The Post Carbon Reader Series: Health

Human Health and Well-Being in an Era of Energy Scarcity and Climate Change

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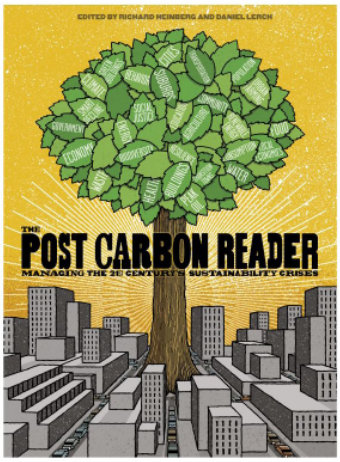

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This publication is an excerpted chapter from *The Post Carbon Reader: Managing the 21st Century's Sustainability Crises*, Richard Heinberg and Daniel Lerch, eds. (Healdsburg, CA: Watershed Media, 2010). For other book excerpts, permission to reprint, and purchasing visit http://www.postcarbonreader.com.

In the past hundred years, we have created lifestyles, communities, food systems, water systems, transportation systems, and health systems that are entirely reliant on cheap and plentiful oil and that assume a favorable and stable climate. Our health and well-being have been shaped by these lifestyles and systems, but they have not necessarily been well served: Climate change and the threat of energy scarcity now pose serious challenges to our "health system," specifically health care services and public health services.

The consequences of climate change and energy scarcity will be wide ranging and complex, will affect all aspects of our lives, and will touch all people—some more so than others. Energy scarcity will result primarily in reduced capacity, capabilities, and services in the health care and public health systems. Climate change will cause new and increased demands on our current capabilities and services. Without preparation, early responses to these challenges will likely be motivated simply by rising and volatile energy prices—and characterized by trial and error, incorrect decisions, and highly politicized debate. Fortunately, we can plan ahead to provide communities with the essential capabilities and resources they'll need to be resilient, safeguarding individual and family health in an increasingly uncertain future.

Health and Its Many Determinants

> *Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.*
>
> —World Health Organization, 1948

PHYSICAL, MENTAL, AND SOCIAL WELL-BEING

A definition of health as merely the absence of disease is much too limiting. The broad definition of health above was formulated more than sixty years ago and has remained widely useful. Although *physical* health is important to well-being, humans also need *mental*

health, which starts with the absence of mental illness but also includes such concepts as freedom from fear of personal harm, freedom from fear about not meeting basic needs (food, water, shelter, safety), and so on. In addition, we are *social* creatures and require a sense of community: stimulating, trusting, and regular interactions with others, plus a sense of usefulness, satisfaction, and security in what we do and how we live our lives as members of groups. Without all three kinds of well-being—physical, mental, and social—we are not healthy.

When health and well-being have been defined broadly, it becomes easier to understand what the health impacts of energy scarcity and climate change are likely to be. Many things that are not considered to be "health related" *per se* are nevertheless important determinants of health; all of the factors below contribute to physical, mental, and social well-being—or lack thereof—and each of these is likely to be influenced by the coming energy and climate challenges:

- Community economic vitality
- Employment rate
- Social stability
- Neighborliness
- Dependability and affordability of basic needs like food and water

Climate change and the threat of energy scarcity now pose serious challenges to our health system.

- Urban planning and design
- Reliable transportation systems
- Discrimination
- Political/military conflict
- Population dislocation/mass migration
- Confidence/worry about the future
- Equity/inequity
- Freedom of/restrictions on movement
- Disaster preparedness (how communities respond to droughts, floods, and heat waves)
- Availability of public health and health care services

Researchers studying what affects the health of society as a whole (as well as the health of smaller social groups) have identified "large-scale" factors far outside of an individual's control that can have profound influences on health.[1] For example, while tobacco smoking, inactivity, high-fat diets, high-salt diets, and obesity account for a large share of the world's incidence of heart disease, there is also substantial risk associated with adverse socioeconomic conditions. Thus, while many of us acknowledge that our behaviors influence our health in good ways and bad, few recognize the social context in which health-related behaviors occur and become socially patterned.[2] These social determinants of health are critically important and go a long way toward explaining different rates of disease across populations.

RISK REGULATORS

Human actions and behaviors are influenced by many different dynamics and at many different scales. Here are just a few:

Dynamics	Scales
Cultural	Global
Economic	National
Environmental	Community
Historical	Workplace
Political	School
Religious	Family
Social	Individual

The opportunities and constraints created by these dynamics are called *risk regulators*, defined as features and phenomena of the social and built environments that shape, channel, motivate, and induce behavioral risk factors for adverse or good health outcomes.[3] For example, the ongoing war in the Congo that began in 1998 has been responsible for more than 5 million civilian deaths through 2009. Many of these persons

did not die of war *per se*, but rather from the collapse of social and environmental life-support systems such as housing, public health, food, and water. The conditions created by the war exacerbated risks to public health beyond the immediate effects of the war itself.

