of the diversity of environments and environmental issues. Where this workshop was successful was in bringing together architects, psychologists, policymakers, regulatory agencies, scientists, community representatives, health care providers, state officials, industry stakeholders, and concerned citizens, allowing them to interact and hear the various perspectives on the relationship between the environment and citizen health.

While we strive to correct problems in our environment, we need to continue to reach out to all Americans. It is the public that suffers or benefits as we attempt to reach our goals. Some members of the general public and some in industry may feel that the environment is related to regulation and economics; this is not true. All environmental laws are public health laws! I remember when we passed the Clean Air Act in the 1970s, once people understood the problems

facing our access to cleaning the air and what could be done, they strongly supported the effort. The Safe Drinking Water Act provided a safe water supply for many cities throughout the United States, including Washington, D.C., and New York City. Although these are only two examples, they illustrate that environmental laws are in reality public health laws.

Our communities need to embrace a broader view of environmental health. Combating urban sprawl and CO_2 emissions are two of the immediate challenges faced by the human population. Builders, designers, psychologists, scientists, and community leaders need to rethink their approach. Solutions require innovation and forward thinking. Since the landmark legislation of the 1970s, considerable research has been done. The foundation of legislation has been laid, but we need to build on the past. Our approaches should look at what needs to be done and concentrate on how to get there. The overarching message from the workshop stated that we need to work on innovative solutions to properly handle future problems.

We have accomplished significant changes in many health-related issues, but more has to be done in the future. The Institute of Medicine's Environmental Health Sciences Roundtable was formed to provide a neutral place for debates of the current issues in environmental health. This workshop summary, prepared by Kathi Hanna and Christine Coussens, summarizes the discussions that occurred during the 2-day meeting. It is an informational document that provides a message that workshop participants can take back to our federal, state, and local agencies, companies, academic institutions, and other organizations and indeed the public itself.

Paul G. Rogers
Chair

REVIEWERS

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Eula Bingham, University of Cincinnati Medical Center

Richard Lynch, Rutgers, The State University of New Jersey

Hugh McKinnon, United States Environmental Protection Agency

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Mel Worth, Scholar-in-Residence, Institute of Medicine, who was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Foreword

Kenneth I. Shine, M.D.
President, Institute of Medicine

In looking back at the 20th century it is clear that for most of it, science was dominated by the physical sciences, particularly mathematics and physics. It is worth reminding ourselves that it was only in 1955 that Watson and Crick described the double helix, which ultimately led to the revolution in molecular biology. As an undergraduate, I took a seminar from a young assistant professor named James Watson who had just come to Harvard. In the course of that seminar we speculated on how long it would take to identify the amino acids with relation to the DNA code. We were quite confident that it would take 20 to 25 years, which is a good example of understanding something about direction and very little about velocity.

The point is that with the evolution of molecular biology in the last part of the 20th century, it has become clear that the 21st century offers remarkable opportunities in the life sciences. In trying to understand the directions that the life sciences will take, it is worthwhile to note that the last part of the 20th century was about reductionism in science, that is, knowing more and more about smaller and smaller components of the biological phenomenon, down to the molecular level. I believe we will see a reverse movement toward looking at systems and organs, for example, understanding the structure of gene products, and using the capacity of powerful computers to model not only proteins, but ultimately the environment in which the proteins live and the organization of the cell, organ, and the human body.

A second major trend will be melding other disciplines with the life sciences. We know that much illness is related to behavior, and as a result, the social and behavioral sciences will play an increasing role in preventing and treating disease in the 21st century. Consequently, we have to make substantial

investments in research that aims to understand human behavior and its relationship to disease and health. In addition, as the border between public health and medicine becomes increasingly blurred, there is a greater need for the disciplines to work with and understand each other. The same kinds of challenges exist with regard to environmental health; that is, there is a critical need to bring together a variety of medical specialties in activities that will further the science, education, and health of the community.

Contents

Rebuilding the Unity of Health and the Environment

Summary

This is a summary of the workshop *Rebuilding the Unity of Health and the Environment: A New Vision of Environmental Health for the 21st Century*. The goal of this workshop was to emphasize the connection between human health and the natural, built, and social environments. This workshop integrated talks from many fields and created a dialogue among various environmental health stakeholders. The language presented in this respect should not be viewed as an endorsement by the Environmental Health Sciences Roundtable or the Institute of Medicine of what action is needed for the future, but rather as an effort to synthesize the various perspectives presented.

The introductory presentations laid the overarching arguments for sponsoring the workshop. These talks highlighted that many individuals believe that a new vision is needed because the infrastructure for linking environmental health and public health is not working as well as it should. Commonly one finds that environmental health at the local level has become narrowly focused, very much defined around regulations and the attendant regulatory debate. Instead, asserted many workshop participants, environmental health needs to be concerned with establishing and maintaining a healthy livable environment for humans and other species. This environment must coexist with a setting in which population growth, manufacturing, and agriculture can thrive.

Twenty years of research since the Safe Drinking Water Act of 1974, the Clean Air Act Amendments of 1977, the Clean Water Act of 1977, and the Superfund statute of 1980 have provided a wealth of new knowledge, including the special vulnerability of children. Yet scientists and policymakers have not drawn the clear connections between education, health, and the environment, asserted

keynote speaker Timothy Wirth, president of the United Nations Foundation. Money has not been invested in the research needed to build on the accomplishments of the 1970s, said Lynn Goldman of Johns Hopkins University. Despite a near doubling in the size of the National Institutes of Health budget, there has not been a comparable increase in the investment in public and environmental health—particularly in the area of prevention, she noted. Several speakers highlighted a number of challenges we face in the future, including population growth, urban sprawl, and energy use.

Many speakers emphasized that the natural environment and human health have strong connections. Research has demonstrated this connection, and our own behavior reflects this link: people flock to our national parks and zoos, and pet ownership remains high year after year. Many Americans search for solitude or a place to commune with nature. As urban sprawl continues, communities increasingly are relying on federally owned land as a place to provide much needed green space, according to David Hayes, U.S. Department of the Interior. He noted that this is providing an increasing strain on the environment, and other speakers, such as Mayor J. Christian Bollwage of Elizabeth, New Jersey, emphasized the need to protect our green space.

Advances in the field of environmental health have taught us much about human health hazards. For example, air pollution can cause respiratory disease, heavy metals can cause neurotoxicity, and global climate change is likely to fuel the spread of infectious disease, said Howard Frumkin, Rollins School of Public Health. Thomas Lovejoy of the World Bank spoke about how biodiversity is a necessity for human health. For example, many microbes are essential for cleaning up environmental health hazards, while other organisms provide vital products (e.g., cyclosporin) for use in the treatment of human disease. The challenges of pollution control, sustainability, and maintaining biodiversity will require a more holistic and integrated approach to assessing and redressing the impact of the environment on human health.

The built environment—that is, the environment designed and constructed by humans—presents as many opportunities as challenges to environmental health, according to many speakers. Cities and designers have created places in which we work and live as if the individuals will leave and move to a new place, noted William McDonough, University of Virginia. Several speakers asserted that modern society needs to develop a new strategy, assigning a true value to building materials and embracing the notion that everything can be recycled. For example, interior environments should be designed with human needs and health in mind; people should be provided with natural daylight and fresh air that can be delivered under their control.

Providing a healthy environment must extend to all people regardless of race, socioeconomic status, or location, said several speakers. Thirty years after studies documented the toxicity of lead, childhood lead poisoning still occurs, noted Mindy Fullilove of Columbia University. She added that false dichotomies often are constructed when trying to resolve environmental issues in the built environment, such as jobs versus the environment or jobs versus health.

Nancy Adler, University of California, San Francisco, addressed the added adverse impact of poverty beyond environmental stress; poorer neighborhoods tend to have few doctors and pharmacies, inadequate transportation, unsafe or inconvenient recreational facilities, and low availability of affordable, healthy food. Add to this the destruction of a community as a result of an environmental insult, and there is a loss of a sense of community, said Fullilove. Communities store things in their common memories, and this is lost when a community is destroyed. The challenge, according to speakers and panelists, is to ensure equal enforcement of laws and regulations, and involve members of the community, regardless of economic status, early on in the process of remediation.

Historically, the role of people and social activity as part of the environment has received less attention but is the most immediate proximate cause of many adverse consequences to the environment and health, according to several speakers. For example, the United States has experienced an increase in obesity in recent years, which has direct connections to our health and the environments we have created, said Bill Dietz of the Centers for Disease Control and Prevention. Many of the speakers pointed to a need to feel safe in neighborhoods as a way to increase physical activity, for example, creating connectivity in the built environment (direct paths for getting from one place to another). Increased community planning and promotion of physical activity were suggested as two ways to encourage better exercise habits.

All speakers highlighted the central conclusion that improving our health through a better environment requires the cooperation of many stakeholders outside traditional health care systems. The speakers and panelists discussed many ideas and actions. The challenge remains for the various stakeholders to collaborate in actively rebuilding the environment to promote better health for all species.

1

Introduction

REMARKS AND CHARGE TO PARTICIPANTS

Samuel H. Wilson, M.D.
Deputy Director, National Institute of Environmental Health Sciences

This workshop was designed to assist the Institute of Medicine's (IOM) Roundtable on Environmental Health Sciences, Research, and Medicine in clarifying the scope of the term environmental health. The presentations and discussions will help to define and shape the future Roundtable activities and outreach. This talk will focus on the working goals of environmental health and the challenges faced by individuals both now and in the future. At the conclusion of this talk, we will discuss the charge to the speakers and participants.

The goals of environmental health include the following: (1) establishing and maintaining a healthy livable environment for humans and other species and (2) promoting an environment that improves well-being and a high quality of mental health. In addition, this environment must be sustained into the future and be a setting in which population growth, manufacturing, and agriculture can thrive. We all recognize that in recent decades, many important achievements have helped create a cleaner, healthier environment, yet our national needs in environmental health are not being fully met. The infrastructure for linking environmental health and public health is not working as well as it should. Moreover, environmental health at the local level has become narrowly focused, very much defined around regulations and the attendant regulatory debates.

A key to success in the future is to define broader environmental health goals that call for better linking of environmental and public health. There is no doubt that environmentally related diseases will continue to pose problems in the future. The amount of chemical and biological waste generated by human activity will increase, the total environmental burden will grow due to population growth and industrial development, and pollution will continue to be gener

ated in all parts of the world. Failure to understand and manage this environmental challenge could have truly disastrous consequences.

The charge to the workshop speakers and participants is that environmental health in the future requires an expanded vision, which is the focus of this workshop, specifically:

- What are the approaches that will maintain and extend environmental health beyond the traditional regulatory approach?
- What are the approaches for building environments that actively improve human health?
- How can we obtain the involvement and leadership of citizens, business leaders, public health workers, and others in addressing environmental health at the local community level?
- What new mechanisms are needed to realize the breadth of environmental health?
- How can we raise awareness and promote community-based environmental health?
- How can we build educational approaches, federal and state programs, and economic incentives to enhance environmental health?
- How can we encourage university scientists to participate in developing effective environmental regulations?
- How can we promote environmental health that is both sensitive to the needs of local communities and flexible enough to allow a range of approaches?
- Finally, how can we integrate environmental health with pressing economic development and social issues and changes in the global environment?

This talk has posed many open-ended questions that are intrinsically very difficult to answer. Nevertheless, these questions will form the framework for the workshop discussions. The challenge will then be to the leadership of the federal environmental agencies and other leading thinkers in this field to look for answers to these questions and to help us all move forward with the challenges facing the field of environmental health.

STATEMENT OF WORKSHOP OBJECTIVES

Lynn R. Goldman, M.D., M.P.H.
The Johns Hopkins School of Public Health

The title of this workshop is *Rebuilding the Unity of Health and the Environment: A New Vision of Environmental Health for the 21st Century.* Why do we need a new vision? First, the local infrastructure for delivering environmental health is not working. It is overtaxed; in so many communities, the demands on public health simply to deliver medical services to the poor have overshadowed almost all public health functions. Very little has been done to rebuild and repair that system, yet evidence is solid that the public strongly supports public health,

particularly environmental health. Despite this support, there is little doubt that in this country the science issues in environmental health and the functions of our environmental regulatory system are extremely adversarial. Too often we are fighting with each other rather than searching for solutions to problems.

Those in the profession of environmental health are very much a part of the problem. All too often we are not engaged in the real issues in environmental health—such as land and energy use, transportation, and consumption. Rather, we tend to focus narrowly on specific issues—for example, the question of which oxygenate should be present in fuel—rather than on the question of how to reduce pollution from our transportation system and energy use. So although we are focused on the details of how to ensure environmental health, we have lost sight of the big picture.

There are some positive signs of change in federal agencies, such as the environmental justice initiatives, urban health centers, and children's health centers at the National Institute of Environmental Health Sciences. In addition, the Centers for Disease Control and Prevention and the Healthy People 2010 plan define objectives for environmental health protection using public health goals that can be tracked. However, these efforts do not go far enough. During the last decade, despite a near doubling in the size of the National Institutes of Health budget, there has not been a comparable increase in the investment in public and environmental health, particularly in the area of prevention.

One of the great challenges facing environmental health is population growth. According to the recent National Research Council (1999) report, *Our Common Journey: A Transition Toward Sustainability,* we need to begin today and have only two generations in which to complete action in order to cope with the changes associated with the enormous success that we have had as a species on this planet. While we have a strong infrastructure for building a global economy, we do not have the necessary infrastructure for managing the environmental impacts of that economy. This workshop aims to address the connections between human health and the natural environment.

Another issue is the relationship between human health and the built environment; this is where the discussions must focus on acting locally. Most of the things that need to be done to address environmental issues, even global problems, have to be done at a local level. We need to understand the environmental consequences of how we build our homes, buildings, and cities.

The social environment and its impact on human health also deserve consideration. Because it is our species that is shaping the evolution of the planet, the major problems that face us frequently involve human behavior. Thus, we must find better ways of educating the population about consumption and resource use. We need to recognize the broad range of people who are involved in environmental health, especially the general public and communities at all levels.

We have only two generations in which to act. This means that we and the next generation will shoulder much of the responsibility for solving the problems that we have both inherited and created. We need nothing less than a new vision of environmental health for the 21st century.

2

Keynote Address

ENVIRONMENT AND HEALTH: A CONNECTION TO THE CURRENT DEBATE

Timothy E. Wirth
President, United Nations Foundation

Significant progress has been made in addressing environmental health concerns since the Cuyahoga River caught fire in 1969, including the Rio Conference in 1992 and the 1994 Cairo Conference on Population, where over 180 countries came together and developed an aggressive program of action concerning the urgent need to stabilize the globe's population.

