Global Health Mapping:

NEW BOUNDARIES OF RISK & OPPORTUNITY

INSTITUTE FOR THE FUTURE
Health Horizons Program
124 University Avenue, 2nd Floor
Palo Alto, CA 94301
650.854.6322 | www.iff.org
January 2006 | SR-970
Global Health Mapping:

NEW BOUNDARIES OF RISK & OPPORTUNITY
INSTITUTE FOR THE FUTURE

The Institute for the Future is an independent, nonprofit strategic research group with over 35 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide our members with insights into business strategy, design process, innovation, and social dilemmas. Our research generates the foresight needed to create insights that lead to action. Our research spans a broad territory of deeply transformative trends, from health and health care to technology, the workplace, and human identity. The Institute for the Future is based in Palo Alto, California.

HEALTH HORIZONS PROGRAM

The Health Horizons Program draws from a deep understanding of health care delivery, consumer behavior, health technologies, and societal forces to identify the important emerging trends and discontinuities in the broad health industry landscape. Then, through strategic forecasting, we help make sense of what these mean for health-related companies over the next three to ten years.

Acknowledgments

Author: Bern Shen
Contributors: Jody Ranck and Michael Leibhold
Editors: Peter Shanks and Robin Kerns
Art Direction and Design: Jean Hagan and Robin Bogott

©2006 Institute for the Future. All rights reserved. This report is proprietary for Health Horizons members. Reproduction prohibited without written permission.
## Contents

List of Figures ................................................................. iv
Executive Summary ......................................................... 1
1. Why Global Health Matters ............................................. 3
2. A Conceptual Framework: Health Risks, Inputs, Outcomes, and Opportunities .... 15
3. Redrawing Boundaries: Border-Crossing Forces ................. 21
4. Geospatial Data Analysis and Display: The Role of GIS ............ 25
5. Key Questions ............................................................... 31
Appendix I: Case Studies .................................................... 33
Appendix II: Glossary ......................................................... 41
Appendix III: References ..................................................... 43
Global health matters to a wide range of stakeholders for pragmatic as well as idealistic reasons. The human and economic costs of disease are substantial, whether they derive from infections, environmental causes, or structural issues such as poverty, lack of education, or armed conflict. One tool for usefully organizing an approach to this extremely complex set of topics is a conceptual framework of health risks, inputs, outcomes, and opportunities.

Another useful tool is health mapping, particularly using computer-based geographic information systems (GIS). New methods of geospatial data display and analysis can provide insight, decision support, and competitive advantage for a variety of stakeholders concerned with the impact of global health issues.

Although most international studies have used traditional geopolitical boundaries to define units of analysis, many forces in health cross these boundaries—for example, population migrations, epidemics and disease vectors, environmental hazards, and cultural beliefs. By delineating these border-crossing tendencies in new maps of health risk and opportunity, and by combining this new cartography of health with analysis of trends in health risks, inputs, outcomes, and opportunities, we can improve health- and business-related decisions.
In an increasingly connected world, traditional barriers of distance and geography no longer insulate us from health problems halfway around the world. Exotic diseases and pests can hitch rides in ships and planes and be at our doorsteps in hours or days. “Six degrees of separation” means being close not only to movie stars but also to teeming masses in São Paulo, Lagos, and Mumbai. The realities of global production and global value chains mean that most large firms in one way or another rely on developing countries, whether for raw materials, manufacturing, call centers, or markets. Because of these dependencies, only the most isolated corporations, government agencies, non-governmental organizations, and citizens can ignore global health issues when thinking about the future. The visible and invisible complex cascades of cause and effect that reach around the world mean that health problems in Chengdu and Bangalore can now impact boardrooms in Chicago and Boston. In this chapter, we outline the business case for global health and briefly review some major global health issues.
THE BUSINESS CASE FOR GLOBAL HEALTH

The business case for global health includes at least three categories of argument: the idealism of corporate social responsibility (CSR), the threats posed by a shrinking world, and the benefits of the virtuous circle of health and business.