The health threats of climate change and energy scarcity can be thought of in the same way. Climate change and energy scarcity have direct effects on health, such as through extreme weather events and the impacts of rising fuel prices on dietary choices. But they will also increasingly affect other systems that are essential to public health around the world, from food and water to economic activity and political stability. In addition, they will change the advantages and disadvantages different populations have for dealing with these crises. Some people and communities will find new opportunities in the changes brought by climate change and energy scarcity, but many more will be confronted with new and greater constraints. Most especially, populations that are already starting out disadvantaged in terms of resources, health, and political power—or with less of what might be termed *resilience*—will be more severely impacted.

HEALTH AT RISK

One of the most important determinants of risk to our health in the United States has turned out to be the spatial organization of our communities. We have spent the last sixty years building a physical infrastructure—including highways, office buildings, housing subdivisions, and shopping malls—that was entirely shaped by the availability of cheap and plentiful oil. Homes are far removed from jobs, services (including health services), and even places for recreation and social gathering—all things we need for our well-being. Thus our built environment becomes an important health risk regulator as energy scarcity makes distance more of an obstacle.

Another unexpected determinant of health risk is what might be termed our "provisioning system"—that is, the ways in which we provide our communities with the goods they need. The manufacture and transport of most goods will be impacted in obvious ways by the challenges ahead, but the health risk of the food system is probably the most worrisome. Our food generally comes to us from industrial models of food production, thousands of miles away and completely dependent on fuel, pesticides, herbicides, fertilizers, and plastics made from petroleum and natural gas—a very vulnerable situation in a future of oil prices double or even triple what they are today. In addition, climate change threatens to bring not just more crop-damaging extreme weather (especially droughts/floods) but major shifts in agricultural zones and pest ranges.

Climate change and energy scarcity will create direct challenges for our health system, but they will also create myriad *indirect* problems for health simply because of how we have built and provisioned our communities and economies up until now.

SUSTAINABLE WELL-BEING

Dr. John Holdren, currently the lead science and technology policy adviser in the Obama administration, has argued that human well-being rests on a foundation of three pillars of conditions and processes[4]:

- *Economic:* production, employment, income, wealth, markets, and trade.
- *Sociopolitical:* national and personal security, liberty, justice, law, education, health care, science, arts, civil society, and culture.
- *Environmental:* air, water, soils, mineral resources, living organisms, and climate.

For sustainable human well-being, each is indispensable, none can be identified as the most important, and the three are highly interdependent. What Holdren did not make explicit was that energy scarcity and climate change will adversely influence each of the three pillars and limit options for responding to the tremendous challenges they create. He highlighted the "energy-economy-environment dilemma" that reliable and affordable energy is essential for meeting human

needs, but the way we currently use energy is responsible for many challenging environmental problems. According to Holdren, "energy is the hardest part of the environment problem; environment is the hardest part of the energy problem; and resolving the energy-economy-environment dilemma is the hardest part of the challenge of sustainable well-being for industrial and developing countries alike."

Recent U.S. national-security reports state that climate change will pose serious threats to national security because it will likely increase poverty, lead to serious environmental degradation, and weaken national governments—findings that are interestingly similar to Holdren's three pillars and the idea of risk regulation.[5] A growing number of analysts are viewing climate change and energy scarcity through these lenses and the conclusion is unmistakable: Climate change and energy scarcity pose unprecedented challenges to human health and well-being.

Health Care and Public Health

PHILOSOPHY AND PRACTICE

Most people are familiar with the *health care system*—its primary function is to take care of us when we get sick, and as such is often referred to as the "illness care system." Your doctor's office, clinics, hospitals, medical laboratories, outpatient surgical facilities, and diagnostic centers such as for MRIs are all part of the health care system. It focuses on the health of an *individual* who seeks the advice of a health care practitioner for a specific health problem. The practitioner then typically takes a history, completes a physical examination, performs some laboratory or other diagnostic tests, formulates a diagnosis, and then offers a treatment plan. While the health care system usually focuses on persons who are sick, it also offers clinical preventive services to detect disease early (e.g., colonoscopy for colon cancer, mammogram for breast cancer) or prevent it (e.g., immunization for influenza).