The environment has entered the political lexicon; most leaders at least acknowledge the issue, if for no other reason than fear of the environmental constituency. In the United States, in an amazingly short period of time in the 1970s, we passed a number of bills designed to protect our air, water, and soil. In slightly more than 6 years, Congress laid the groundwork for what is still the most sophisticated framework of environmental law and regulation constructed by any nation, including the following:

- *The Safe Drinking Water Act of 1974* was designed to set basic federal standards for drinking water quality in response to an avalanche of data showing that state and local governments were failing to protect the public from water-borne diseases, chemicals, and heavy metals.
- *The Clean Air Act Amendments of 1977* established the regulatory structure and an enforceable timetable for reducing urban air pollution, when the serious public threats presented by ozone and particulate matter were being quantified for the first time.
- *The Clean Water Act of 1977* sought to make rivers and lakes safe for fishing and swimming.

- *The Superfund statute* enacted in 1980, in response to Love Canal and Times Beach, to protect communities from the health dangers of hazardous waste disposal sites.
- *The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)* and the Toxic Substance Control Act *(TSCA,* pronounced *Tosca)* enacted in 1972 and 1976, respectively, to require analysis of chemicals to which the public might be exposed through food or other pathways.

It is striking, however, how little policy progress has been made in the years since, even though we were then proceeding on the most rudimentary scientific knowledge about the highly complex relationship between the environment and public health. Our policy proposals were correspondingly crude, with a heavy focus on protecting adult Americans from pathogens and carcinogens. Now we know so much more, and we are doing so much less.

For example, 20 years of research have produced a wealth of new knowledge, an enormous amount of it pointing to the special vulnerability of children to their environment. Yet politicians and policymakers have yet to lead the public by drawing clear connections among education, health, and the environment.

Over the past decade, environmental health research has revealed that infancy and the prenatal period are critical in the development of intellectual capacity. As the brain develops, critical micronutrients and the corrosive effects of microcontaminants that function as neurotoxins have long-lasting impacts, and children can be permanently deprived of their intellectual potential. Examples include the health effects of iodine, zinc, and iron deficiencies; and elevated blood levels of and fetal exposure to mercury, polychlorinated biphenyls (PCBs), and common pesticides.

A growing body of evidence shows that far lower levels of some neurotoxins can have more serious impacts on intelligence and behavior than anyone had previously believed. In addition, new research has raised substantial concerns about these contaminants' contributions to a wave of behavioral disorders now affecting our schools. These range from attention deficit hyperactivity disorder, to aggression, to impulsive behavior.

These disabilities are clearly the result of complex interactions among genetic, environmental, and social factors, and their apparent increased prevalence is, in part, due to improved detection or record keeping. Yet, these trends are still disturbing and should be part of any discussion about education and health. Because children's special vulnerability to microcontaminants has become clear only in the past 15 years, virtually all of our exposure standards for neurotoxins are failing to protect American children. Fifteen years ago, we were largely ignorant about the lower thresholds at which children are sensitive to toxic exposures, due to lower body weight and other factors; the multiple pathways through which children are exposed to a chemical, resulting in an increased cumulative exposure far above safe levels; and the synergistic effects of multiple chemical exposures.

We were also in the dark about the massive amounts of neurotoxins being released in the United States every year. More than a billion pounds of neurotoxins were released by large industrial facilities into the air, the water, and on land. Even after all we have learned about the danger of lead, Massachusetts' data showed that the use of lead in manufacturing increased 77 percent in that state alone from 1990 to 1997.

Moreover, the reach of many of these chemicals is global. For example, Inuit mothers in the Arctic, far from sources of industrial pollution, show some of the highest worldwide levels of PCBs in their breast milk as a result of a diet high in fat from marine mammals, as the toxins emitted at lower latitudes moved up the food chain.

The costs to society of impaired learning capacity in children because of environmental contamination are difficult to measure, but we know that the cumulative loss of intellectual capacity is tragic not only at the personal level, but at the societal level. Moreover, the social costs of caring for a larger fraction of the population classified as mentally retarded far exceeds the cost of the needed environmental protection and prevention. For example, the elimination of lead from gasoline and paint may be one of the most significant educational advances of the 20th century. Research results equate a 10-point drop in blood lead levels with an average 2.8-point gain in IQ. Since the elimination of lead from gasoline in the United States, we have witnessed a 15-point drop in blood lead levels. This gives every baby born today a gift of 4–5 additional IQ points. What is this worth economically?

These concerns extend around the globe. UNICEF estimates that around the world, iodine deficiency has produced lowered mental ability in some 300 million people. In many, if not most, of the large cities in the developing world, the percentage of children affected by lead poisoning is staggering; in some African cities, it is as high as 90 percent.

These issues also tap a deep well of social injustice. While lead poisoning, inadequate nutrition, and exposure to neurotoxins cross all socioeconomic, geographic, and racial boundaries, the burden falls disproportionately on low-income families and families of color. In the United States, children from poor families are eight times more likely to be lead poisoned than children from higher-income families. African-American children are five times more likely to be lead poisoned than white children. In addition, the astonishing statistics about today's Russia grimly illustrate the health effects of a poisoned environment. The greatest legacy of the communist era will be not only the poisoned rivers, depleted soils, and toxic dumps, but also the birth defects, learning impairments, and rampant childhood diseases now overwhelming that nation's young.

This pattern is repeated internationally. Poor nutrition and greater contamination go hand in hand. Together, they reinforce for entire communities a vicious cycle of learning deficiency and poverty. The result is poor productivity and substandard lives—communities that cannot compete in the global economy. Too many nations, already pressed by appalling poverty and sharply in

creased levels of population, are simply unable to invest in the public health and nutritional measures that would halt this cycle.

These causes of intellectual decline are a potent threat to any attempt to move the world toward sustainable development. Poverty is both a cause and an effect of high birth rates. Lowered intellectual capacity leads to economic difficulties, an inability to manage the environment in a sustainable manner, increasing poverty, and high birth rates. High birth rates mean that populations grow beyond the capacity of the environment to feed them, and poor nutrition results. Poor nutrition contributes to intellectual decline, which, through illiteracy, may precipitate high birth rates and poverty.

This is a global problem, and we must respond globally, through a strong Convention on Persistent Organic Pollutants. This treaty is currently being negotiated under the auspices of the United Nations. This convention will enable measures to be taken to reduce or eliminate exposure to the most potent persistent organic pollutants now found in the environment and will also establish a framework for considering additional compounds as the science advances. The convention is about public health. It is also about intellectual development, and ultimately economic competitiveness, because virtually all of the compounds under consideration are known or suspected to interfere with developmental processes in the fetus.

We allowed too many compounds such as DDT and PCBs to move into global use before we understood their tragic consequences. The proper place to carry out experiments is not in our children's bodies or in the ecosystems of the world. It is in government, industry, and academic laboratories, resolving health questions before a chemical goes into widespread use and its recall becomes problematic.

Here at home, we are operating with a regulatory framework that is 20 years out of date, built on the rudimentary science of the 1970s. The Environmental Protection Agency (EPA) has required complete tests for developmental neurotoxicity for only 12 pesticides and has only recently begun to require further testing. Nearly 75 percent of the top high-volume industrial chemicals have undergone little or no neurotoxicity testing, despite the fact that 28 percent of the current inventory of 80,000 chemicals in commerce has neurotoxic potential. Under the 1970s SCA statute, EPA cannot require testing unless it has evidence of danger and cannot prove it has evidence of danger without testing.

Changing this increasingly dangerous situation will require a major shift in our approach to chemical regulation and in our debate over education in America. We can no longer act to protect society from the impacts of chemicals only after a scientific consensus is reached and hundreds of thousands or millions of Americans and their children have been exposed without their knowledge or consent. The disturbingly long time it has taken the federal government to act on dioxin, the most potent carcinogen identified, makes this clear. We must substitute a far more protective standard and follow the Europeans in developing a broad precautionary approach to chemical regulation. Public health, economics, and the future of our children demand it.

3

Human Health and the Natural Environment

Fifty years ago, the World Health Organization (WHO) defined health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." This definition should serve as a reminder that redefining the view of environmental health and the natural environment requires many shifts in thinking, as well as a willingness to pursue a diversity of approaches.

Advances in the field of environmental health have taught us much about human health hazards; for example, air pollution can cause respiratory disease, heavy metals can cause neurotoxicity, global climate change is likely to fuel the spread of infectious diseases. Domestically, the response has been to clean up the environment, a laudable goal, said Rafe Pomerance of Sky Trust. Environmental health issues traditionally have been addressed at the international level within the context of such issues as ozone depletion, climate change, and biodiversity. Countries have tried to address these issues through the multilateral process, such as multilateral agreements and commissions, bilateral assistance and cooperation, private sector investment, trade, the work of nongovernmental organizations, education, and training.

These efforts can be profoundly effective, asserted Pomerance; witness the reductions in the emissions of chlorofluorocarbons achieved through legislation and transnational agreements in the 1970s. Industry, especially newer companies with the capacity to design "greener" manufacturing practices, has made some inroads into environmentally friendly production. However, efforts have not been so successful in maintaining biodiversity, said Pomerance, as the world

continues to lose species on a daily basis. Challenges also remain in assuring a safe and healthful food supply.

The natural environment, broadly conceived, can also enhance health, for example, many pharmaceuticals are derived from plants and animals, providing a compelling argument for preserving biodiversity. In addition, contact with the natural world may be directly beneficial to health. If so, then the field of environmental health needs to extend beyond mere considerations of toxicity. According to the speakers, research and policy must be directed toward understanding the interactions of human health and the natural environment, from the most personal level—that is, how individuals interact with the world around them—to the global scale—that is, how nations agree to reduce pollution, pursue sound agricultural and land use practices, and feed their citizens. Each of these issues is explored below.

THE IMPORTANCE OF CONTACT WITH NATURE

A theoretical basis for the notion that contact with nature is beneficial comes from E.O. Wilson, who introduced the term *Biophilia* almost 20 years ago, defined as the innately emotional affiliation of human beings to other living organisms. From an evolutionary perspective, a deep-seated connection with the natural world should be no surprise. Humans have been evolving for more than 2 million years, yet have lived relatively insulated from nature for only the last 10,000 years. As Wilson (1993) noted, "it would be quite extraordinary to find that all learning rules related to the natural world have been erased in a few thousand years, even in the tiny minority of peoples who have existed for more than one or two generations in wholly urban environments."

This is not a new idea, claimed Howard Frumkin of Emory University. The human connection to nature and the idea that this might be a component of good health have a long and fascinating history in philosophy, art, and popular culture. There is ample evidence—from animals, plants, landscapes, and wilderness experiences—that we can build on this affiliation to enhance our health.

Animals have always played a prominent part in human life. Today, more people go to zoos each year than to all professional sporting events. More than half of all U.S. households own pets. Animals comprise more than 90 percent of the characters used in language acquisition and counting in children's preschool books. A considerable body of evidence links contact with animals to human health. According to Frumkin, preserving the bond between people and their animals, like encouraging good nutrition and exercise, appears to be in the best interests of those concerned with public health.

Exposure to plants and flowers also nourishes a sense of our well-being. In a 1998 National Gardening Survey of more than 2,000 randomly selected households, half of the respondents agreed with the statement that flowers and plants at theme parks, historic sites, golf courses, and restaurants are important to enjoyment of these locations, and 40 percent agreed with the statement that

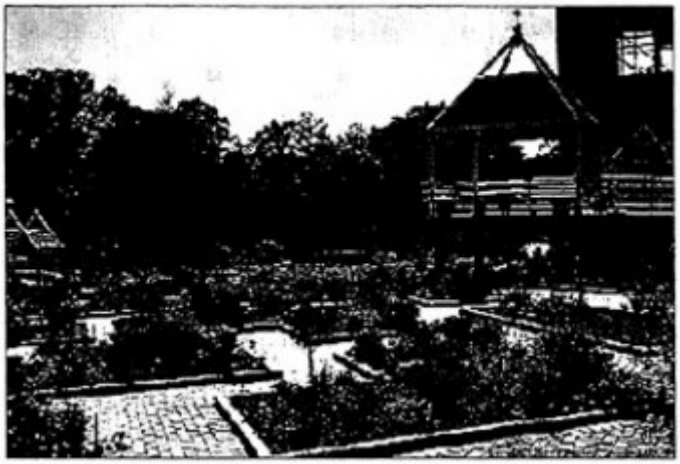


FIGURE 3-1 The addition of gardens has been shown to be essential for mental health and helps individuals recuperate after illness. SOURCE: H. Frumkin. Reprinted with permission.

being around plants makes them feel calmer and more relaxed. Office employees report similar feelings, stating that an office with plants is a more desirable place to work. Psychologist Michael Perlman has written of the psychological power of trees, as evidenced by mythology, dreams, and self-reported emotional responses. Indeed, the concept that plants have a role in mental health is fairly well established, said Frumkin. Of note, hospitals have traditionally had gardens as an adjunct to recuperation and healing. Perhaps this time-honored practice reflects a recognition that proximity to plants, like proximity to animals, may in some circumstances enhance health (see Figure 3.1).

To return to an evolutionary perspective, human history probably began on the African savanna, a region of open grasslands punctuated by scattered stands of trees and denser woods near rivers and lakes. When offered a choice of landscapes, people react most positively to savanna-like settings, with moderate to high depth or openness, relatively smooth or uniform-length grassy vegetation or ground surfaces, scattered trees or small groupings of trees, and water, a finding that is consistent across every culture studied.

This effect may extend beyond aesthetics, to restoration of health or recovery from stress. Research on recreational activities has shown that people viewing savanna-like settings report feelings of tranquility, peacefulness, or relaxation. On psychometric testing, people viewing such settings show decreased fear and anger, enhanced positive affect, and improved mental alertness, attention, and cognitive performance.

The same results emerge from studies that directly consider conventional health end points. In 1981, University of Michigan architect Ernest Moore found that “prisoners assigned at random to cells along the prison’s outside wall with a view of rolling landscape and trees, had significantly lower frequency of sick

call visits compared to those in the inside cells." Moore could not identify any design features to explain this difference and that the outside view may provide some stress reduction (Moore, 1981).

Similar observations come from health care settings. A 1984 paper in *Science* bore the provocative title *View Through a Window May Influence Recovery from Surgery.* "Postoperative patients, assigned essentially randomly to rooms with views of trees, had statistically significantly shorter hospitalizations, less need for pain medications postoperatively, and fewer negative comments in the nurses' notes, compared to patients with the brick views" (Ulrich, 1984).

Physician David Cumes has described "wilderness rapture," including self-awareness; feelings of awe, wonder, and humility; a sense of comfort in and connection to nature; increased appreciation of others; and a feeling of renewal and vigor (Cumes, 1998). These outcomes are often cited in favorable accounts of so-called wilderness therapy for a variety of psychiatric, organic, and emotional disorders. Most published studies relate to mental health end points, and although they are limited, many do suggest some benefit from wilderness experiences. Mental health has been studied more than somatic conditions, and short-term benefit has been demonstrated more than long-term benefit.

The value of wilderness is not lost on the American public, said David Hayes, U.S. Department of the Interior. The Interior Department owns about half a million acres—more than 20 percent of the land mass of the United States—through the National Park Service and the National Wildlife Refuge System. Americans rely on these for open space and recreational opportunities. According to Hayes, the Interior Department manages more than 300 million visits a year, reflecting a deeply rooted interest in our physical environment.