Corporate Social Responsibility

Milton Friedman famously said, “The business of business is business.” But Ian Davis, worldwide managing director of McKinsey, points out that in fact we’ve moved beyond this to recognize that social issues are both fundamental to business and important indicators of future opportunities. While some corporations have included CSR in one form or another as a part of their business practice for generations, in the last few years there has been a noticeable growth of interest in the “triple bottom line” of social and environmental, and economic returns.

This interest is due to a confluence of negative public perceptions about corporations, a related decline in consensus that unbridled market forces are a panacea for serious health and economic disparities around the world, and the enabling effect of the Internet to foster increased transparency and to mobilize public opinion.

The negative public perceptions of corporations stem from a complex web of widely destructive corporate scandals at Enron, WorldCom, Tyco, AIG, and others; discomfort with the human costs of “Chainsaw Al” approaches to improving shareholder value; growing dissatisfaction with the disconnect between executive compensation and performance; and, of course, the highly visible cases of lapses in CSR that led to environmental disasters such as Love Canal and Bhopal, and to perceived corporate shortfalls in providing health benefits for workers both in the United States and abroad.

In February 2005, Sandy Weill, the chairman of Citigroup, urged corporations to get more involved in philanthropy to counterbalance the recent wave of accounting scandals that have tarnished the image of much of corporate America. Weill praised General Electric for launching a $20 million project to improve community health in Ghana. At the same conference, Novartis CEO, Daniel Vasella, underscored the point by claiming that “we are convinced that it not only makes sense from a humanistic point of view, but it is also of benefit from a business perspective to integrate universal principles and shared values into corporate activity.”

In other examples of CSR initiatives, Procter & Gamble—which consistently scores at or near the top of Business Ethics magazine’s list of the 100 Best Corporate Citizens—has donated funds to help combat childhood malnutrition in India, contributed to earthquake relief in Turkey, fostered cause-related marketing to help
deliver 11 million doses of TB vaccines to Senegal, and used one of their drinks to improve dietary micronutrient levels in Tanzania. Kimberly-Clark has engaged in an 8-year partnership with UNICEF to help children in Africa orphaned by AIDS or war, and Humana has operated an assistance project in Romania for 15 years.

Another widely cited positive example of corporate behavior is Merck’s donation—some years back of the drug ivermectin to combat river blindness. Note, however, that this didn’t confer a permanent halo for the company. A few years later, Merck suffered negative publicity for resisting the reduction of prices for antiretroviral drugs used to treat AIDS in developing countries. And Merck is currently involved in a serious imbroglio around its anti-inflammatory drug, Vioxx.

Consumers respond positively to CSR efforts. A recent survey by the Global Business Coalition on HIV/AIDS released in November 2004 revealed that two-thirds of top consumers across the United States said that they would pay more for a brand if they “knew that the extra money was going specifically to a program to fight AIDS.” These consumers also felt it was more important to be involved in HIV programs than the arts or the United Way.3

In contrast, Nestlé came under severe criticism in the 1970s and 1980s for its marketing of infant formula in a way that discouraged breast-feeding. More recently, Coca-Cola experienced the wrath of activists when it was perceived not to be doing enough to offer HIV prevention and treatment options as part of its health benefits package in Africa. In these cases and others, consumer boycotts tarnished brands and impacted bottom lines. The volatility and impact of consumer protests are quite likely to increase in coming years given the power of connective technologies such as the Internet, instant messaging, and cell phones, as well as the ubiquitous presence of global media.

Thus, CSR, including attention to global health issues, can be good for business in addition to being the right thing to do. In this arena, Europe leads the world, with a broad range of social labels and certifications, awards, codes of conduct and ethical guidelines, social reporting guidelines, legislation, and CSR toolkits. And beyond corporate social responsibility, the United States and other countries still have abundant opportunities to follow up on the recent G8 debt forgiveness initiative to demonstrate national or global social responsibility, including substantive support for the UN Millennium Development Goals.4
Shrinking World

A second argument for the business relevance of global health relates to threats from our shrinking world. The increasing number and speed of connections among points on the globe forges denser personal, institutional, economic, and health links within a tightly coupled, small world. We’ll look first at the potential downside of this linkage.