BOX 29.1
SARS and the Public Health System

The events surrounding the severe acute respiratory syndrome (SARS) epidemic of 2002–2003 provide a good example of the public health system in action, and also a good example of what can happen if it doesn't work well. The SARS epidemic began in Guangdong Province, China, in late 2002. For a variety of reasons, the response of the Chinese public health system was not adequate, and SARS spread rapidly, eventually infecting people in thirty-seven countries. Once the World Health Organization learned what was going on, however, public health professionals sprang into action to research and identify the cause of the illness, determine how it was transmitted and how to stop its spread, and inform public health agencies around the world. Here in the United States, monitoring and surveillance systems were set up to detect the first cases, make sure adequate treatment was obtained, and prevent the spread of the disease to others by tracing contacts and keeping infected persons separated from others. What could have become a global epidemic was reined in and successfully stopped by the public health system.

In contrast, people are generally less familiar with the *public health system* and how it differs from the health care system. The goal of the public health system is to improve and maintain well-being in *communities and populations* rather than in individuals. In the United States it is made up of local and state health departments, public health laboratories, and the Centers for Disease Control and Prevention (CDC), all staffed with specially trained public health professionals. The public health system is most visible in its work to detect and stop outbreaks of infectious diseases (see box 29.1), but its functions also include:

- Working with government agencies to monitor air and water quality.
- Preparing for and providing services after a disaster (e.g., the provision of food, water, and shelter for affected residents).
- Enforcing health laws, such as by conducting restaurant inspections, to ensure health and well-being.
- Educating communities about good health-maintenance practices and informing the public about potential health hazards.

- Detecting, tracking, and responding to disease outbreaks.
- Mobilizing community members and organizations for health-related activities.
- Researching innovative solutions to health problems.

These are all useful functions not only for dealing with the consequences of climate change and energy scarcity, but also for working with the public to develop strategies for stabilizing the climate and preventing some of the negative consequences of energy scarcity.

CHALLENGES FACING THE HEALTH CARE SYSTEM

> *We have seen the impact of acute shortages on the health care system in patient transport via ambulance. After Hurricanes Gustav and Ike compromised refinery and transport capacity in the Gulf, the Southeast experienced a short-term fuel shortage, and in Atlanta our ambulances had to travel much farther than usual to fuel up. While service was maintained, this demonstrated for us the need to consider fuel storage for EMS organizations to maintain supplies in the face of acute shortages. It's the long-term price increases that are ultimately a greater concern, however, as they will ramify throughout the health care system and are likely to cause significant inflation in health care costs above and beyond what we're already seeing from other sources. It's a strain that our health care system likely cannot bear.*
>
> —Dr. Jeremy Hess, Emergency Room Physician[6]

Hospitals are energy intensive, requiring high-technology diagnostic and patient-care equipment—and personnel to operate them—around the clock. Furthermore, concerns about spreading infection have led to the reliance on disposable single-use supplies and equipment, which contributes to the resource use of hospitals. Rising energy costs will add a significant burden to the future cost of providing illness care.

One of the most energy-intensive aspects of the health care system is emergency medical assistance. Current practice guidelines recommend that only the level of care required to stabilize the patient be provided in the field. The patient is then transported to a hospital emergency room or tertiary care provider such as a burn center or a trauma center to receive the majority of his or her medical care. Emergency transportation typically occurs in helicopters, with an average fuel mileage rate of about 10 miles per gallon (range is 1 to 15 miles per gallon, depending on flying conditions and the size and power of the helicopter), or ambulances, with an average fuel mileage rate usually less than 10 miles per gallon (although newer designs can approach 20 miles per gallon). Emergency medical transport companies faced economic hardship during the summer of 2008 when gasoline exceeded $4 per gallon. With petroleum prices increasing, the long-term feasibility of this system as currently configured is questionable.

Petroleum-based transportation of patients is also important to the health care system in non-emergency situations. Patients must typically transport themselves to clinics and hospitals to receive care, medical personnel must transport themselves to work every day, and patients are transported from one medical facility to another for specialty medical care or to be closer to family. Many rural areas are already experiencing what suburbs and urban areas might expect to see in a future

Petroleum is a basic manufacturing material for many medications and medical supplies.

of energy scarcity, with more difficult access to health care and more cost associated with transit to and from the hospital for routine or urgent care.

Petroleum is a basic manufacturing material for many medications and therefore its increasing scarcity could well make medications more expensive. Many people will likely be willing to bear the added cost for necessary medications; patients on fixed incomes, however, will find it more difficult to pay for needed prescriptions and their health will suffer accordingly. Petroleum is also a basic material in many medical supplies, especially those made of plastic such as intravenous bags and tubing, syringes, and oxygen masks. Plant-based alternatives may provide acceptable substitutes but will require testing for potential negative interactions with pharmaceuticals and body fluids.