BIODIVERSITY AND HUMAN HEALTH

There is a powerful connection between the variety of life on earth and our own well-being, for example, the contributions of natural products to the pharmacopoeia, research, and diagnostic tools, and as indicators of pollution-related disease.

In the pharmacopoeia, the natural world is continuously offering compounds that are useful in medicine, and the search for biologically active compounds continues. Tom Lovejoy of the World Bank provided examples of this, including compounds obtained from slime molds from the banks of the Zambezi River that are effective in the treatment of tumors resistant to taxol; the immunosuppressant cyclosporin, which comes from a fungus; analgesics from tropical sea organisms and poison frogs; and lovastatin, which comes from the bacterial world.

> Biodiversity is essential for guaranteeing the healthiness of humans.
> —*Tom Lovejoy*

Natural products are often essential in both research and diagnostic tools, said Lovejoy, the prime example being the polymerase chain reaction, which

relies on a naturally occurring substance to initiate the reaction. Another example involves horseshoe crabs, the blood of which is useful in detecting certain impurities in drugs. Other species can also provide unexpected insight into our own biology; for example, a pit viper from South America has a venom that causes its victims' blood pressure to drop to zero permanently. Brazilian scientists studying this snake 20 to 30 years ago uncovered the angiotensin system of blood pressure regulation. This research eventually led to the development of a class of drugs known as ACE (angiotensin-converting enzyme) inhibitors.

Biological diversity also serves as a set of indicators of environmental change, for example, the study of endocrine-disrupting chemicals in wild species and the decline and disappearance of the world's amphibian species. Biological diversity becomes the ultimate integrator of all the things affecting living systems, said Lovejoy. An additional way in which biodiversity connects with human health is in reducing environmentally caused disease. There is an active field using biological systems, principally microbes, to clean up toxic waste problems in the environment, particularly PCBs, oil spills, and heavy metals. Biological systems increasingly are being seen as potential means of cleaning up the water supply through the restoration of watersheds.

ENSURING THE FOOD SOURCE WHILE ADDRESSING ENVIRONMENTAL HEALTH

Agriculture directly affects human health in two major ways: (1) through the environmental and ecosystem changes of farm production and (2) through an available and nutritious supply of food. According to Richard Rominger, deputy secretary of the U.S. Department of Agriculture (USDA), USDA nutrition programs help feed one in six Americans each month. Federal agricultural initiatives also aim to develop new technologies to protect the environment by shifting to lower-risk pesticides or pesticide alternatives and by conducting research on greenhouse gas and carbon storage that will affect global climate change. At the local level, USDA provides technical assistance to help private landowners with conservation practices in order to promote sustainable development. Sustainability recognizes that farmers can be productive and profitable and still be wise stewards of their lands and the environment.

> Sustainability recognizes that farmers can be productive and profitable while being wise stewards of their land and the environment.
> *—Richard Rominger*

The provisions of the 1996 Farm Bill aim to achieve environmental benefits that include soil, air, water, and wildlife habitat conservation, as well targeted efforts to preserve the health of rivers and streams. In early 2000, President Clinton proposed a conservation security program to further strengthen the economic–environmental linkage. By providing direct stewardship payments to farmers with comprehensive conservation plans, the program highlights the vol

untary and locally led aspect of private land conservation efforts. This is far bigger than just a farm issue. Society benefits from a healthy environment and the plentiful food that it produces.

One key provision of the program boosts funds to help producers with nutrient management. For example, improperly managed animal feeding operations can contribute to water pollution, outbreaks such as *Pfiesteria* in the Chesapeake watershed, or excessive runoff from dairy operations.

For agriculture, greenhouse gas emissions present some challenges and perhaps some opportunities. The U.S. Global Change Research Program has reported that the production of major crops could very likely increase with global warming, but there might also be a 20 percent increase in the use of pesticides, with an environmental impact that could be substantial. Current research is centering on agriculture's capability as a huge sink to absorb and store carbon. By sequestering carbon in agricultural soils, we could achieve more than just pulling carbon dioxide out of the atmosphere and cutting the rate of global warming, said Rominger. Increasing the soil's organic content would improve its water-holding capacity, fertility, and productivity.

While considering the impact of agricultural systems on global climate change, we must also narrow the focus to the connection between microbiological pathogens and food safety. It is estimated that 5,000 people die and 76 million get sick each year from foodborne illnesses. In the past 7 years, said Rominger, the nation's science-based inspection system has resulted in a sharp drop in the prevalence of salmonella in raw meat and poultry. Science and technology are the first line of defense against future food safety challenges, for example, via Foodnet and Pulsenet. However, certain pathogens and other microbes are evolving resistance on a global scale to traditional control methods, including antibiotics.

While food safety is a key aspect of a food-secure world, it is just part of the definition. There can be no security if food is not available and abundant and if nutritional needs are not met. "Our farmers can grow the most abundant and nutritious produce in the world," said Rominger, "but if Americans do not heed the advice of newly released dietary guidelines, their diets will still get a failing grade." This is more a matter of education than farm and agricultural policy. It is as central to the total environmental health connection as conservation measures on the farm and pathogens under the microscope.

SUMMARY

Common sense tells us that a sound environment is important to human health. However, only in recent years have science and technology provided us with ways to measure the correlation between a healthy environment and a healthy body. The natural environment in which we spend our days and the national and international community in which environmental protections must be

negotiated provide both a local and a global perspective by which to consider environmental health.

Although there clearly is an interdependence between public health and the environment, workshop participants noted that we have limited resources for identifying and understanding challenges to health or implementing intervention strategies. Some of the higher-order issues, such as sustainability, must be addressed if we are to achieve better health, noted Rafe Pomerance. Another central quandary is the reduction and disposition of waste. We cannot continue to have consumption that outweighs the production capacity of our ecosystems, and we cannot continue to produce waste at a rate that outweighs our ability to assimilate it back into the ecosystems without negative impacts, said William McDonough.

A second challenge is to develop baseline data on different environmental stressors. Impacts of a poor environment on public health can be direct or indirect. Speakers noted that we have tended historically to focus on the direct effects of pollution on public health—for example, toxicity or adverse health effects—and less on the bioindicators that can measure direct and indirect effects through impacts on ecological systems.

To meet these challenges, several workshop participants stated that we need to develop more holistic and integrated approaches to environmental health that incorporate considerations of human biological and ecological health and achieve better understanding of these interrelationships. The systems view of the ecologist must be adopted as a new paradigm for the environmental health scientist.

4

Human Health and the "Built" Environment

The "built" environment, that is, the one designed and constructed by humans, presents as many opportunities as challenges to environmental health. It also raises some of the most difficult social and political tests, because it inevitably involves issues of commerce, social justice, and community.

Clearly it is at the community level that many of the most important aspects of environmental health are being addressed. According to several workshop speakers, academic scientists must learn to convert the concerns of the community into research that is responsive; that is, they must actually work with the community in doing the research, hiring local people, creating a citizen's advisory panel, and developing a research agenda. Designers, besides taking a more responsible view of their work, have to consider human needs and health when planning the places in which we will live and work.

DESIGNING A BETTER FUTURE

A modern American society has a tendency to design its environment as if the people who will live or work in it will eventually be leaving, said William McDonough of the University of Virginia. It is time to think of a new strategy where we assign a true value to building materials and embrace the notion that everything can be recycled. Design is the first signal of human intention (Figure 4.1), said McDonough. Designers should not be negligent; they should fully understand the environment in which they are creating designs and know what is in the materials that will be used in construction. A new vision of design is to accept responsibility for the consequences of construction, to create safe objects

FIGURE 4.1 A bird flying over this GAP, Inc., office in San Bruno, California, would not know that a building is there. Designers need to plan buildings so they are part of the environment. SOURCE: GAP, Inc. Reprinted with permission.

of long-term value, and to eliminate the concept of waste—even to consider the value of waste in producing new materials. Moreover, designers also have an obligation to object to work they find unethical or offensive, and regulations should increasingly be viewed as signals of design failure.

> Waste is food—everything is a nutrient.
> —*William McDonough*

Eco-efficiency in design should not be the goal, because efficiency is not always better. Rather, design should achieve eco-effectiveness. This means that natural laws should be engaged by designers to produce, for example, fabrics that are free of toxic chemicals; carpeting that is not embedded with polyvinyl chloride (PVC), fiberglass, and nylon; athletic shoes with uppers that are infinitely recyclable, and shower gels and cosmetics that go back into the water systems and start biodegrading.

Interior environments should be designed with human needs in mind. Corporate campuses should provide people with natural daylight and fresh air delivered directly to their breathing zone under their own control. Buildings can be designed that make more energy than they need to operate with solar collectors and a living machine waste treatment plant.

SMART GROWTH

Many cities must work with what they have in order to build new businesses and create jobs because urban areas lack developable properties and

green space. Reclaiming land can raise revenues without razing the environment, and it prevents further destruction of invaluable green space that is becoming a precious commodity in many cities.

Innovative designers can also contribute to "smart growth" in urban areas. Smart growth has many positive effects on the economy, attracting new businesses, encouraging development, and making health problems easier to address in the local community. For example, in New Jersey, brownfields development has actually enhanced environmental quality and saved local governments money by reserving fiscally beneficial open space. With the threat of urban and suburban sprawl, smart growth encourages retaining communities and enabling the preservation of selected open space, while allowing the development of urban centers. Vacant lots can become ballfields, and empty buildings can house much-needed grocery stores (Box 4-1).

While some urban areas are finding ways to better use the space within their borders, many cities such as Atlanta continue to spread outward, creating sprawl that not only increases environmental pollution and overtakes green space but creates an increasingly stressful environment for its inhabitants (Figure 4.2).

There is increasing recognition that our quality of life has been diminished by the intrusion of urban sprawl and unrestrained growth, said Robert Bullard, of Clark Atlanta University. For example, when a city like Phoenix chews up 1 acre per hour, there is something wrong. When we are sitting in traffic, when we have no opportunity to pass by a forest preserve or green open space, or when

BOX 4-1 TURNING TRASH INTO CASH IN ELIZABETH, NEW JERSEY—A CASE STUDY

The city of Elizabeth, New Jersey, was an industrialized area up until the 1970s and 1980s, when manufacturing jobs were leaving the Northeast and the economy went dowhill. A 166-acre landfill took Elizabeth's solid waste up until 1972, when it was closed, leaving an environmental and health challenge for the city.

Under the leadership of Mayor J. Christian Bollwage, the site is now the location of the Jersey Gardens Mall, with 250 stores, 20 restaurants, and a planned 22-screen multiplex cinema. Development of the site required almost 20 permits under New Jersey's ECRA, or Environmental Clean Up Responsibility Act. In addition, the owner of the property acquired a consent decree, which makes clear and legally binding exactly what the remediation steps will be.

More than $216 million was spent on the land and the construction of the mall, $38 million on site improvements, and $103 million on public access and infrastructure. Educating the public about changes in the environment and the potential for redevelopment was also important. In the first 90 days of the mall's opening, 3 million people visited the location, paying only a 3 percent sales tax under legislation deeming the area an urban enterprise zone. In the future, light rail service will provide transportation to the site.

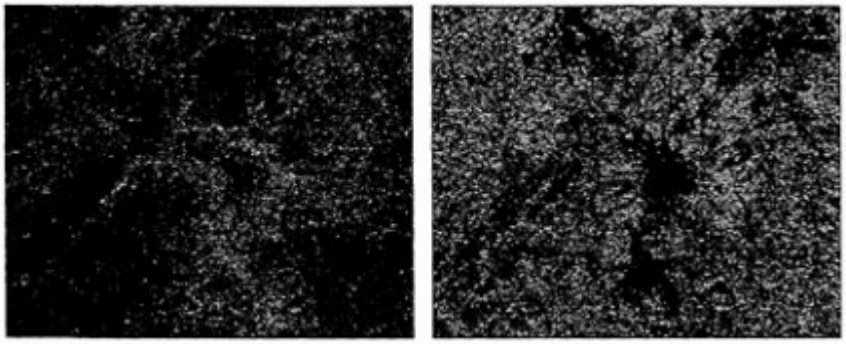


FIGURE 4.2 Atlanta's heat island. NASA scientists have discovered that Atlanta's sprawl development pattern is creating thunder storms. SOURCE: American Forests.

our children are being pushed into closer urban environments without the opportunities for play, something dire is going on. Some states are taking action.

California passed a $2 billion bond for new parks. New Jersey authorized $100 million to invest in open and green space. Georgia passed a bill that requires all counties to protect 20 percent of their land base for open and green space. At the federal level, the Conservation and Restoration Act builds on the President's lands legacy, which proposes to set aside $900 million on a mandatory basis off-budget for land acquisition and protection of special land. Clearly, the momentum has swung toward reclamation and restoration of green space, but there is more work to be done.

COHERENCE IN THE BUILT ENVIRONMENT

When talking about healthy people, healthy homes, and healthy communities, the environmental justice framework is a good place to start. The environment is where we live, work, play, and go to school, as well as comprising the physical and natural world (Figure 4.3). The concept of environmental justice embraces the principle that all communities are entitled to equal protection of their environment, and health is at the forefront of environmental justice.

Unfortunately, too often the search for environmental justices places the burden of proof on the victims, which has created a whole industry around risk assessment and risk management, where science is sometimes used as a tool to create a divide between the public and the scientific community.

In addition, merely conducting the proper scientific studies is not enough. After 30 years of studies documenting the toxicity of lead, for example, we still have childhood lead poisoning, because the major social justice issue—housing—has not been solved. In addition, false dichotomies are often constructed when trying to resolve environmental issues in the built environment—for example, jobs versus the environment or jobs versus health. What is really needed

FIGURE 4.3 Hermineo taking clothes home to his mother in their cardboard shack. Living in environments such as this wears people out. Neighborhoods like this one have problems with AIDS, drug addiction, increased mortality, and asthma. SOURCE: *No Easy Walk.* Photograph by Helen M. Stummer. Reprinted with permission.

are efforts to identify and eliminate discriminatory policies and practices; ensure equal enforcement of laws, regulations, and policies; address disparate impacts; and involve the community early on and throughout the process (Figure 4.4).

Coherence in the built environment is fundamental to the health of communities, said Mindy Fullilove, Columbia University. When neighborhoods are torn down or destroyed, more than a community is at stake. For example, the spread of the AIDS epidemic in New York City can be linked to pockets of intense poverty in the South Bronx in which the demolition of housing, followed by the closing of city and municipal services, led to the relocation of intravenous drug users to other parts of the city. The resulting social disruption increased risky health behaviors. Moreover, these individuals were infected with the AIDS virus, which led to spikes of the infection rates in the communities to which they migrated.

> A community is very hard to build up but easy to tear down.
> —*Mindy Fullilove*

We often view the destruction of a poor community as destroying nothing of any social value, but a ghetto community is still a community and a home to real people, asserted Fullilove. Communities store things in their common memory and when the community is dispersed, all of this common memory of how to live together is lost and has to be rebuilt from scratch. A community is very hard to build up but easy to tear down, reflected Fullilove, in describing the intense effort it takes to rebuild a run-down neighborhood.