Soon, a billion people will cross international boundaries each year—an average of 25 per second (Figure 1.1)—and the increasingly dense network of global traffic in people and goods means that we’re increasingly intimately bound to events and people across the globe. From a network topology or epidemiological point of view, cities connected by direct flights begin to look like next-door neighbors no matter how far apart they are geographically.

The SARS outbreak in 2003 provides a good example. For the first few months, cases were confined largely to southeastern China, but in February 2003, an infected medical doctor from Guangdong checked into room 911 of the Metropole Hotel in Hong Kong. Within a few days, at least 14 people who spent time on the ninth floor of that hotel carried the SARS virus with them to the rest of Hong Kong, Viet Nam, Singapore, the United Kingdom, and Toronto. According to the Asian Development Bank, the economic impact of an epidemic that infected less than 7,000 people was so large that it cost the Asian Pacific region roughly 0.3 percentage points of GDP, nearly US$28 billion. The GDP loss in Canada was approximately US$1.5 billion; the cost for Toronto alone was nearly US$30 million a day for much of the period.

Less publicized, but even more worrisome than SARS, is polio. This once-dreaded scourge had been eliminated in all but six countries in the world when clerical opposition to vaccination in Nigeria enabled it to spread and make a comeback in Africa, reemerging in several countries where there had been no cases for a decade or more. And in a chilling development, polio recently hopped via a pilgrim to Mecca and then to Indonesia, the world’s fourth most populous country, where an outbreak of over 150 cases has sent officials scrambling to set up an emergency vaccination program.

As the above examples illustrate, the growing number and speed of links between points on the globe help to create what in systems theory jargon is called a “tightly coupled system”—one more vulnerable to volatility, instability, and what Perrow
terms “normal accidents” compared to systems that are more far-flung and decoupled. Perturbations can spread quicker, farther, and in a more nonlinear fashion in complex, tightly coupled systems, raising serious challenges to attempts to prevent or control the consequences. Computer viruses are a familiar example.

During the Asian financial crisis of 1997, which was explicitly likened to a “flu,” we saw how the “electronic herd” caused profound economic swings and crises in distant but interlinked parts of the globe. Likewise, two locales connected by a business dependency (for example, a seller-customer relationship) are also affected by the health of each other’s population. A disease outbreak on another continent may directly affect employees in your offshore office, call center, or manufacturing plant, with eventual impacts on your bottom line. Because of the ravages of AIDS, for example, costs for training replacements for those who have died at a young age or who must take time off to care for sick relatives or to attend funerals can increase dramatically for companies with facilities in many parts of Africa, Asia, or Latin America. This can be particularly problematic in an era of just-in-time production, when inventories are lean and speed is vital.

In addition to strict business dependencies, networks of personal ties can also be significant. Today, when 34 million Americans (nearly one in eight) were born abroad, ties to friends and family in their country of origin mean higher risks of both absenteeism and “presenteeism”—when employees come to work but are preoccupied and thus less productive. In this context, perhaps John Muir’s observation is apropos: “When we try to pick out anything by itself, we find it hitched to everything else in the Universe.”

In a tightly coupled world, the threat of pandemics becomes more stark. Figure 1.2 shows the dramatic impact of the 1918 flu pandemic on the U.S. infectious disease death curve, which otherwise improved smoothly for most of the twentieth century. With the world population having more than tripled since 1918, the human and economic toll of a similar outbreak from H5N1 or a related avian flu could be much higher. For those mathematically inclined, the spread of epidemics, like that of forest fires, can often be described as a Markov process; by analogy, if a forest is dense and dry enough, it doesn’t matter where you light the match—eventually the entire forest will be ablaze. Because in such a vulnerable network a multi-billion-dollar “incident”—like SARS or BSE (more commonly known as “mad cow disease”), which cost the United Kingdom $6–12 billion in lost trade, tourism, and

Figure 1.2
U.S. Death Rate from Infectious Disease, 1910–1990

Death rate from infectious disease per 100,000

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>First continuous municipal use of chlorine in water in the United States</td>
</tr>
<tr>
<td>1920</td>
<td>First use of penicillin</td>
</tr>
<tr>
<td>1940</td>
<td>Salk vaccine introduced</td>
</tr>
<tr>
<td>1960</td>
<td>Passage of Vaccination Assistance Act</td>
</tr>
<tr>
<td>1990</td>
<td>Influenza pandemic</td>
</tr>
</tbody>
</table>

indirect costs—can arise almost anywhere and have widespread effects, it’s becoming more imperative to improve public health and prevention worldwide.\(^8\)