CHALLENGES FACING THE PUBLIC HEALTH SYSTEM

> *The connections among the global just-in-time economy, energy availability, and public health are far more extensive than almost anyone can imagine.... [T]he public health community has been largely absent from this consideration and discussion of energy issues.*
>
> —Dr. Michael Osterholm, director of the Center for Infectious Disease Research and Policy (CIDRAP) at the University of Minnesota[7]

The public health system will face unprecedented challenges from energy scarcity and climate change. Threats to population health and the public health system's inability to deal with them will be even greater challenges than the already formidable issues facing individual health care.

The backbone of the public health system is the network of health departments in every state and locality. Energy scarcity will likely be felt first by these agencies in their budgets; transportation costs will be the first spike, but upstream transportation costs involved in providing materials and supplies will also rise, stressing already tight budgets in practically every area. Eventually, services will have to be cut and/or models of delivery redesigned.

Many communities are located in areas at risk from extreme weather, seismic or volcanic activity, sea-level rise, and freshwater floods. When such risks become actual events, immediate disaster response usually involves the rapid transport of massive amounts of medical supplies and personnel into an affected area. Disaster preparation for some events also involves the rapid evacuation of the population. With transportation costs rising as a result of energy scarcity, however, disaster planners will need to design new models for preparation and response.

Transportation is an integral component of the public health system. Although some direct services rely on individuals going to a clinic or office, many local and state health departments provide services that require department personnel to travel regularly. For example:

- Food inspectors must travel around to the places where food is stored, prepared, and sold.
- Outreach workers must travel to the homes of tuberculosis patients for many months to observe them taking their medicine—even after their symptoms are gone—so as to avoid spread of the disease.
- Investigations of disease outbreaks require health professionals to gather information from many sources in the community to ascertain the cause of the outbreak and devise a plan to stop it.

Challenges for Health in General

Until recently, most public discussion of the adverse health impacts of fossil fuels has focused on their combustion (i.e., air pollution) rather than on the overwhelming fossil-fuel dependence of the systems that influence our health.[8] This discussion needs to change, as discussed above, and it also needs to broaden to include climate change in particular and the interaction of energy scarcity with environmental challenges in general. The problem is that we are entering the era of energy scarcity at the same time that the effects of climate change, ecosystem degradation, and species and biodiversity losses are accelerating.

For more than a century, we have used cheap and plentiful energy to insulate ourselves from the negative health consequences of our environmental destruction. If we depleted fish stocks in one area, we trawled deeper and farther using cheap energy to harvest other species. If we degraded ecosystem services such as capturing, purifying, and storing freshwater, we used cheap energy to drill deeper into aquifers or built desalination plants, a direct way of converting energy into potable water. If drought adversely affected food production in one locale, we used cheap energy to transport food great distances from elsewhere. If severe storms impacted our cities, we used cheap energy to bring in relief supplies, rebuild, and, in some cases, put in place structures to lessen the effects of the next storm.

We will soon no longer be able to use cheap and plentiful energy to mask the effects of the massive environmental changes we've caused. Global climate change is occurring and if left unchecked will have severe consequences for the health and well-being of citizens of every nation. Even under the best-case scenarios, an average global temperature increase of 2 degrees Celsius (3.6 degrees Fahrenheit) above pre-industrial averages is inevitable. Even that seemingly small amount of average global warming will have significant health impacts.

Finally, energy scarcity and climate change have important implications for health disparities—that is, large differences in rates of disease for populations that differ by race/ethnicity or socioeconomic status. These concerns are already a key challenge for public health but are likely to get much worse as populations face the local effects of climate change, increasing or volatile energy prices, and international population movements forced by these challenges. Local movements of people, including wealthier, previously suburban-dwelling families returning to cities and displacing predominantly poorer minority families, will also influence population health.

HEAT STRESS AND WORSENING AIR QUALITY

Global warming is tracked by following the average global temperature, but averages can be misleading. For example, relatively small average temperature increases mask one of the hallmarks of climate change: more frequent and longer-lasting severe heat waves. In 1995, a heat wave hit Chicago resulting in more than 700 deaths; more than 45,000 people died in heat waves during the summer of 2003 in Western Europe; and the summer of 2006 brought scorching heat to much of the United States and Canada, killing 300 in California

alone and sending tens of thousands to emergency rooms and hospitals.[9]

Some people are more vulnerable to heat than others, including babies, children, the elderly, the poor, those who live in inner-city neighborhoods, and the socially isolated (again highlighting the importance of social well-being). More Americans die every year from heat stress than from any other weather-related event, with the exception of Hurricane Katrina. Computer models suggest that if climate change occurs unabated ("climate chaos"), by 2040 heat waves as severe as the 2003 event that killed so many people in Europe could occur every other year.[10]

Heat waves are especially deadly because warmer temperatures worsen air quality. For example, higher temperatures increase concentrations of ground-level ozone (the primary component of smog and an important contributor to global warming), which damages the lungs, blood vessels, and heart. People who have asthma and other breathing disorders are especially vulnerable to the effects of ozone, requiring more medications and leading to more emergency-room visits and hospitalizations. The combination of high temperatures and high ozone concentrations is especially deadly and plays an important role in the numbers of people who die during heat waves.[11] Other kinds of air pollution are expected to get worse with climate change as well.