In the ideal world, good community life includes appropriate socialization of children to care for the environment and the promotion of pride. Community life in urban centers is often based on communication between and among the parts of the urban environment, perhaps from window to window or front porch to front porch. In a coherent environment, people understand and carry out behaviors related to neighboring friendliness. When buildings are torn down and high-rise housing projects are constructed, it is difficult for people to maintain group life, and individual well-being is destroyed. Buildings do not necessarily make homes.

Vacant, blighted lots separate people who then have to carry on daily life without the amenities and visual landscape that make daily life easy and meaningful. This wears people out, and it is under these conditions that increases occur in all kinds of diseases, including but not limited to AIDS, drug addiction, infant mortality, and most recently, asthma. A cycle begins of decay, disinvestment, abandoned housing, increased drug use, and violence.

Some cities have taken a new approach, that is, to ensure that every single lot is tidy and a part of the neighborhood (see Figure 4.5). Lots are not abandoned, and efforts are made to ensure that poor and working people who live in the area can remain residents in the neighborhood.

EMBRACING NATURAL CAPITALISM

"Although we cannot survive without the ecosystem services that make all life possible, we do not know how to produce most of them and there is no market in them," said Amory Lovins, chief executive officer (research) of Rocky

FIGURE 4.4 Industry-induced relocation destroys communities and has profound effects on human health
SOURCE: Environmental Justice Resource Center, Clark Atlanta University. Reprinted with permission.

Mountain Institute. "Yet we can behave *as if* they were properly valued—without needing to know their actual value—and thereby make business far more successful, both economically and environmentally."

FIGURE 4.5 Manchester, New Hampshire, and other cities have taken a new approach to ensure that every single lot is tidy, green, and part of the neighborhood. SOURCE: M. Fullilove. Reprinted with permission.

We are not running out of mineral resources, such as copper and oil because powerful extractive technologies are keeping ahead of depletion. Yet we *are* running out of biotic resources and the services that ecosystems provide, so our prosperity is increasingly limited "by fish, not boats and nets, and by forests, not chainsaws," said Lovins.

Natural Capitalism, the title of a book by Paul Hawken, Amory Lovins, and Hunter Lovins (1999), defines an environmentally and socially restorative way of doing business as if nature and people were properly valued. It calls for radically improved resource productivity; the redesign of production along biological lines with no waste and no toxicity; a business model that rewards both of these shifts; and reinvestment in natural capital.

Even today, when nature and people are valued at roughly zero, it is highly profitable to reduce and eliminate waste because there is so much of it. The flow of materials extracted, used, and disposed of in the U.S. economy averages 20 times our body weight per person per day; yet only 1 percent of this ends up in

durable materials, and only one-fiftieth of that gets reused or recycled. The materials system is thus about 99.98 percent pure waste—a vast business opportunity. Energy is similar: our cars use only 1 percent of their fuel energy to move the driver, our buildings are a few percent as efficient as the laws of physics permit, and our power stations throw away waste heat equal to Japan's total energy use for everything. Yet highly integrated design can make buildings 10-fold more energy efficient and usually cheaper to construct. Hypercar™ vehicles will ultimately eliminate the current version of the car: big, uncompromised versions getting more than 100 miles per gallon (Figure 4.6) will enter production by 2005 and ultimately will displace as much oil as the Organization of Petroleum Exporting Countries (OPEC) now sells, while decoupling road transport from cli

FIGURE 4.6 In 10 years, these hydroelectric vehicles will save as much oil as OPEC now sells. They will also help to avoid adverse climate effects and smog, which will lead to better quality of urban air. SOURCE: A. Lovins. Reprinted with permission.

mate and air quality. Each such vehicle is also a plug-in fuel-cell power plant that can earn back a third to a half of its ownership cost by selling power back to the grid when parked (normally 96 percent of the time).

Simple common sense applied to designing energy-efficient buildings can also make people happier and more productive, according to Lovins. For example, new office designs—in which people can see what they are doing because of high-quality and natural lighting, can hear themselves think because of good acoustics and the absence of mechanical noise, and feel more comfortable because of better thermal design—can yield as much as a 16 percent gain in labor productivity. Indoor air quality and daylight also make a big difference, contributing to health and reducing fatigue. Students in daylit schools do about 20 to 26 percent better on test scores. In factories, good day lighting reduces or eliminates lost-time accidents.

A second principle of natural capitalism, according to Lovins, is loop closing that eliminates the entire concept of waste. Instead, products that have been used get turned back into something useful via reuse, repair, remanufacturing, or recycling. Both biologically inspired, closed-loop, nontoxic design and radically increased resource productivity are rewarded by the "solutions economy" business model, which shifts from selling products to leasing a flow of services. Done right, this can align the interests of providers and customers, so that both make more money by doing more, better, with less, for longer. The resulting profits can then support reinvestment—as any prudent capitalist would do—in restoring and expanding the dwindling stocks of natural capital.

Where this is taking us is to a world in which successful businesses take their values from their customers, their designs from nature, and their discipline from the marketplace. By design, urbanists too can treat their cities' formidable economic, social, and ecological needs not as competing priorities to be traded off, but rather as interlinked design elements with synergies to be captured. By using integrated design, early adopters of natural capitalist principles are finding striking gains in short-term profitability and competitive advantage—and the most exciting places to work.

SUMMARY

Many workshop participants noted that environmental justice is clearly a central area of concern when considering human health and the built environment. There is no question that there is more environmental injustice in disadvantaged minority neighborhoods in the United States, and there is no question that there are more people in these environments who are unhealthy, said Mindy Fullilove. She added that experts can argue for a long time about cause and effect and the relationships between exposure and risk, but there is an undeniable truism that people who are unhealthy in general are more susceptible to environmental problems. Addressing the challenge of the built environment requires much more than just looking at chemical exposures and risks, it requires a holis

tic look at the entire built environment and the social issues involved with it. Lovins highlighted the need for multidisciplinary approaches that go beyond the usual boundaries of public health, urban planning, engineering, and design. Many speakers emphasized that government agencies can act to energize, inspire, and motivate integration of the various disciplines. Finally, there was discussion by several speakers that we must be more responsible about evaluating the consequences of our decisions in order to realign our thinking with each new effort to build health into the environment.

5

Human Health and the Social Environment

Human behavior stands as the most immediate proximate cause of many of the adverse consequences to the environment. Thus, any solution will come from some constellation of changes in human attitude, knowledge, capacity, behavior, and perhaps incentives. According to the speakers in this session, one area that historically has received considerably less attention is the role of people and social activity as part of the environment and as part of the basis on which an environment may be salutary or the source of harm. Human behavior itself is an aspect of the environment that may benefit or harm our health.

SUSTAINABLE DEVELOPMENT, ENVIRONMENT, AND HEALTH

At this time, our ability to deliver public health or environmental quality is being overtaxed, said Nicholas Ashford of the Massachusetts Institute of Technology. Part of our inability lies in the fact that science is increasingly uncovering problems that we never thought existed, such as endocrine disruption or low-level chemical exposure associated with behavioral problems.

There is a dynamic nature to the trends in industrial development and the diverging impact that this development is having on public health and the environment, said Ashford. Moreover, there is a disconnect between the industrial encouragement of more production and more consumption and industries' alleged commitment to sustainable development. For example, the manufacture and promotion of sports utility vehicles —currently 50 percent of new cars being

sold—does not conform with the automobile industry's assertion that it is interested in sustainable development.

Some believe that innovation and commitment to sustainable development will not occur without deliberate directive policies, stated Ashford. There is an important role for government to provide a solution-focused, technology-based approach to addressing and setting priorities for environmental and public health problems. However, government actions must not rest on the false assumption that cost–benefit analysis, including risk assessment and rational choice theory, is the way to plan public policy. We need to shift attention from problems to solutions.

> We need to shift our attention from problems to solutions, from what we are doing to what we can be doing.
> —*Nicolas Ashford*

Health and the environment do not drive industrial and economic systems. In the United States, trade is considered the engine of economic growth. An economy based on trade tends to keep its industrial plant and sell as much as it can of the old product to the rest of the world.

It cannot be assumed that the industries that have caused the problems are the industries that will come up with the solutions, stated Ashford. Industries that have a technological fix and a narrow view are not capable of displacing themselves in the significant ways needed to achieve sustainable development. Who is going to give us the pollution control device—the pollution control industry, which constitutes half of the environmental export industry in this country? The regulated firm may be able to change some things, but it takes other respondents—new entrants—to displace the products and change the nature of services.

Regulation is another positive force for change. Technological responses to regulation have produced such innovations as end-of-pipe pollution control, changed inputs to production processes, or entirely new products or services. The history of regulation in this country has forced the formation of new technologies, concluded Ashford.

Thus, said Ashford, achieving sustainable production and consumption requires (1) a shift in policy focus from assessing and characterizing problems to designing solutions; (2) an appreciation of the differences between targeting technological innovation and diffusion as a policy goal; (3) the realization that the most desirable technological responses do not necessarily come from the regulated or polluting firms; (4) understanding that comprehensive technological changes are needed that co-optimize productivity, environmental quality, and worker/public health and safety; and (5) an appreciation of the fact that in order to change its technology, a firm must have willingness, opportunity, and capacity to change (Box 5.1).

BOX 5.1 SUSTAINABLE BUSINESS, ECONOMY, AND HEALTH— A CASE STUDY

The Dow Chemical Company has 40 manufacturing sites globally. The Midland, Michigan, plant is the third largest, with 550 buildings and 40 chemical production plants in a 1,900-acre facility. The air emissions of the facility have declined over time as it shifted from high-volume, commodity-type chemical processes to more of a specialty batch-based process. In 1994, the Dow Chemical Company set a goal for 2005 to cut all wastes and emissions by 50 percent, said Jeffrey Feerer of Dow Chemical Company.

The attitude and belief inside the company by the late 1990s were that no further gains could be made in emission control at this facility. Two new goals were set: (1) to have capital accrued by April 30, 1999, to essentially cut waste and emissions by 35 percent, and (2) to start to foster institutional changes within Dow to shift the corporation's thinking from compliance to pollution prevention and to further integrate health and environmental concerns into core business decision making through the Michigan Source Reduction Initiative (MSRI).

Working with the community, activists, and pollution control consultants, Dow engineers identified pollution prevention opportunities and brought these opportunities to the entire group for consideration. The company decided early on that since its had a goal of reducing all chemicals by 50 percent, it did not care which chemicals the group decided to work on first.

Of the chemicals identified by the group, it turned out that essentially 18 million pounds were produced a year: 81 percent were incinerated, none were land filled, 13 percent went to a wastewater treatment plant, 4 percent went up the stack as air emissions, and 2 percent were fugitive emissions. So the MSRI process was deceptively simple, but the interactions were very complex. Every plant that had an MSRI chemical in it participated in the study and came up with pollution prevention opportunities for the group to consider. One of the boundaries of the project was that Dow was looking for cost-effective pollution prevention. A key attribute of the process was direct interaction of environmental activists with Dow's key business and manufacturing leaders.

The resulting projects reduced waste and emissions by 12 million pounds per year. MSRI wastes were reduced from 17.5 million to 11 million pounds per year, a 37 percent reduction. MSRI emissions were reduced from 1 million pounds a year to slightly more than a half a million pounds per year, a 43 percent reduction. Non-MSRI waste and emissions were reduced by another 5 million pounds per year.

In this facility, the common belief had been that there were no cost-effective pollution prevention projects left to pursue. In the end, 17 projects were identified with a combined return on investment of 180 percent, or a savings of $5.4 million per year. The total one-time capital expenditure was $3.1 million per year, so the company is saving $5.4 million a year.

HEALTH AND THE URBAN ENVIRONMENT: THE FORGOTTEN ECOSYSTEM

A photographic essay of environmental hazards in a number of cities was presented. Until the 1980s, the swamps of Newark Bay in Jersey City, New Jersey, contained 4 billion pounds of chromium slag, used as "clean" fill for a good part of the past century throughout the city. During the 1960s, Jersey City underwent what was called "urban renewal," which basically meant knocking down housing and filling in with chromium slag, reported Thomas Burke of the Johns Hopkins School of Public Health. In the 1980s, the city realized that it had an environmental hazard on its hands, in addition to rampant drug abuse. Those working within the public health infrastructure had to worry about the physical safety of the field crews.

Upriver, the Diamond Shamrock plant in Newark produced Agent Orange and other chemicals, as well as some of the nation's highest levels of dioxincontaminated soils. Further south is the oldest refinery complex in America, in South Philadelphia, in close proximity to the neighborhoods of South Philadelphia. Still further south, in east Baltimore, a waste incinerator sits near a major housing project, Armistead Garden. These scenes are repeated in every city in America, said Burke.

Often, urban areas are polluted because of neglect of the simple basics of sanitation, siting of facilities such as coal- and oil-burning generating stations in close proximity to housing, sewage treatment, and abandonment of factories containing hazardous materials. A direct result of efforts on a national scale to control pollution is neglect of the ecosystem in the cities, said Burke. Fragmentation of environmental health definitions of environmental regulations has resulted in an inability to deal with these broad public health problems, which are very much tied to the economics and the social and behavioral aspects of public health. This has resulted, in part, from the scientific community's distancing itself from the local community, said Burke. Communities have a good idea of the kinds of things that are troubling them. They also are realistic about this, not looking to close down business, but, rather, seeking a fair enforcement of existing laws. Citizens in these communities are concerned about cancer rates, asthma and respiratory disease, chemical sensitivity, and the general health of their children.

Sometimes by trying to solve one problem—for example, ocean dumping— we create another, such as enormous composting operations for solid waste. These shifts in the problem inevitably land next to poor neighborhoods. For example, legislation that required the removal of underground storage tanks necessitated the construction of rotary kilns to bake out the volatile components of petroleum-contaminated soil. These kilns were placed in already environmentally and economically stressed areas, such as those found in South Philadelphia.

Although disease rates show these urban areas to be unhealthy communities with ecosystems in trouble, indicators of health are difficult to obtain for most major cities. In an era of unprecedented economic growth there is an opportunity

to do something for the environment of the cities, said Burke. The greatest gains in public health could be made by cleaning up the urban ecosystem. Revitalization calls for a public health approach with a much broader context than the current environmental regulatory approach.

SOCIOECONOMIC STATUS AND HEALTH

It is common sense to assume that socioeconomic factors contribute to health and illnessaccording to Nancy Adler of the University of California, San Francisco. However, the association between socioeconomic status and health is not simply due to the adversities of poverty, although these are important and pervasive. The predominant view has been one of a threshold effect; that is, better income will bring you better health, up to a certain point but not beyond it. This view has been challenged by results from the Whitehall studies, * which are ongoing investigations of the British Civil Service. The British Civil Service has nine gradations, from the lowest entry level through the top level of management. All of the participants are employed, none are in abject poverty, and all have access to the National Health Service. When Whitehall participants were followed over 10 years it was found that there were significant differences in mortality and that these differences formed an upward gradient. So, the higherlevel administrators had cumulatively lower mortality than the lower occupational grades.