This lesson has not been lost in national security circles, as confirmed by simulations of bioterrorist incidents such as the “Dark Winter” exercise involving a hypothetical smallpox attack on the United States.\(^9\) In an interesting twist, a recent RAND report observed, “Countries that do not pose an obvious military security danger may be the ones most likely to pose a disease risk owing to poorly developed and underfunded public health systems. Such possibilities will need to be recognized and factored into strategic threat analysis.”\(^10\)

**Virtuous Circle of Health and Business**

A third set of arguments for the relevance of global health focuses on the flip side of the threats just discussed. As markets in the United States, Europe, and Japan mature, companies increasingly look to the developing world as the locus of sustained growth and increased shareholder value, whether on the supply side (as sources of raw materials, low-cost manufacturing centers, and call centers) or on the demand side (as a customer base). This brings them up squarely against the need to deal with health problems in the developing world. Simply put, a healthier and better educated population will generally be a more productive workforce and consume more goods and services—including those aimed at improving health—thereby, with a few notable exceptions, producing a virtuous circle of health and business (Figure 1.3). Let’s examine this dynamic in more detail.

The connection between health and development comes from a wide research base but was probably stated explicitly for the first time in the *1993 World Development Report*,\(^11\) an annual report from the World Bank, which, with nearly $23 billion committed to projects since 1985, is probably the largest single source for health development aid globally.\(^12\)

Reports from the World Bank and other groups have amply demonstrated that high rates of HIV or other health problems increase the cost of doing business in sometimes invisible but dramatic ways. Rather than spending money on education, infrastructure, and other priorities, countries must divert resources to cope with the multidimensional effects of the HIV epidemic. At some point, it makes eminent business sense to invest in programs that can prevent infectious diseases and poverty from worsening. Paul Farmer’s inspirational work in Haiti is one of the earliest and most striking examples of recognizing the importance of attacking disease by addressing structural problems such as joblessness, lack of education, and poverty.
Even industrial giants such as DeBeers have openly recognized that the price of diamonds and the cost of doing business have increased dramatically due to the HIV epidemic. They and other firms have replaced workers’ hostels with family housing and brought down infection rates considerably due to the fact that these new living arrangements prevent spouses from being separated for long periods of time. Likewise, India’s Tata corporation, which builds most of the heavy machinery and trucks used to transport goods throughout India, has been at the forefront of developing “safe trucker and highways” initiatives, recognizing that these transportation routes are also the main arteries for the spread of HIV.

One important example of how the private sector can work to address problems such as HIV is the Strategic Simulation conducted by Booz Allen Hamilton in New Delhi in 2003. Key stakeholders from business, civil society, and government formulated strategies to address the epidemic proactively. By bringing together diverse stakeholders, they were able to open up lines of communication, take stock of lessons, avoid replicating services, identify gaps in funding, and develop new collaborations. By agreeing that effectively dealing with HIV required broader support of the primary health care system and other infrastructure, they were able to design 53 new partnerships and 100 new initiatives that were projected to prevent a simulated loss of $31.5 billion in GDP and prevent a loss in discretionary spending of nearly $9.2 billion in the next decade.

Through explorations like this, many multinationals have come to realize that the base of the global consumer pyramid—the vast majority of the earth’s population that live in poverty yet have higher aspirations—can be an important set of markets for consumer products, electronics, telecommunications, and pharma, to name a few. Whether as part of CSR, as a result of our shrinking world, or as part of the virtuous circle of health and business, through promoting good health across the globe it’s possible to both do good and do well.

A BRIEF OUTLINE OF MAJOR GLOBAL HEALTH ISSUES

Given the above business case for global health, let’s now look at the size and impact of some key diseases.