Air conditioning is a partial and temporary fix for heat waves but requires substantial amounts of electricity. With the majority of the American electricity supply coming from burning coal, the use of air conditioning over the long term will only exacerbate the climate problem. Making matters worse, power plants themselves become overheated during heat waves and are sometimes forced to shut down, as happened in Greece during heat waves in 2007 and in the U.S. Southeast during the 2006–2008 drought. Energy production is also expected to be constrained by climate change because of impacts on local precipitation cycles, reducing river flows. We simply cannot solve our climate-related health challenges by increasing our energy use.

BOX 29.2
Climate Change and Dengue Fever

Bill McKibben, as quoted in "Americans Who Tell the Truth"

I wrote the first book [*The End of Nature*] on climate change in 1989, so I've been writing and speaking about it for a long time. But some years ago I took a trip to Bangladesh to do some reporting. And while I was there they were having their first big outbreak of dengue fever, a mosquito-borne disease now spreading like wildfire because of global warming. Since I was spending a lot of time in the slums, I got bit by the wrong mosquito myself.

I was as sick as I've ever been, but because I was healthy going in, I didn't die. Lots of people did, mostly old and young. I remember standing in the hospital ward looking at rows of cots of shivering patients, and thinking to myself: these people did nothing to deserve this.

You can barely measure how much carbon Bangladesh produces: a nation of 140 million, but most of them don't have electricity or cars. Whereas in the U.S. 4% of us manage to produce 25% of the world's carbon dioxide. A quarter of those hospital beds were our fault.

When I figured that out in my gut, I came home and started organizing, and that's what I've been up to ever since.

Source: Americans Who Tell the Truth, "Bill McKibben," http://www.americanswhotellthetruth.org/pgs/portraits/bill_mckibben.php.

INFECTIOUS DISEASES

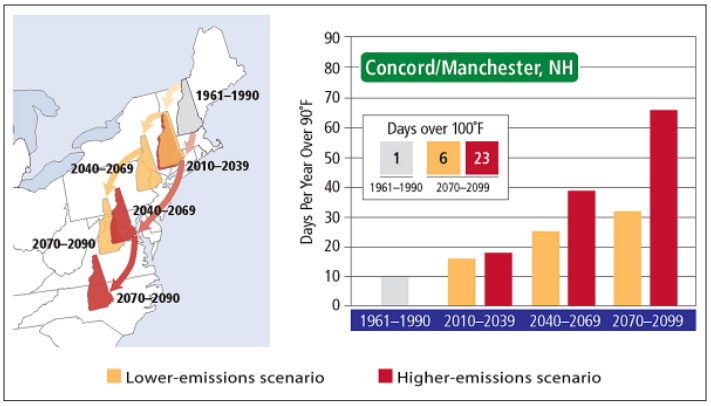
Warmer temperatures, milder winters, precipitation changes, and other effects of climate change can influence the distribution and risk of many infectious diseases. Debilitating and deadly insect-borne diseases such as malaria, dengue fever, and Lyme disease are especially sensitive to changes in temperature, humidity, and rainfall patterns and will likely increase their ranges and possibly their transmissibility (see box 29.2). Waterborne infectious diseases will also be influenced by warmer temperatures, changes in precipitation patterns, and the compromised ability of degrading ecosystems and suboptimal built environments to deal with heavy precipitation events.