What are the mechanisms or pathways by which socioeconomic status affects health? One way to think about this, said Adler, is to study the major causes of early mortality and morbidity (Table 5.1) or the proximal causes of death. Scientists at the Centers for Disease Control and Prevention (CDC) analyzed these in terms of four factors. They found that inadequacy of health care accounts for about 10 percent of premature mortality, genetics for about 20 percent, environment for about 20 percent, and health behaviors and life-style

TABLE 5.1 Factors Contributing to Premature Mortality

Factor	Percent
Health care system	10
Genetics and inherited factors	20
Environment	30
Health behaviors and life-style	50

* The Whitehall studies, which began in the 1960s, grew out of a productive working relationship with the British Civil Service. Involving a large number of colleagues at UCL and other institutions, the study was of great importance in demonstrating the relation between aspects of life-style, biological risk factors, and subsequent disease.

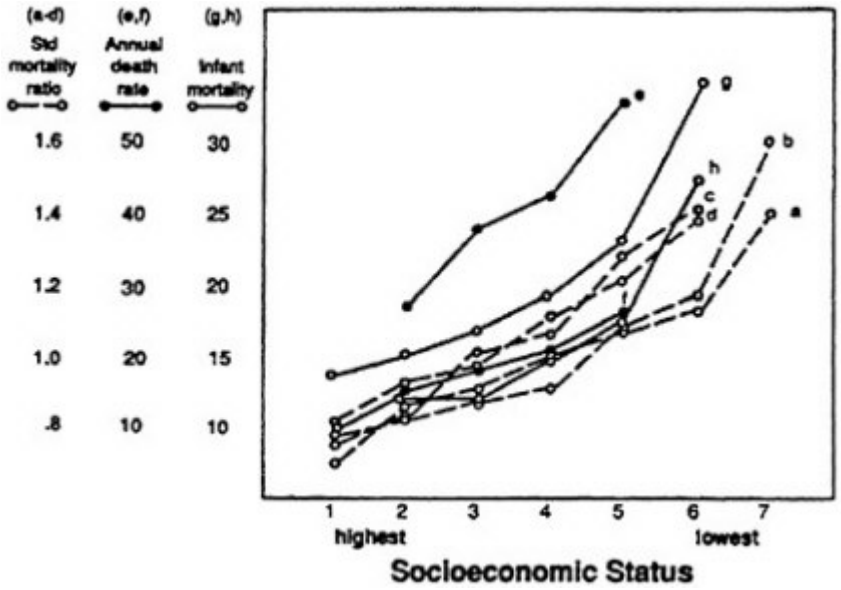


FIGURE 5.1 Mortality rate by scoioeconomic status level. SOURCE: N.E. Adler. Reprinted with permission.

for about 50 percent. There are interactions among these, but the order of magnitude is instructive. Socioeconomic status is pervasive in part because it influences many of these factors (Figure 5.1).

Poorer neighborhoods tend to have fewer doctors and pharmacies; inadequate transportation, lack of safe and convenient recreational facilities; and low availability of affordable, healthy food. So even if an individual is motivated to be healthy, it is harder if he or she lives in a poorer area. One implication, then, is that efforts to improve environmental health might be explicitly tied to the very factors that are going to encourage health-promoting behaviors and discourage health-damaging behaviors. Improving access to recreational facilities, increasing the availability of affordable healthy foods, and reducing the easy availability and marketing of tobacco and alcohol would be particularly helpful, said Adler.

Similarly, we know that exercise is an important health benefit. A recent survey found that those who viewed their neighborhoods as unsafe were more likely to be physically inactive. So, as we design neighborhoods, if we can design them in ways that will facilitate health-promoting behaviors, this might have a powerful impact on health.

The other pathway to health or illness is through differential exposure to stress, said Adler. This has to do less with the physical and material aspects of environments than with the psychsocial environment. Stress follows the same gradient as income, education, and health; that is, the lower one is in the social hierarchy the greater is the stress. There is substantial evidence that stress is

associated with physiological responses that increase the likelihood of diseases, including cardiovascular disease, metabolic syndromes, diabetes, and infection.

Stress occurs when individuals feel that they do not have adequate resources to deal with the challenges that face them. One of the factors that buffers people from the adverse effects of stress is a sense of control. The Whitehall studies have found that the sense of control is closely related to occupational grade; as one moves up the occupational ladder, there is a greater feeling of control. A sense of control also appears to be important in communities. The term "collective efficacy" describes the extent to which a neighborhood shows high levels of the sense that people can control what is happening there. It can be measured in terms of social control—that is, the likelihood that neighbors can be counted on to intervene in different adverse situations—or by social cohesion—how much neighborhood residents feel that others in their neighborhood can be trusted, share their values, and get along with one another. Collective efficacy is highly related to socioeconomic characteristics and shows a direct relationship to rates of violence and health outcomes.

These issues speak to the role of nonregulatory communities in addressing environmental health, suggesting not only that greater empowerment of community groups might help through the changes they achieve in the physical environment, but also that the very process may be beneficial to health through increasing collective efficacy, building social capital, and enhancing the social environment. The health effects associated with this process might be equal to or perhaps even greater than those associated with the outcome.

NUTRITION, PHYSICAL ACTIVITY, AND HEALTH

The relationship between the food supply and health is changing in at least three significant ways, said Bill Dietz of the CDC. First, the biodiversity of the nutritional food supply is narrowing as we concentrate seed production in the hands of fewer and fewer agricultural companies. Second, the opportunity to use genetic engineering of plants to concentrate limited nutrients, such as vitamin A or iron, could address major nutritional deficiencies around the world. Third, increasingly, socioeconomic status, even in the United States, affects one's access to affordable and nutritious foods.

The importance of nutrition and pure water to health has been recognized for a long time, most notably when the prevalence of rickets was determined to be related to the lack of enrichment of milk with vitamin D and of sun exposure in urban areas because of coal smoke and particulates. More than a century ago, the country was swept with epidemics of dysentery, which were eliminated by water sanitation. These basic public health measures had a phenomenal impact. Today, however, the responsibility for water and air purity and quality has moved into a fairly esoteric area, characterized largely by toxics and toxicology. It might be necessary to return to a basic appreciation of the role of the physical environment in chronic disease prevention.

One of the newest health threats to Americans is obesity (Figure 5.2), that is, a body mass index greater than or equal to 30, which is about 30 pounds overweight, said Dietz. Obesity accounted for about 5 percent of the U.S. health care budget in 1995 dollars, mediated through the comorbidities associated with obesity, such as diabetes, cardiovascular disease, hypertension, gallbladder disease, and cancer. Physical activity, or the lack thereof, plays a very important role.

From the prevention point of view, the promotion of physical activity—in contrast to a singular focus on the food supply—might go a long way toward weight maintenance. If the entire population started maintaining its weight today, rather than gaining weight with age and time, we could arrest many of the comorbidities associated with the obesity epidemic. Despite the fact that physical activity may not contribute substantially to weight reduction, the promotion of physical activity alone may have an impact on chronic diseases independent of any effect on weight. Thus, the strategy is to understand the factors that contribute to the inactivity of the population so that they might be reversed.

In the United States, only 1 percent of trips are by bicycle, 10 percent are by walking, and 85 percent are by car. In addition, 25 percent of all of the trips made in the United States are less than 1 mile, but 75 percent of these are by car. Moreover, one third of all children who live within a mile of school walk to school. All of this is a consequence of the infrastructure of our communities. Thus, the suburbs may now be more hazardous to our health in some respects than urban areas because of the consequences for physical inactivity. In developments where the streets are more densely populated, and there are more ways to get from one place to another (i.e., connectivity), the likelihood of physical activity is increased.

Increased walking is an essential strategy for weight maintenance, which will require that many communities retrofit their streets with bicycle paths and sidewalks. Likewise, we cannot expect our children to walk to school unless there are safe crossing areas for them to do so. This requires a community-based strategy (Figure 5.3). There are also opportunities for physical activity within our buildings, for example, through stair use. Passive, inexpensive changes in stairwells can promote physical activity, reported the CDC's Dietz.

We need to employ a social strategy that is based not only in health services and aimed at life-style changes but that also employs the regulatory strategies necessary to influence the political will, concluded Dietz. Perhaps it is necessary to promote these changes not so much for the sake of public health, but because they improve the livability of communities, which creates an alliance of groups not commonly considered partners in public health.

A MORE COMMUNAL APPROACH TO HEALTH

During the last three decades of the 20th century, industrial capitalism gave rise to an electronic era and the globalization of trade. These trends have influenced medicine, healing, and the environment, in particular. Ancient history

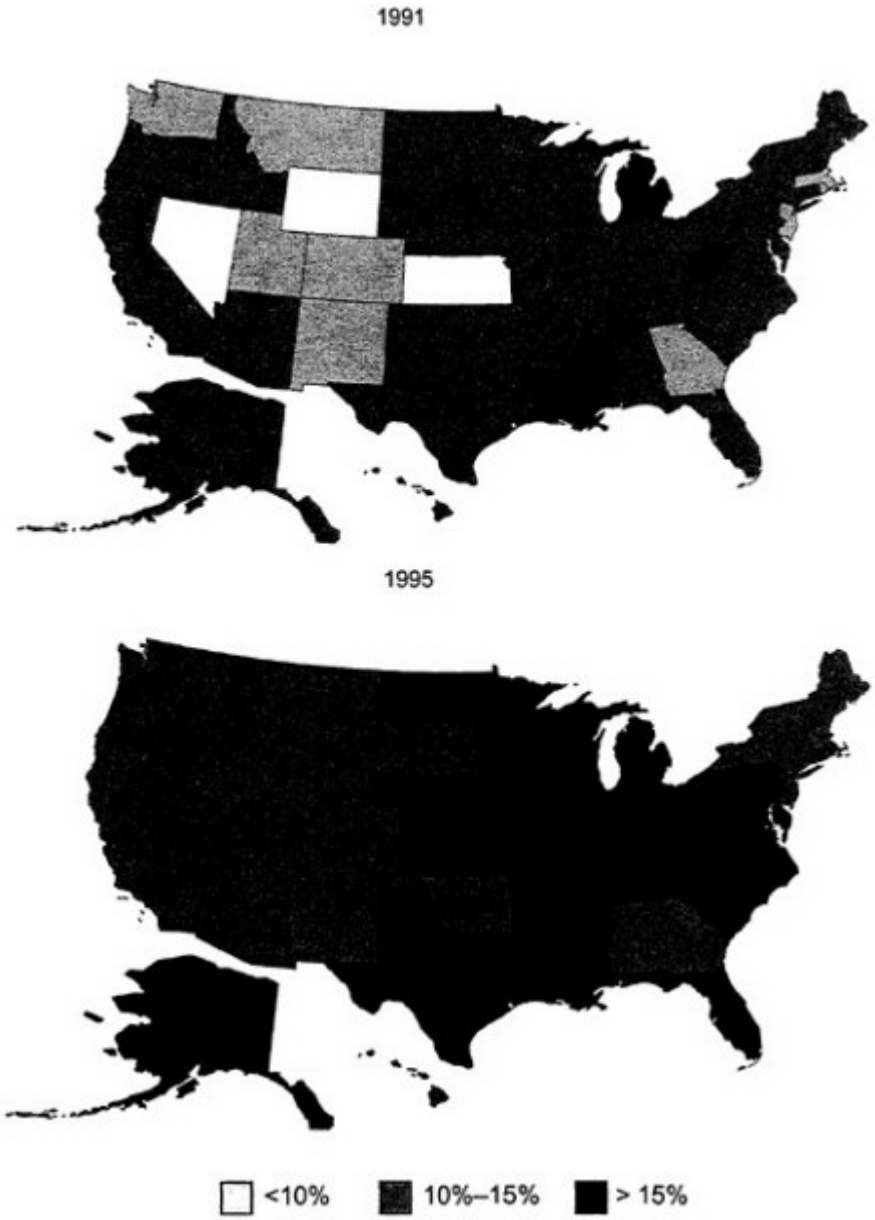
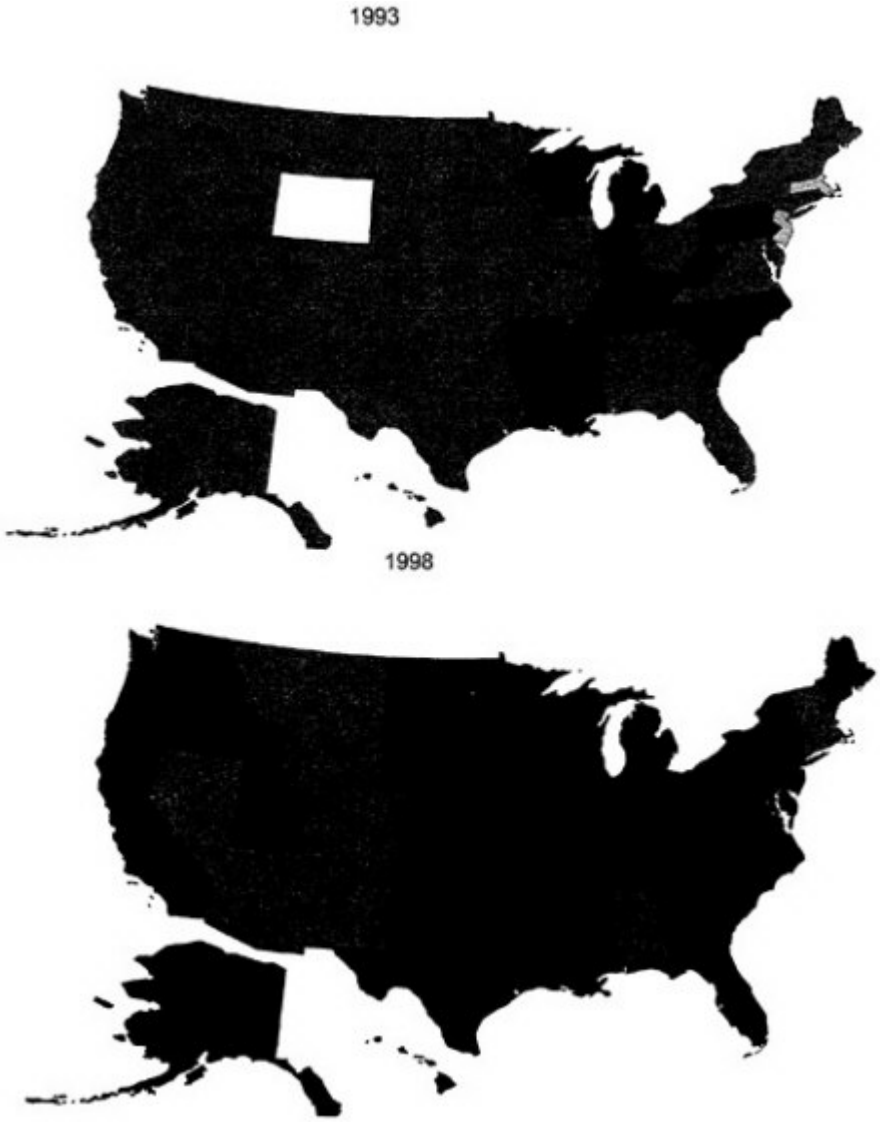


FIGURE 5.2 Prevalence of obesity among U.S. adults, 1991, 1993, 1995, and 1998. SOURCE: Must et al. (1999). Reprinted with permission.



reveals how the impact of humans—in terms of overgrazing, or misuse of waer—led to abandonment of the sites of early civilization. This history teaches us that the globalization of the earth is just in its infancy, said Donald Conroy, president of the International Consortium on Religion and Ecology. Over much of this history, a male-dominated view of medicine, which is very mechanistic, as predominated, with a strong emphasis on the individual and less on the spiritual or community involvement in health.