Global Burdens of Disease and Health Disparities

Burdens of disease vary in type, severity, and location in complex ways. If we look at the causes of poor health worldwide, the top two, malnutrition and poor water and sanitation, point to enduring health risk disparities between rich and poor (Table 1.1 on page 10). Malnutrition, which affects one in eight people worldwide, remains perhaps the single most important global risk factor for ill health and is
related to poor water and sanitation. Around the world, infectious diarrhea strikes roughly 100 children every second and kills a child every 15 seconds.

If we look at the major causes of death, however, it becomes clear that it is too simplistic to say that developing countries are plagued by “diseases of too little” while developed countries have to deal with “diseases of too much” (Table 1.2). To be sure, cancer and diabetes are more common causes of death in developed countries while perinatal and infectious diseases are more of an issue in developing countries, but ischemic heart disease and stroke lead both lists, and pneumonia and chronic obstructive pulmonary disease (COPD) both sit among the next four causes of death on both lists. The apparent paradox of both malnutrition and obesity as major health problems, often in the same country or even family, is a clue to a theme we’ll come back to later—that of overlapping risks.
A common tool for thinking about burdens of disease is the notion of the “disability-adjusted life year,” or DALY. Introduced in the World Bank’s 1993 World Development Report and subsequently extended by WHO and the Harvard Burden of Disease research group, this methodology basically assigns a weight from 0 to 1 to each year of an individual’s life, with 0 being death and 1 perfect health. This forms the basis for a calculation of the total amount of healthy life lost, whether from disability (physical or mental) or premature death.

The DALY framework is intended to create a consistent measure of disease burden, to enable cost-effectiveness studies across diseases and interventions, and thus to help evaluate and prioritize health interventions. For example, if having HIV decreased your weighting factor from 1 to 0.5, then over a 10-year period you will have lost 5 DALYs. Conversely, if taking antiretroviral drugs restored your weighting factor to 1, over a 10-year period you will have gained 5 DALYs. If (in the United States) the cost of the drugs over those 10 years was $20,000, the cost per DALY would be $20,000 ÷ 5 DALYs = $4,000 per DALY saved. By way of comparison, public health measures in developing countries are considered good values if they cost less than about $150 per DALY saved, and excellent values if they cost around $5–50 per DALY saved. Table 1.3 shows the cost per DALY and the cost per capita per year for some basic public health measures.

Although the DALY concept is quite useful, we should note that it has been critiqued on several grounds:

• The method for determining the weighting factors for various conditions is complex and may be flawed.
• The approach implicitly assigns a lower value to health programs aimed at extending the lives of disabled people compared to those for people without disability.
• Discounting future health gains and losses disadvantages preventive medicine, children, and future generations.
• Age weighting, which is part of the method, handicaps children and old people.
• DALYs focus on the societal usefulness of people’s life years rather than the individual utility of life.
• DALYs do not take into account the price decreases associated with technologies after initial introduction, which can make a specific technology more cost-effective in the long run.

Although the DALY concept is clearly not perfect, our intent in introducing it here is to point to a type of approach that can help sharpen thinking about global health problems and at least start us down the road toward a framework for prioritizing problems, interventions, and investments.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Cost per DALY</th>
<th>Cost per capita per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment of STDs</td>
<td>1–4</td>
<td>0.3</td>
</tr>
<tr>
<td>AIDS prevention programs</td>
<td>4–7</td>
<td>2.3</td>
</tr>
<tr>
<td>Short course chemo for TB</td>
<td>4–7</td>
<td>0.8</td>
</tr>
<tr>
<td>School health programs</td>
<td>27–34</td>
<td>0.4</td>
</tr>
<tr>
<td>Management of sick child</td>
<td>41–68</td>
<td>2.2</td>
</tr>
</tbody>
</table>


Table 1.3 The Cost of Public Health Interventions
Infectious Disease

By any reckoning, a major category in global health is that of infectious disease. In introducing an influential Institute of Medicine report in 1992, Nobel Laureate Joshua Lederberg remarked, “We acted as though we had won the war on infectious disease, but the fact is, infectious microbes have been around all along and will continue to pose threats to public health.” Indeed, although in the last seven decades humans have made great strides in developing drugs to treat infections, it’s not clear how long we can stay ahead of pathogens that can mutate and develop resistance faster than we can develop antibiotics. Far from having conquered infectious disease, we’re waging a constant struggle against it. Figure 1.4 maps significant global outbreaks in just the first half of 2005.