THREATENED WATER AND FOOD SUPPLIES

Clean water is vital to life and health, but climate change will seriously threaten water supplies around the world. In general, regions that are typically wet now will get wetter and those that are dry now will likely get drier. Even wetter regions, however, may still experience frequent bouts of water shortages because more of the precipitation will come in the form of heavy precipitation events, leading to greater runoff of stormwater and longer periods of droughts in between rain events.[12]

Much of the world's population gets its freshwater from glaciers and mountain snowpack. Mountain ranges collect water, purify it, store it as ice or snow, and release it over time into streams and rivers. Global warming has already caused many of these glaciers and snowpacks to melt far more rapidly than expected. If glaciers in the Andes continue melting at present rates, they will likely disappear completely within one or two decades. The Himalayas are melting so fast that Chinese and Indian farmers are seeing more river water than usual, making it even harder to motivate the water-conserving changes necessary as these glaciers—which provide freshwater for more than one-sixth of the world's population—disappear. Much of the western United States is in a similar situation, relying on the threatened snowpack of the Rocky Mountains, the Sierra Nevadas, and the Cascade Range for much of its water. This has serious implications for the entire country: The farms of California alone account for approximately half of U.S.-grown fruits, nuts, and vegetables and more than one-fifth of the milk supply.[13]

There are many reasons why the effects of climate change could lead to diminished food supplies. Plants require certain amounts of moisture and nutrients and can live only in particular temperature ranges. With climate change, previously productive agricultural zones are becoming too hot or too dry to grow some traditional crops, forcing the production of those crops northward or eliminating their cultivation altogether. For example, by the end of the century the climate of New Hampshire is projected to be like that of North Carolina today.[14] Unfortunately, the plant and animal species in New Hampshire evolved over hundreds and thousands of years to take advantage of the climate of northern New England, not the climate 800 miles to the southwest.



By the end of the century the climate of New Hampshire may be like the climate of North Carolina today. (Image source: Northeast Climate Impacts Assessment, *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions*, 2007).

Other negative climate effects on agriculture include:

- More frequent, longer-lasting, and more severe droughts and floods
- Warmer temperatures
- Chronic water shortages
- Higher concentrations of ozone and other air pollutants that hamper plant growth
- Stronger and more resistant plant pests and diseases

Energy scarcity promises to further compound our food-production challenges. The American food supply has become reliant on fewer and larger farms using a number of fossil-fuel inputs in the form of fertilizers, pesticides, pump irrigation, heavy machinery, and long-distance transport to accomplish what was once done by many people, locally, without the various fossil-fuel inputs. Constant erosion of topsoil and cultivation of single-plant crops have led to a reliance on chemical fertilizers created from natural gas and chemical pesticides largely derived from petroleum. Practically all

Climate change promises to bring more extreme weather events which increase the risk of injury and death.

communities now rely on food produced using these methods and transported long distances—frequently from other regions of the United States, other countries, or even from the other side of the world—to arrive at our grocery stores. Without a steady supply of inexpensive fossil fuels, especially petroleum, the current American food system will not function—and health depends on an adequate supply of nutritious food.

EXTREME WEATHER EVENTS

The most well-known effect of climate change is rising sea levels, which threaten coastal areas with inundation. Climate change also promises to bring more severe and potentially more frequent extreme weather events such as hurricanes, tornadoes, and heavy rainfall, all of which increase the risk of injury and death and cause social disruption (itself an important cause of adverse health impacts). With more of our precipitation coming in less-frequent heavy-rainfall events, freshwater flooding is becoming a greater problem, creating both immediate and long-term risks. A recent study documented that the majority of outbreaks of waterborne disease in the United States occurring between 1948 and 1994 followed heavy-rainfall events that overwhelmed water treatment facilities.[15] Another study found that flood survivors often experience greater risk of chronic diseases such as diabetes and heart disease long after the floodwaters have subsided.[16] For decades, evidence has mounted that centuries of building levees and draining wetlands has increased the risk of flooding—another example of how the decisions we make about our communities and economies can indirectly but profoundly affect public health risks.

Other evidence of how failed ecosystems wreak havoc on human settlements, compromising health and well-being, includes the finding that intact coastal wetland ecosystems might have reduced the height and/or speed of the storm surge created by Hurricane Katrina in 2005 and possibly prevented the resultant flooding that devastated New Orleans.[17] The loss of these coastal wetland ecosystems is largely due to human activities such as offshore oil drilling and refining, importation of invasive species, and boxing in the Mississippi River so that it is no longer able to deposit sediment to replace coastal land lost to erosion.

CONFLICT AND HEALTH

Competition for shrinking environmental resources, especially the necessities of water, food, and housing, could potentially result in greater conflict within and between geopolitical entities. There is ample evidence that the scarcity of environmental resources has played an important role in many areas of conflict, such as the genocides that devastated Rwanda and continue to occur in Darfur, the ongoing clashes between Zapatista rebels and the federal government in Mexico, and the

decades-long modern Israeli-Palestinian conflict.[18] That is, what have been termed "ethnic conflicts" have actually been exacerbated by, if not directly caused by, environmental scarcity. Such conflicts will increase in the era of energy scarcity and climate change. In addition, the number of environmental refugees created by rising sea levels and failure of the local ecosystems to meet basic needs could increase by many hundreds of millions.[19] These refugees will face a greater risk of attack and conflict if they must cross political or cultural borders and will face the same hardships in many countries as those who flee war zones. As climate change worsens the gap between those with resources and those without, social unrest may worsen and spread into previously stable areas. This is another example of a risk regulator. If left unchecked, environmental degradation and the challenges it creates can ultimately threaten the basis of society itself.