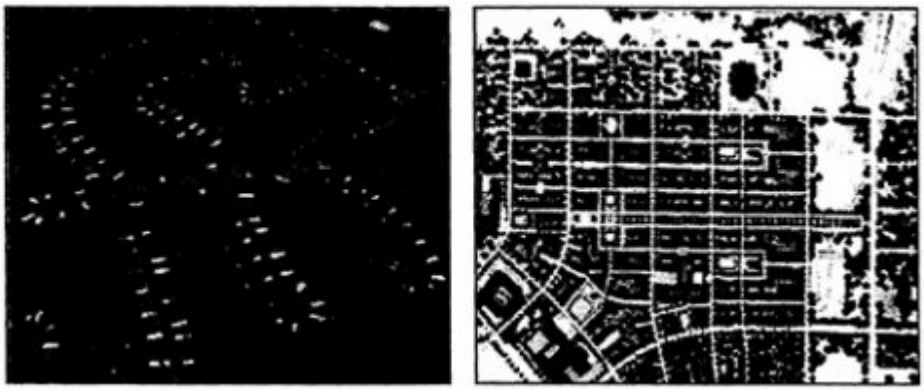


FIGURE 5.3 Exercise, including walking, is essential to weight maintenance. Many communities will need to retrofit their streets with sidewalks and bicycle paths. SOURCE: W. Dietz. Reprinted with permission.

A comprehensive survey of cultures in the history of health care and medicine, however, provides an alternative approach to health care, one with a more communal and "feminine" emphasis. This approach emphasizes the value of various noninvasive therapeutic methods, including diet and nutrition; includes holistic types of body, mind, and soul techniques for curing; views healing within the context of community and family; and is more open to a perspective in which life and death are seen as part of a natural ecological cycle of birth and regeneration. It also relies on nonmechanistic and nonintrusive methods of diagnosis, including a greater emphasis on the patient's own story and cultural habits. Therefore, treatment is multifaceted, requiring rest, relaxation, reassurance, and a sense of hope to activate the natural healing powers within the person. Conroy emphasized the need to view these approaches as another way of recovering from and dealing with illness and as an alternative to the singular "battlefield" type of medicine practiced today.

CHANGING THE EDUCATIONAL ENVIRONMENT

Health is a hard word to define. It cannot be reduced in its essence to any kind of single discipline, said David Orr, director of the Environmental Studies Program at Oberlin College. Quoting Richard Levins of Harvard Medical School, Orr said that "the emphasis ought to be on wholeness and process in complexly connected networks of causes that cross the boundaries of disciplines." Moreover, health is a big subject, not a single discipline, thus, it should not be confined to schools of public health or schools of medicine.

Humans cannot be healthy in an ailing ecosystem, said Orr. Human health is related to climate, the loss of biological diversity, soil, and rainforests, increased population, and the death of the seas. This ecological disorder, or the

disordering of ecosystems, reflects a prior disorder of mind and of the way in which we think, said Orr. Thus, it should be a matter of great importance to educational institutions that purport to improve the way we think.

> Humans cannot be healthy in an ailing ecosystem.
> *—David Orr*

Orr believes that those in education have been and are part of the problem. "What would it mean if colleges and universities and public schools took health seriously in this large sense of the word, in the sense of dealing with causes not symptoms?" he asked. No institution or organization has a right to undermine the stability, integrity, and beauty of natural systems—the consequences of which would always fall as a kind of "irrevocable remote tyranny" on students and future generations. The same institutions that purport to induct young people into responsible adulthood ought themselves to operate responsibly.

The work of organizations such as Second Nature, the National Wildlife Federation, and the Center for Respect of Life and Environment is leading a revolution in higher education, said Orr. They are effecting a change in the operations of universities and colleges through promoting policies on college and university campuses that govern the purchase of food, materials, paper, and all of the goods that flow through and across a campus. Second, they are working to revolutionize how we build college campuses, constructing buildings that emit no waste products, use solar power, locate materials from sources certified as sustainably managed and sustainably harvested, and develop fabrics that are compostable and free of carcinogens. A third revolution continues in terms of investments and how colleges buy, purchase, and exert financial power in the world.

Orr believes that these efforts are beginning to change operations in a way that makes campuses models of ecological designs so that they reflect health in all that they do. If health is not the aim of education, as Orr paraphrased Aldo Leopold, then what is education for?

SUMMARY

Human behavior stands as the most immediate proximate cause of many of the consequences to the environment that are the basis for environmental health research. If indeed there is to be any solution or change, that too will come from some assemblage of changes in human attitude, knowledge, capacity, behavior, and perhaps incentives, noted Lynn Goldman. Any intervention to change the status quo will certainly involve the role of people in the environment.

Several workshop participants discussed that these changes must include involvement (and empowerment) of the community, intentionally designed opportunities for increased activity, freedom from toxic exposures (especially in the poorest neighborhoods), reexamination of the incentives provided by government and industry (Box 5.2) to achieve environmental health, and education of the young by example.

BOX 5.2 INDUSTRY AND THE NATURAL ENVIRONMENT: REDUCING INTEL'S ENVIRONMENTAL FOOTPRINT—A CASE STUDY

Intel, manufacturer of microprocessors, changes its manufacturing process every 2 years as it miniaturizes the next generation of computer chips. During each transition, reported Terrence McManus of Intel, there are major opportunities for environmental improvements, for example, through chemical selection, facility design, waste management, ergonomics, and manufacturing equipment selection.

The Resource Conservation Recovery Act, or RCRA, required companies to focus on waste minimization, which resulted in an evolution in the technology. In making changes, Intel often has to make critical choices with different environmental implications, for example, should the chemical be consumed in the product or should the company "borrow" the chemical from the manufacturer and return it for recycling?

Other aspects of planning include projecting over 10 years, or five generations of manufacturing, to predict environmental health and safety impacts. Goals are then set that must be integrated into the design development process as opposed to being some appendage to it.

Examples exist from improvements made in past transitions. For example, one process uses hydrofluoric acid to etch wafers. Intel reduced the water use in this process by 40 percent and achieved better management of the exhaust, which actually reduced energy use. Other efforts have resulted in the recycling of hazardous waste and reductions in emissions of volatile organic compounds: currently 37 percent of waste is recycled; 17 percent goes to energy recovery; and 46 percent goes to landfill, incineration, or other treatment. Intel has been able to reduce water and energy use per manufacturing unit on each of its last four generations of semiconductor technology. Intel also builds ergonomics into the equipment, going so far as to design a handbook for the people who make its equipment.

Intel's StRUT program, or Students Recycling Used Technology, recycles personal computers, after students have upgraded and cleaned the hard drives, for donation to schools and nonprofit organizations.

A key to Intel's successful environmental record, said McManus, has been the company's ability to put together a green plan that integrates design for the environment while aiming for sustainable activities of other operations, which often requires partners in diverse fields to make it work.

Design, as McDonough, Lovins, and others are defining it, begins by seeing nature as the standard for what humans do: how we farm, how we build, how we work, and how we live. They see civilization as being powered by contemporary sunlight, not ancient sunlight stored as fossil fuel. They see design, when we get it right, as protecting diversity—not just biological diversity but cultural diversity as well. They see an economic system, when we get the design right, characterized by prices that tell the truth about what we do in the world. Finally, when we get design right, said McDonough, we do not just recycle waste, we eliminate the very concept of waste.

6

Toward an Integrative Approach to Environmental Health

This workshop highlighted the interdependence between public health and the environment. Speakers illustrated that promoting environment protection also promotes health and yields collateral benefits by focusing on the effects of health on a children's education. There are many constituencies involved; thus, a new vision of environmental health, as discussed by the some speakers, requires crosscutting research and development and the establishment of new linkages between diverse groups, including the medical and public health communities, industry, government, farmers, policymakers, and international groups.

There is evidence that contact with the natural offers health benefits. If so, then we need to articulate a broad vision of environmental health, said Howard Frumkin, one that stretches from urban planning to landscape architecture, from interior design to forestry, from botany to veterinary medicine. Such a vision has implications in at least four arenas: research, collaboration, clinical care, and public health advocacy.

Also, although we suspect that there is often a relationship between environmental exposures and health effects, we need a research agenda directed not only at exposures suspected to be unhealthy, but also at those suspected to be healthy, and at outcomes that reflect not only impaired health but also enhanced health, concluded several speakers. New research questions pose challenges of defining and operationalizing unfamiliar variables. Landscape architects, horticulturists, and environmental psychologists work with the exposure variables, but those of us in environmental health do not. Similarly, the outcome variables that reflect health instead of disease are less familiar and must be developed and

validated. These challenges offer broad opportunities for methods development and hypothesis testing.

Environmental health specialists, from researchers to clinicians, have long recognized the need to collaborate with other professionals, for example, with mechanical engineers to build exposure chambers, chemists to measure exposures, and software engineers to apply information systems to health data. Workshop participants noted that we also need landscape architects to help identify the salient features of outdoor exposures, interior designers to do the same in micro-environments, veterinarians to help us understand more about human relationships with animals, and urban and regional planners to help link environmental health principles with large-scale environmental design.

On the public health level, environmental health has a long history of providing data, and advocating action based on these data, to achieve control of environmental hazards, air and water pollution, pesticides, and workplace and other hazards; in the same way, we need to act on emerging evidence of environmental health benefits, noted several speakers.

Environmental health could become a factor in policy decisions that affect human contact with nature—urban design, land use, and regional planning decisions, even forest policy. Environmental health might play a role in policy initiatives to protect green space, conserve trees, build bicycle paths, zone neighborhoods or regions, or design schools. Environmental health could appear in the curricula of schools of architecture and civil engineering. As we learn more about the health benefits of contact with the natural world, we need to apply this knowledge in ways that directly enhance the health of the public, said Frumkin.

The solutions for solving many health problems lie clearly outside the health care system. They rest in the environments in which we live, work, go to school, and play. Because of this, they inevitably require innovation and persistence to solve problems. Efforts by designers, engineers, architects, city planners, developers, and communities can change the health status of a community by considering human needs in design and construction.

Some participants suggested that the challenge is to get the health sector to recognize some of these issues and collaborate actively in rebuilding the physical community. Natural and social capital are critically important in addressing more than the symptoms of poor health and in getting at the root causes of public health in the broadest sense.

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Abstracts of Talks

A NEW VISION OF ENVIRONMENTAL HEALTH: THE ROLE OF SOCIOECONOMIC STATUS

Nancy Adler

The best single predicator of a person's health is his or her socioeconomic status (SES); the lower individuals are in the socioeconomic hierarchy, the shorter is their life and the greater is the likelihood of their experiencing a wide range of diseases. SES effects are pervasive; increasing socioeconomic resources are associated with better health not just for those in poverty, but on all levels of the socioeconomic ladder. Two of the pathways by which SES influences health will be considered.

The discussion of SES determinants of health must be grounded in consideration of what is known about the general determinants of health. The Centers for Disease Control and Prevention has estimated that 10 percent of premature mortality is due to deficiencies in health care, 20 percent to environmental exposure, 20 percent genetics, and 50 percent to behavior and life-style. This is necessarily oversimplified since there are obvious interactions among these categories, but it gives some idea of the magnitude of the effects. The analysis did not include socioeconomic factors as direct contributions to death, but SES underlies risk in most of these areas: SES influences health care, environmental exposures, and health behaviors.

The most obvious health-related effect of SES is access to health care. However, health care overall contributes relatively little to premature mortality. Other evidence also suggests that health care is not the major factor in socioeconomic disparities in health. For example, the SES health gradient emerges in countries with universal access to health care and in diseases for which health care is relatively ineffective.

The second pathway is through environments associated with socioeconomic levels. This includes work and residential environments inhabited by

those at different levels of the SES hierarchy. SES environments differ in the relative exposure to carcinogens and pathogens. Poorer neighborhoods have higher rates of toxic exposure; similarly, lower-SES jobs are more likely to involve such exposure. If one expands environment to include the social environment, SES has even greater effects. A key aspect of environments is the extent to which they are experienced as stressful by those who inhabit them. At both work and home, higher-SES individuals are less likely to confront uncontrollable stress. Research on British civil servants has shown that a sense of control over work varies directly with occupational grade and accounts for much of the effects of occupational level on mortality. Community-based research has shown that in urban environments, neighborhoods that demonstrate a sense of "collective efficacy" and social cohesion have lower rates of violence as well as lower mortality from other causes of death; these associations hold even when controlling for traditional socioeconomic level.

Another pathway from SES to health is through health behaviors. Health-risking behaviors, including cigarette and other substance use, high-fat diets, and sedentary life-style, vary inversely with SES; lower SES is associated with higher rates of all these behaviors. Although these are individually based behaviors, they are shaped by physical and social environments. Neighborhoods constrain the choices individuals can make; poorer neighborhoods provide more access to health-damaging goods (e.g., alcohol, tobacco) and less access to goods that foster health (e.g., fresh fruit and vegetables, low-fat food). Poorer areas also have fewer recreational facilities and safe areas for walking and jogging, thus discouraging exercise.

SUSTAINABLE DEVELOPMENT, ENVIRONMENT, AND HEALTH

Nicholas Ashford

Progress in environmental health is hampered by the balkanization of the knowledge base. People and organizations are working on pieces of the problem, but they are not connected and communicating. The role of the government has focused on regulation, but it has past information rather than the state of the art. States such as Massachusetts, New Jersey, and Minnesota have taken a lead by requiring industries to talk about what they could be doing rather than what they are doing.

In order to address and set priorities for environmental and public health problems, there is a significant need for industrial transformation or displacement of technologies and sectors that give rise to serious environmental and public health problems. This is especially true for those industries that have remained stagnant for some period of time and are ripe for change. Achieving sustainable production and consumption requires (1) a shift in policy focus from assessing and characterizing problems to designing solutions; (2) an appreciation of the differences between targeting technological innovation and diffusion

as a policy goal; (3) the realization that the most desirable technological responses do not necessarily come from the regulated or polluting firms; (4) understanding that comprehensive technological changes are needed that optimize productivity, environmental quality, and worker/or public health and safety; and (5) an appreciation of the fact that in order to change its technology, a firm must have the willingness, opportunity, and capacity to change.

PLANNING THE COMMUNITY: CITY PLANNING AND HUMAN HEALTH

J. Christian Bollwage

Public policy on the environment impacts our cities. Like other communities, the city of Elizabeth, New Jersey, was an industrialized area until the 1970s and the 1980s when manufacturing jobs were leaving the Northeast. The city needed to undergo revitalization to become a service economy.

Revitalizing a land tract from a landfill into a usable piece of land requires strategic planning and collaboration between public and private stakeholders. In Elizabeth, this planning created 5,000 jobs while cleaning a previous hazardous waste site. Other activities in the city include redeveloping vacant brownfields into ballparks, supermarkets, and so forth. The revitalization of brownfields raised revenues while preventing further destruction of invaluable green space—a precious commodity in cities.

TRANSPORTATION AND HUMAN HEALTH

Robert Bullard

Health is more than the absence of disease. When we discuss healthy people, homes, and communities, environmental justice is the starting point. Environmental justice embraces the principle that all communities are entitled to equal protection of environmental laws, housing laws, et cetera. Integration of the environment is not about profits, protecting or regulating corporations, and providing permits. There is a false view that a dichotomy occurs such that it must be jobs versus the environment or jobs versus health. There does not have to be a trade-off. Our society and court system put the burden of proof on the victims and the community to prove that chemical X caused Y disease.

There is a direct correlation between per capita income and waste generation. Further, individuals with higher incomes do not live near toxic waste sites or waste dumps. This results in an uneven distribution of exposure to potentially harmful environments and a need to relocate the entire community.

Urban sprawl is creating additional problems throughout the United States. The effect on the environment is dramatic. Ground-level ozone and the creation of a heat island are two of these problems. Identifying the problems is not enough.

One must also identify the strategies to solve them. Environmental justice is needed to ensure that the national agenda reflects the diversity of this nation.

HEALTH AND THE URBAN ENVIRONMENT: THE FORGOTTEN ECOSYSTEM

Thomas A. Burke

Public health concerns can be approached from many points of views or perspectives. When grappling with issues and determining what has been done for public health, the community as viewed by its members must be examined. Across the United States—whether in New Jersey, Philadelphia, or Baltimore—one can find neighborhoods or pockets in which the environmental health infrastructure has collapsed. These communities have realistic concerns about sewage treatment, air emissions, uncontrolled solid waste, et cetera. They have concerns about their health—cancer, asthma, and other respiratory ailments; chemical sensitivity; and lead poisoning.

Areas in our communities in which the greatest opportunities for redevelopment and revitalization exist, are also the sites where the most improvements to public health are needed. As part of any revitalization and redefinition efforts, we have to include a public health approach. We need to study population health status and realize that the health of communities can inform us about where the ecosystem must be protected.

COMMUNITY PARTICIPATION

Donald Conroy

Environmental concerns are not new to modern society. Since earlier times, overgrazing and misuse have resulted in people abandoning grazing sites and moved westward. The decline of ancient cities in Iraq and Chaldea may also be connected with environmental problems. In modern times, we are moving away from industrial capitalism and moving rapidly toward the electronic era and globalization of trade.

The approach to medicine has been “male dominated,” focused on surgery and other invasive techniques as the approach to cure disease. This type of approach is needed when the focus is on the individual as a result of warfare, industrial accidents, car accidents, and so forth. However, a more feminine or communal emphasis is another valid approach to health care at the community level. Using noninvasive techniques to cure, including diet and nutrition; holistic types of body, mind, and soul techniques; and meditation and reflection, may be important to address a dynamic, ever-changing awareness of well-being and health.

Religion also plays a major role in the well-being of the individual and the community. Many religions are shifting from individual anointing of the sick toward community well-being. Some research has shown that individuals who

incorporate religion into their treatment plan recover at a faster rate than those who do not. Incorporating religion and a feminine or communal emphasis in medicine are necessary aspects of community health.

NUTRITION AND HEALTHY LIFE-STYLES

Bill Dietz

The physical environment has always had a link to health and chronic disease prevention. Exposure to sunlight and the addition of green spaces at the turn of the 20th century led to a decrease in ricketts. In modern life, we have a new epidemic of chronic diseases related to obesity due to an increased sedentary life-style. A number of comorbidities are associated with obesity, including diabetes, cardiovascular disease, hypertension, gallbladder disease, and cancer.

The United States relies heavily on the car, using it in 85 percent of all trips; 25 percent of these trips are less than 1 mile but 75 percent are made in the car. By contrast, in the Netherlands, 30 percent of trips are by bicycle, 20 percent by walking, and 45 percent by car. Suburbs are building shopping centers, schools, and so forth, near major traffic arteries, which promotes the use of cars. Increasing the connectivity in the environment will increase the probability of walking or riding a bicycle. This means that going to the store or school must be by streets and sidewalks that are easy and safe to travel. To enhance the livability of communities, environmental health will have to rely on coalitions to achieve these objectives.

AT THE INTERFACE OF ENVIRONMENTAL INTEGRITY AND ECONOMIC VIABILITY: MICHIGAN SOURCE REDUCTION INITIATIVE

Jeffrey Feerer

“Hey, there is a $100 bill on the floor over there!”

“That can’t possibly be a real $100 bill. If it were, someone would have already picked it up.”

Most environmental policymakers and business leaders believe that opportunities to reduce pollution and save money at the same time would be implemented without hesitation if such opportunities were ever discovered. The fact that such opportunities are seldom trumpeted leads to the belief that they must be very rare. Therefore, many people subscribe to the “dollar bills on the floor” theory, which holds that if such opportunities really existed, they would have already been seized.

This project, the Michigan Source Reduction Initiative (MSRI), shows that this widely held impression is wrong. Over only a 2-year time frame, the project found opportunities to reduce nearly 7 million pounds of wastes and emissions

at the Dow Chemical manufacturing site in Midland, Michigan, while saving the company more than $5 million annually. In the course of this project, Dow committed capital to these projects, and the reduction and saving have already largely taken place.

Perhaps more incredibly, by the reckoning of Dow managers, the reductions and cost saving identified and approved in this project would not have occurred without the unique involvement of a group of outside environmental activists. Thus, this success defies a second piece of conventional wisdom, which holds that only company experts themselves can accomplish pollution prevention successfully. To the contrary, the MSRI experience shows that companies can benefit substantially from interaction with informed critics drawn from the community and from regional and national environmental organizations.

REDEFINING ENVIRONMENTAL HEALTH AND THE NATURAL ENVIRONMENT

Howard Frumkin

This talk will focus not so much on redefining the definition of environmental health but more on suggesting a broader approach and research that is a result of that approach. Many people have studied the environmental hazards that have negative effects on our health. However, a broadly conceived natural environment can also enhance life. Contact with the natural world may be directly beneficial to health. Our connectivity to nature is not new and has a long and fascinating history in philosophy, art, and popular culture. Four aspects of the natural world demonstrate the enhancement of our health: animals, plants, landscape, and wilderness experiences.

Animals have always had a major role in our lives and contribute to human health. Animals comprise more than 90 percent of the characters used in language acquisition and counting in children's preschool books. Numerous studies show that household animals are considered family members: we talk to them as if they were human, we carry their photographs, we share our bedrooms with them. Preserving the bond between people and their animals, like encouraging good nutrition and exercise, appears to be in the best interests of those concerned with public health.

People feel good around plants. Individuals report that working in an office with plants makes them feel calmer. A 1989 National Gardening Study found that flowers and plants at events, theme parks, and so forth, increased the enjoyment of visitors. In urban settings, gardens and gardening have been linked to a range of social benefits, from improved property values to greater conviviality. Indeed, the concept that plants have a role in mental health is fairly well established. Horticultural therapy evolved as a form of mental health treatment, based on the perceived therapeutic effects of gardening. It is also used today in health care, rehabilitation, and educational settings.

The third positive enhancement of human health viewing involves natural landscapes. To return to an evolutionary perspective, human history probably began on the African savanna—a region of open grasslands punctuated by scattered copses of trees and denser woods near rivers and lakes. Today, this pattern repeats itself in our choices in parks, cemeteries, golf courses, and lawns. When offered a choice of landscapes, people react most positively to savanna-like settings, with moderate to high depth or openness, relatively smooth or uniformlength grassy vegetation or ground surfaces, scattered trees or small groupings of trees, and water, a finding that is consistent across every culture in which it's been tested.

Wilderness experience—entering the landscape rather than viewing it—is my fourth topic; this also may be therapeutic. Most published studies relate to mental health end points. In one report, for example, a group of emotionally disturbed boys attending an outdoor day camp was compared to a group of similar boys who did not attend camp. The campers' self-ratings of their emotional adjustment, and their teachers' ratings, were significantly better than those of the controls, although neither parents' ratings nor scores on formal psychological testing showed an improvement. This research has some limitations such as selection bias and lack of randomized trials. However, many published accounts do suggest some benefit from wilderness experiences.

There is evidence, then, that contact with the natural world—with animals, plants, landscapes, and wilderness—may offer health benefits. We need to think about a broad vision of environmental health—one that stretches from urban planning to landscape architecture, from interior design to forestry, from botany to veterinary medicine. We need a research agenda directed not only at exposures we suspect to be unhealthy, but at those that we suspect to be healthy as well. Environmental health could become a factor in policy decisions that affect human contact with nature—urban design, land use and regional planning decisions, and even forest policy.

THE ENVIRONMENT AND PUBLIC HEALTH

Mindy Fullilove

This presentation will explore the link between the creation of marginalized communities and the spread of many kinds of disease, using for an example of this process the spread of HIV/AIDS. The thesis to be presented has two main parts: (1) concentration of resources and wastes creates a sharp gradient in the life-carrying capacity of places, and (2) it also undermines the psychological connection to the larger unity of human life (i.e., the psychological basis for an ecological consciousness).

The AIDS epidemic in the United States was first located in several epicenters, including San Francisco, Los Angeles, New York, and Miami. AIDS then spread from the epicenters in two ways: (1) through diffusion along the hierarchies of cities surrounding each epicenter, and (2) through spatial conta

gion/or network diffusion in local areas. The driving force of the national epidemic is the series of local epidemics, which are variously constructed within marginalized communities of displaced persons. In the initial phases of the AIDS epidemic, three types of marginalized communities were identified: innercity communities, gay ghettos, and rural centers of migrant workers.

Dr. Rodrick Wallace, in a seminal series of studies on AIDS in the Bronx, described the ways in which habitat disruption created the niche for the human immunodeficiency virus. As a backdrop to Dr. Wallace's work, it is important to point out that major social, physical, and economic processes, including the massive building of highways to new suburbs; urban renewal, which decimated older neighborhoods in city centers; and the economic shifts that undermined manufacturing in urban areas of the North and East, led to major population loss in U.S. urban centers after World War II. This "shrinkage" of the cities led some to call for a "planned" process that would guide the downsizing of urban areas. In particular, it was proposed that poor neighborhoods be leveled, concentrating the population elsewhere in the city.

This forced "internal resettlement," like other experiences of massive displacement, sundered social relationships, undermined community life, and imposed heavy psychological burdens on the uprooted. The abrupt decline in social conditions created preconditions for a series of epidemics that acted synergistically to cause an explosive increase in morbidity and mortality. The epidemics further undermined social functioning. The series of assaults—first from displacement and then from epidemics—led to disintegration of the social functioning of affected communities.

Among other psychological effects of such upheaval is the weakening of the sense of belonging to a given place and, by extension, to all places. Because caretaking is tightly linked to belonging, the ecological consciousness is undermined as well by massive experiences of upheaval.

In contrast to the drastic and deleterious effects that follow forced displacement are the salubrious effects that follow organic community development. This principle of benevolence drove the redevelopment of the Manchester neighborhood in Pittsburgh, the happy result of a partnership between community-level organizations and the Pittsburgh History and Landmarks Foundation. Together, these groups inventoried the resources of Manchester's built environment and made plans to restore the deteriorating housing stock and revitalize the connections to industry and commerce. Today, the Manchester neighborhood is an intimate and charming place, secure in its history and looking forward to the future. It is a healthful place, and this goal has been reached by meticulous attention to the simple question, What else do we need to consider? Take, for example, the restoration of gardens. A landscape gardener with experience in historical preservation noted that the front yards in Manchester used to have gardens. The gardens were restarted. Quickly, it became the "thing" to have a small garden and to work in your garden in the evenings. Neighbors might stop by and admire your roses, children could help water the plants, and a new way of "neighboring" was introduced.

The reintroduction of gardens is a connection with the past that solidifies the present. By creating a deeper bond with nature, it supports the ecological consciousness that is our only hope for the future. Out of such a series of linkages came another extraordinary linkage: an exhibit about Manchester at the Carnegie Museum of Art. This was an occasion to bring all of Pittsburgh together to celebrate the rebirth of a neighborhood and, in so doing, to restore some balance to the relationships Manchester had with richer enclaves on all sides.

SPECIAL ADDRESS

David Hayes

As suggested by the workshop agenda, environmental health is more than pesticides, ozone depletion, or endocrine disrupter issues, and many federal agencies have a stake in it, including the Department of the Interior. As one of the nation's largest landowners, the Department of the Interior owns more than 20 percent of the land mass of the United States. Many cities, which are now encountering incredible problems with sprawl, look to the Bureau of Land Management as a provider of open space and recreation opportunities. In addition, the Department of the Interior has regulatory responsibility, including the Endangered Species Act and tribal trust issues.

The Department of the Interior and many other agencies are faced with issues of protecting our environment. Americans know and love our physical environment—possibly to death. People have a connection with their environment, possibly from their childhood, and seek out these places. Enjoying nature provides spiritual, emotional, and physical satisfaction. There is concern when cities are involved with urban sprawl, chewing up an acre of land per hour. This provides less green space for people to enjoy. The Department of the Interior has been working to set aside green space in communities to help people, the environment, and other species. This also has a positive effect on the natural water flow, resulting in better drinking water for current and future residents.

BIODIVERSITY AND HUMAN HEALTH

Thomas Lovejoy

Biodiversity and human health can be parsed in various ways. There are six major connections or contributions of biodiversity to human health. First, the natural world and diversity contribute to the pharmacopoeia. We have not tested all biologically active compounds for potential benefit. A slime mold from the Zambezi River has recently been shown effective in the treatment of tumors. Cyclosporin, an important medicine for organ transplantation, is derived from a fungus. Without biodiversity, these compounds might not have been discovered. Second, biodiversity contributes to the development of research and diagnostic tools (e.g., polymerase chain reaction). Third, biodiversity is a living library for

the life sciences. The study of pit vipers uncovered the role of angiotensin in the regulation of blood pressure. Fourth, endocrine disrupters in wild species may impact human reproduction. Fifth, some organisms help to reduce environmentally caused, or pollution-caused disease (microbes are used to clean up toxic waste or oil spills in the environment). Sixth, biodiversity provides a stable supply of clean water. The summation of these benefits provides a strong argument about how biodiversity has a direct impact on our physical well-being.