MENTAL HEALTH EFFECTS

The risks to mental well-being in a future of energy scarcity and climate change are quite significant. Examples include persons forced from their homes due to extreme weather events; the inability of the environment to provide sufficient food and water; individuals faced with job loss, separation from family and friends, and concern about the future; and persons coping with the various disruptions to life caused by an unstable climate. Such mental health outcomes as depression, anxiety, and post-traumatic stress disorder are expected to increase as a result.[20]

The Future of Health Care and Public Health

What health care and public health services will look like in a world constrained by energy scarcity and climate change depends on the choices we make in response to these challenges—and what happens to economies and communities as a result.

Energy prices will influence where people live and how they transport themselves from place to place. It is likely that these changes will influence future communities to be more compact, higher density, and more walkable; to contain a mixture of residential, commercial, and even recreational uses; and to be transit accessible. At the same time, populations will be on the move from the effects of climate change, including extreme weather events, drought, sea-level rise, declining food production in some areas, and the inability to make environments hospitable owing to energy costs. To meet the needs of an energy-constrained future, the public health system as well as the health care system will need to be redesigned.

Unfortunately, policy discussions about reforming the health care system have not mentioned energy scarcity or climate change. The next iteration of our health care system must nevertheless be designed to meet these challenges and function within their constraints. In general, the allocation of financial resources, personnel, and energy should be shifted to favor public health and preventive services—for all members of society—instead of focusing primarily on illness care. More than anything else, this would result in lower energy requirements for the health care system while building more resilient communities nationwide, benefiting all citizens at all socioeconomic levels.

There are many other opportunities to improve health care and public health while preparing for the energy- and climate-constrained future. Of these, the three largest have to do with delivery of services, disaster response, and food.

DELIVERY OF SERVICES

The most immediate challenge to health in the United States is the sheer energy intensity of our current health care system. We present four basic ways in which this challenge could be met. In reality, a combination of many approaches will likely be needed.

1. *Reorganize where care is provided.* For many years the trend has been to centralize health services in larger hospitals and reduce services in or even close smaller hospitals. Care for rare or complicated illnesses will need to remain in centralized high-level hospitals, but smaller hospitals and care centers that could care for most medical problems could be more numerous and located at midlevel transportation hubs for easier access. Health services could even be brought directly into neighborhoods, through many small, scattered, local "pods" of public health workers who are able to perform many functions in their specific neighborhoods. Many of these changes would require reworking the way public health professionals are educated and trained.

2. *Use technology to decentralize more services.* Remote imaging and video conferencing technologies, which allow specialists at larger institutions to diagnose and treat patients remotely, can be used to improve care at decentralized facilities. These technologies can also be used to develop and monitor skills in localities and to transfer skills there. Of course, such high-tech solutions would require energy and resources to put into place and to maintain. As transportation becomes more expensive, new models of health service delivery will be required.

3. *Practice medicine differently.* Some energy-intensive procedures may not be medically necessary. We recommend reducing reliance on energy-intensive diagnostic procedures when those procedures are used only to confirm what a physician knows from a physical exam and less invasive tests. This would require changes to how health care providers are reimbursed and might also require a change in the liability laws so that health providers do not feel obligated to defend their clinical judgment from potential lawsuits with unnecessary diagnostic tests.

4. *Plan for smart decision-making about energy usage.* As fossil-fuel supplies decline, the costs of transporting goods and people, powering facilities and machines, and manufacturing synthetic products will all rise. The health care industry should follow the example of most other industries and push for greater energy efficiency in its facilities and technologies. It may also be necessary to consider how the increasingly scarce resources will be apportioned for energy use (e.g., emergency medical transport) versus materials use (e.g., pharmaceuticals, plastics).

DISASTER RESPONSE

Disaster responses currently rely on the ability to ship in resources and personnel from afar and to evacuate large populations if necessary. As energy prices rise, disaster preparedness will need to focus far more on building local resources and training local personnel. Emphasis should shift from disaster response to disaster prevention and preparedness based on a community's specific areas of vulnerability. Typical efforts to reduce future impacts of disasters, such as building more and taller seawalls or drainage systems, may also be limited by energy scarcity. Alternative—and often smarter—approaches will be required, such as changing zoning regulations to disallow additional development in high flood-risk areas and using native vegetation along wetlands and waterways to buffer storm surges and reduce erosion.