POWERING THE COMMUNITY: ENERGY AND HUMAN HEALTH

Amory Lovins

There is a broader context for thinking about the relationship between business, buildings, and health. It is called "natural capitalism"—a way of doing business as if nature and people were properly valued. Operationally, it wrings enormously more benefit from resources; it redesigns production along biological lines with closed loops, no waste, and no toxicity; it rewards both of these efforts through a "solutions economy" business model in which both customers and providers profit from doing more and better with less for longer; and it reinvests some of the resulting profits in natural capital. It is very profitable to reduce and eliminate waste because there is so much of it. In the United States, the materials flow is more than 20 times the average person's body weight per person per day.

Some examples of what integrated design can do for an individual follow: I live and work with no heating system at 7,100 feet in the Rocky Mountains where temperatures can drop to minus 44 degrees Celsius. The heating system was not needed because superinsulated construction and highly integrated design made the building thermally 99 percent passive. People are more productive, healthy, and happy in this building than in an ordinary office where they soon get irritable. The building's 99 percent savings in space and water heating, 90 percent in household electricity, and 50 percent in water all paid for themselves in 10 months with 1983 technology. Another example is the ultralight hybrid-electric vehicles that are being developed and will be widely available within 5 years. Also, advanced resource productivity often improves service quality and boosts human health and performance. For example, office buildings with good day-lighting, air quality, acoustics, and thermal comfort can often increase workers' productivity by about 6–16 percent, while reducing absenteeism by about 15 percent.

If we follow the four principles of natural capitalism, we will be able to live in a world where a successful business takes its designs from nature. By using integrated design, early adopters of "natural capitalist" principles find greater short-term profitability, stunning competitive advantage, and far more fun.

BUILDING THE COMMUNITY: FROM CONSTRUCTION TO CITY PLANNING

William McDonough

As designers, we do everything from fabrics to shoes to automobiles to trucks to buildings. In accomplishing these projects, we apply two principles. First, what we do is medicine. We need to design projects that will allow us to love all the children of all species for all time. Two, from a community perspective, the question remains, At what point can we declare ourselves native to this place? As designers work on a project, at what point do they decide that they do not want to participate in the system (e.g., the building of Auschwitz)? In modern times, can a designer participate willingly in building a system that treats nature as its enemy—a system that measures prosperity by how much natural capital we can dig up, bury, burn, or otherwise destroy?

Looking at the world of tragedies, a designer has to take responsibility for the by-products of the designs. I founded a company based on the following principles: the right of humanity to coexist, recognizing interdependence with the natural world; respect for the connection between spirit and matter; accepting responsibility for the consequences of design; eliminating the concept of waste; relying on natural energy flows. From these principles, we design products with two ideas: (1) waste equals food (i.e., everything is a nutrient), and (2) we must respect diversity. In reaching this goal, we have to imagine what 100 percent "good" looks like and measure progress toward that goal.

INDUSTRY AND THE NATURAL ENVIRONMENT: REDUCING INTEL'S ENVIRONMENTAL FOOTPRINT

Terrence J. McManus

This talk will address how Intel handles overall the issues of environmental health and safety and the performance of these programs. Intel installs a new manufacturing process every 2 years, and this provides a major opportunity for environmental improvements. We target chemical selection, facility design, waste management, ergonomics, and overall manufacturing equipment selection. We view the use of chemicals as part of either end of a bell-shaped curve. Chemicals need to be consumed in the products or borrowed from the chemical company. The latter results in the chemical being returned to the chemical supplier for recycling. Intel has become forward looking by investing in research and development and developing a five-generation road map to identify potential opportunities to further reduce the environmental impact of its manufacturing processes. This results in planning for manufacturing occurring in the next decade. The results of this planning are promising. Of the generated chemical waste, currently 37 percent goes to recycling; 17 percent goes to energy recovery; and 46 percent goes to landfill, incineration, and other treatment. The use of

water has remained constant, while the output of operations has doubled. The goal is sustainability, which has to be implemented regionally.

EDUCATION

David Orr

There are four hypotheses about health. First, health is a broad topic composed of a multitude of disciplines. Second, humans cannot be healthy in an ailing ecosystem. Third, ecological disorders (planetary disease) reflect a prior disorder of mind and how we think. Fourth, it is a matter of great importance to educational institutions that purport to improve how we think.

Colleges and universities need to take this broad view of health services. Institutions and organizations do not have the right to undermine the stability, integrity, and beauty of the natural system. In recent years, there has been a slow-growing trend to change the policies on purchasing food, materials, and papers that are utilized by the campus. Further conversations are occurring in the classroom addressing what is needed in 2050 to make a world that is sustainable. For this to be realized, health in the fullest sense of the word needs to be an integral part of education.

ENVIRONMENTAL HEALTH AND THE GLOBAL COMMUNITY

Rafe Pomerance

There are human impacts on three major global resources that affect our health: the ozone layer, biodiversity, and climate change. Society was close to destroying the ozone layer through the use of chlorofluorocarbons. The United States Clean Air Act and international policies (the Montreal Protocol) stopped further depletion of the ozone layer. Biodiversity is another resource on which humans have a negative impact. Globally, we are rapidly losing species that could be a source of agricultural products and medicines. Humans are also having an impact on the climate. There is an urgency to getting greenhouse gas emissions under control. Many analysts see the doubling of CO_2 levels in 2050 (predicted by modeling) as a problem to be solved decades in the future. We need to solve the problem now because it will be too late when we experience the impacts of global warming. For example, in 1998, coral bleaching occurred due to the increased ocean temperatures. In Palau and other great reef sites around the world, bleaching resulted in massive coral death. Coral reefs are one of the two ecosystems with the largest source of biodiversity. They are sources of nutrition, serve as fisheries habitat, and protect island nations from storms. Climate change will impact our health. Water resources (flooding, drought, etc.) are influenced by the climate system. The location of diseases such as malaria is

affected by the climate change. A warmer climate will aid the spread of diseases into new areas.

ENSURING THE FOOD SOURCE

Richard Rominger

There is a disconnect between the American public and a true understanding of today's agriculture and how it impacts human health. Agriculture affects human health in two major ways: through environmental and ecosystem changes of farm production and through an available supply of food. The United States Department of Agriculture (USDA) is committed to putting food in hungry stomachs and promoting new technologies to protect the environment. One way is to encourage the shift to lower-risk pesticides or pesticide alternatives. Another is to help private landowners with conservation practices. The farmer is a steward of the environment and a guarantor of the nation's future ability to produce an adequate supply of food. We need to keep pushing the frontiers of our knowledge by researching ways to eliminate waste and improve food safety. One example is the use of low-phytase corn that when fed to chickens and pigs results in 50 percent less phosphorus in manure. The result is cleaner water. For the future, we need to believe in the promise of biotechnology to help us achieve food security and environmental benefits globally.

APPENDIX A

Workshop Agenda

Institute of Medicine
The National Academies
Advisors to the Nation on Science, Engineering, and Medicine

REBUILDING THE UNITY OF HEALTH AND THE ENVIRONMENT: A NEW VISION OF ENVIRONMENTAL HEALTH FOR THE 21ST CENTURY

The Roundtable on Environmental Health Sciences, Research, and Medicine
National Academy of Sciences Auditorium
2101 Constitution Avenue, N.W., Washington, D.C.
June 20–21, 2000

TUESDAY, JUNE 20, 2000

8:00 a.m.	**Welcome and Opening Remarks** **The Honorable Paul G. Rogers** Chair, Roundtable on Environmental Health Sciences, Research, and Medicine Hogan & Hartson Washington, D.C.
8:15	**Remarks from IOM President Kenneth I. Shine, M.D.**

8:30 **Remarks and Charge to Participants**
Samuel H. Wilson, M.D.
Deputy Director
National Institute of Environmental Health Sciences
National Institutes of Health

8:45 **Statement of Workshop Objectives**
Lynn R. Goldman, M.D., M.P.H.
Workshop Chair
Adjunct Professor
Department of Health Policy and Management
The Johns Hopkins School of Public Health

9:00 **Keynote Address:** "The Changing Landscape of Environmental Health: An Expanded Vision"
The Honorable Timothy E. Wirth
President
United Nations Foundation

9:45 **Break**

SESSION I: HUMAN HEALTH AND THE NATURAL ENVIRONMENT

Moderator: Larry Reiter, Ph.D.
Director
National Health Effects Research Laboratories
U.S. Environmental Protection Agency

10:00 **Redefining Environmental Health and the Natural Environment**
Howard Frumkin, M.D., Dr.P.H.
Associate Professor and Chair
Department of Occupational and Environmental Medicine
Emory University

10:20 **Environmental Health and the Global Community Rafe Pomerance**
Chairman, Sky Trust, Center for Economic Development;
Former Deputy Assistant Secretary for the Environment, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State

10:40 **Audience Participation: Questions and Comments**

11:00	**Biodiversity and Human Health** **Tom Lovejoy, Ph.D.** Chief Biodiversity Officer The World Bank
11:20	**Ensuring the Food Source** **Richard Rominger** Deputy Secretary of Agriculture U.S. Department of Agriculture
11:40	**Break**
11:50	**Industry and the Natural Environment: Reducing Intel's Environmental Footprint** **Terrence J. McManus, P.E., DEE** Manager, EHS Signature Projects Intel Corporation
12:10 p.m.	**Panel Discussion with Audience Participation** **Panel Members:** • Joseph Brain, Harvard University •Howard Frumkin, Emory University •Tom Lovejoy, World Bank •Terrence McManus, Intel Corporation •Rafe Pomerance, Sky Trust •Richard Rominger, U.S. Department of Agriculture
1:00	**Lunch**
SESSION II: HUMAN HEALTH AND THE "BUILT" ENVIRONMENT	
	Moderator: Donald Mattison, M.D. Medical Director March of Dimes Birth Defects Foundation
2:00	**Building the Community: From Construction to City Planning** **William Mc Donough, FAIA** Professor of Architecture University of Virginia School of Architecture
2:20	**Planning the Community: City Planning and Human Health** **J. Christian Bollwage** Mayor, Elizabeth, New Jersey

2:40	**Transportation and Human Health** **Robert Bullard, Ph.D.** Director of the Environmental Justice Resource Center Clark Atlanta University
3:00	**Audience Participation: Questions and Comments**
3:20	**Break**
3:40	**Public Health and the Built Environment** **Mindy T. Fullilove, M.D.** Associate Professor of Clinical Psychiatry and Public Health Columbia University
4:00	**Powering the Community: Energy and Human Health** **Amory Lovins** CEO and Founder Rocky Mountain Institute
4:20	**Panel Discussion and Audience Participation** **Panel Members:** •J. Christian Bollwage, Elizabeth, New Jersey •Bob Bullard, Clark Atlanta University •M`ndy Fullilove, Columbia University •Bernard Goldstein, Robert Wood Johnson Medical Center •Amory Lovins, Rocky Mountain Institute •William McDonough, University of Virginia
5:00	**Adjourn**
WEDNESDAY, JUNE 21, 2000	
8:00 a.m.	**Opening Remarks** **Lynn R. Goldman, M.D., M.P.H.** Adjunct Professor Department of Health Policy and Management The Johns Hopkins School of Public Health
8:15	**Special Address** **David Hayes, J.D.** Deputy Secretary of the Interior U.S. Department of the Interior

SESSION III: HUMAN HEALTH AND THE SOCIAL ENVIRONMENT

Moderator: Mark R. Cullen, M.D.
Professor of Medicine and Public Health
Yale University School of Medicine

8:45 **Sustainable Development, Environment, and Health**
Nicholas Ashford, Ph.D., J.D.
Professor of Technology and Policy
Massachusetts Institute of Technology

9:05 **Sustainable Business, Economy, and Health**
Jeffrey Feerer, Ph.D.
Environmental Health and Safety Manager, Michigan Operations
Dow Chemical Company

9:25 **Health and the Urban Environment: The Forgotten Ecosystem**
Thomas A. Burke, Ph.D., M.P.H.
Associate Professor
Department of Health Policy and Management
The Johns Hopkins School of Public Health

9:45 **Audience Participation: Questions and Comments**

10:00 **Socioeconomic Status and Health**
Nancy Adler, Ph.D.
University of California, San Francisco
Center for Social and Behavioral Sciences

10:20 **Nutrition and Healthy Life-Styles**
Bill Dietz, M.D., Ph.D.
Director
Division of Nutrition and Physical Activity
Centers for Disease Control and Prevention

10:40 **Community Participation**
Donald B. Conroy, S.T.L., Ph.D.
President
International Consortium on Religion and Ecology, Washington, D.C.

11:00 **Education**
David Orr, Ph.D.
Director, Environmental Studies Program, Oberlin College

11:20	**Audience Participation: Questions and Comments**
11:30	**Panel Discussion and Audience Participation** **Panel Members:** • Nancy Adler, University of California, San Francisco •Nicholas Ashford, Health of the Industry Workforce •Thomas Burke, The Johns Hopkins School of Public Health •Donald Conroy, International Consortium on Religion and Ecology •Bill Dietz, Centers for Disease Control and Prevention •Jeffrey Feerer, Dow Chemical Company •David Orr, Oberlin College
12:00 noon	**Lunch**

SESSION IV: REBUILDING THE UNITY OF HEALTH AND THE ENVIRONMENT

1:00 p.m.	**Summary Panel Discussion and Audience Participation** **Moderator: Lynn R. Goldman, M.D., M.P.H.** Workshop Chair Adjunct Professor Department of Health Policy and Management The Johns Hopkins School of Public Health **Panel of Session Moderators:** •Session I Moderator, Larry Reiter •Session II Moderator, Donald Mattison •Session III Moderator, Mark Cullen
2:15	**Bringing It All Together: Where Do We Go from Here?** **Samuel H. Wilson, M.D.** Deputy Director National Institute of Environmental Health Sciences National Institutes of Health **Dick Jackson, M.D., M.P.H.** Director National Center for Environmental Health Centers for Disease Control and Prevention

3:00	**Closing Remarks and Adjournment** **The Honorable Paul G. Rogers** Chair Roundtable on Environmental Health Sciences, Research, and Medicine Hogan & Hartson Washington, D.C.

APPENDIX B

Speakers and Panelists

Nancy Adler, Ph.D.
Center for Social and Behavioral Sciences
University of California, San Francisco

Nick Ashford, Ph.D., J.D.
Professor of Technology and Policy
Massachusetts Institute of Technology

Mayor J. Christian Bollwage
Mayor, City of Elizabeth, New Jersey

Joseph Brain, S.D. Hyg.
Chair, Department of Environmental Health
Harvard School of Public Health

Bob Bullard, Ph.D.
Director of the Environmental Justice Resource Center
Clark Atlanta University

Thomas A. Burke, Ph.D., M.P.H.
Associate Professor, Department of Health Policy and Management
The Johns Hopkins School of Public Health

Reverend Dr. Don Conroy
President
International Consortium on Religion and Ecology
North American Coalition on Religion and Ecology

Mark R. Cullen, M.D.
Professor of Medicine and Public Health
Yale University School of Medicine

Bill Dietz, Ph.D.
Director, Division of Nutrition and Physical Activity
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APPENDIX C

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