FOOD

Like most other industrialized countries, the United States will need to redesign its methods of producing, importing, and distributing food. Our eating habits will need to change. No longer will much of the nation be able to eat fresh fruits and vegetables flown in from California, South America, and elsewhere in the dead of winter. Instead, during natural harvest times, produce will have to be canned, dried, or otherwise preserved for consumption during the off-season. The public health system can play an essential role in building local food resilience by supporting and educating about:

- Localized food production and processing
- Farmers' markets and regional purchasing by groceries and supermarkets
- Gardening and farming projects in schools and by community groups
- Regional and seasonal cuisine
- Safe food handling and food preservation (canning, drying, etc.)

One significant benefit of increasing local food production is a greater supply of fresh food (if only seasonally for some locations), which often is less processed, better tasting, and more nutritious. Food production may ultimately need to occupy a greater proportion of time for many individuals than has become the norm over the last hundred years. Yet another potential benefit of this is the building of social capital as communities work together to grow and process food, securing a mutually shared food future.

How We Can Adapt

The effects of climate change will create new demands on our health care system and for public health services. We must prepare for this reality, while also doing everything we can to reduce our contributions to global warming. All the health system adaptations we can envision and all the ways to enhance community resilience that we can call for—much less implement—will not be enough if the climate is not ultimately stabilized.

All forms of energy, other than passive warming from the sun, have an environmental and a societal cost. Therefore, using less energy or using it more efficiently should be a primary societal goal, regardless of where that energy comes from. To accomplish this goal, housing patterns, transportation options, food and water provisioning, and many other aspects of our lives will all have to be redesigned to require substantially less energy from any source. Energy scarcity will force these decisions upon us, but hasty decisions to replace petroleum with other liquid fuels, such as ethanol, biodiesel, or oil from oil sands, will only forestall the inevitable for a short time and will greatly aggravate other problems, such as climate change and food and water insecurity.

Some options, however, for addressing the dual challenges of climate change and energy scarcity could make our communities better places to live. A stronger sense of community, greater emphasis on family and friends, less time spent in cars and commuting, and localization of economic activity and food production will all benefit health and well-being.

Transforming our health care and public health systems will require significant policy changes. It's essential that citizens educate their elected officials about the issues and demand prompt, well-informed, forward-looking solutions. This will not be easy, because the necessary changes will likely be seen as politically unpopular and volatile energy prices will encourage actions that do not necessarily serve society well in the long run. But if we make the right choices now, we can maximize the benefits and lessen the risks. The transition to the energy-scarce, climate-constrained future will create significant hardship if tough decisions about how to proceed are not made soon. However, the end result of a more self-sufficient, cohesive, resilient, and healthy society is worth the effort.

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Acknowledgments

Cover art by Mike King. Design by Sean McGuire. Layout by Clare Rhinelander.

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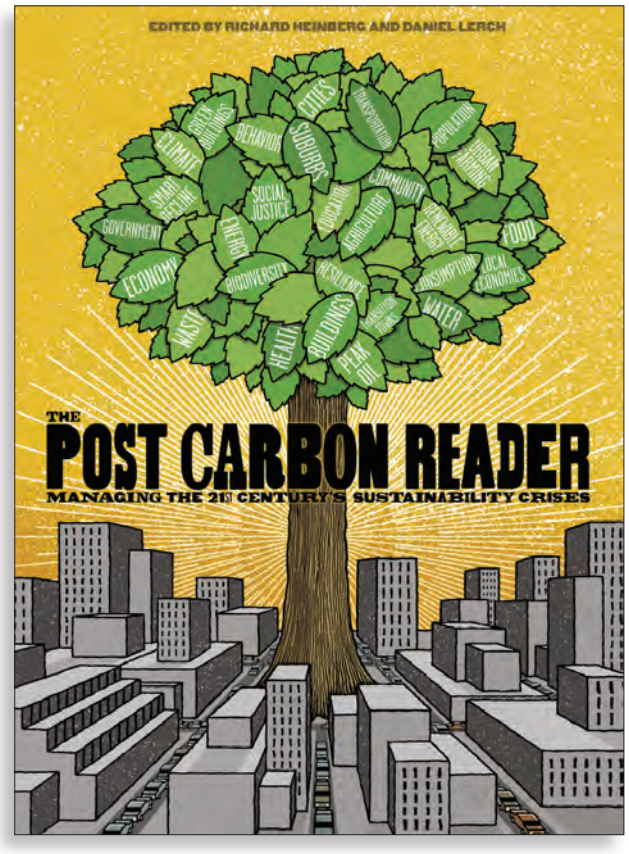

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