The “big four” of global infectious disease are malaria, TB, HIV/AIDS, and diarrhea; together, they infect over one million people a day and kill 10,000 per day in Africa alone. Malaria kills roughly one million people around the world each year (~1 death/30 seconds). TB infects one of every three people in the world and kills roughly 2 million annually (~1 death/15 seconds). HIV/AIDS causes about 5 million new infections each year (~1 new case/6 seconds) and 3 million deaths per year (~1 death/10 seconds)—the equivalent of a jumbo jet crashing every 90 minutes. And infectious diarrhea, which is caused by more than one type of pathogen, causes roughly 3 million deaths each year.
Environmental and Occupational Illness and Injury

The impact of injuries due to accidents and violence is also increasing and may rival infectious disease as a source of ill health by 2020. There are roughly five million deaths per year from injuries of all sorts. The WHO estimates that annually there are 100 million occupational injuries (100,000 deaths) and 11 million occupational diseases (700,000 deaths) worldwide. The costs to society range from 2% to 14% of GDP. Children bear the brunt of the global burden of disease attributable to environmental causes; the WHO has estimated that one-third of childhood ill health is due to unsafe environments, leading to the deaths of over three million children under age five each year. Unsafe water, poor sanitation and hygiene, and indoor air pollution are the main culprits. Although pollution accounts for perhaps 8% to 9% of the total environmental disease burden globally, this proportion is much higher in developing countries, where high levels of indoor air pollution have sparked innovative improvements in the design of cook stoves in recent years.

Noncommunicable Diseases

Heart disease, cancer, stroke, and hypertension are among the most important noncommunicable diseases. As we’ve just seen, although they’re often thought of as affecting people predominantly in industrialized countries, they are increasingly a problem in the developing world, primarily as a result of globalization-associated rises in income and exposure to risk factors such as smoking and obesity. Indeed, cardiovascular disease is already the leading cause of death in developing countries; ischemic heart disease and stroke are projected to nearly triple in many developing regions in the next two decades; and the prevalence of diabetes worldwide will more than double between 2000 and 2030, to one of every 16 people.

Globally, chronic diseases currently account for 60% of all deaths and 43% of the global burden of disease; by 2020, this will rise to 73% of all deaths and 60% of the global burden of disease. Important risk factors include: tobacco use, alcohol consumption, physical inactivity, overweight, low fruit and vegetable intake, raised blood pressure, raised lipid levels, and diabetes. Mental health, previously relatively neglected, accounts for 5% to 10% of the global burden of disease in developing countries, or over 400 million cases, and may become the second leading cause of lost DALYs by 2020.
Public Concerns and the near Future of RFID
Having just sprinted through an introduction to a number of large and complex global health issues, how do we make sense of their current status and future impacts? While most health care, in practice, focuses on individuals, it’s clearly important to take a broader perspective on health, stepping back from the individual, local, or even national level to take a global view. In this context, it’s useful to note the recently drawn key distinction between international health, which concerns a network of nation states, and global health, which includes important nonstate actors such as corporations, non-governmental organizations (NGOs), and a whole range of advocacy and affinity groups (Figure 2.1). With the relative rise in importance of these nonstate groups, a global rather than simply international perspective will be increasingly important in the years to come.

Figure 2.1
Taking a Broader Perspective on Health

Source: Institute for the Future
One way to usefully organize the overwhelming complexity of global health issues is to think of a landscape of underlying health risks, such as exposures to pathogens, environmental hazards, injuries, or stress—as well as contributing risks such as poverty, war, or famine. Over this landscape of risks can be draped a landscape of health inputs, such as health expenditures, number of health professionals per capita, hospital beds, educational programs, health behaviors, or aggregate measures such as the UNDP Human Development Index (Figure 2.2). This then creates a landscape of health outcomes, such as survival rates, disease prevalence rates, or disability scores. Finally, a landscape emerges of health opportunities, which can arise from unmet needs, unexplained gaps, and other mechanisms related to any of the above factors of risks, inputs, or outcomes.

While this framework has limitations (for example, not making explicit reference to interactions or unintended consequences), it allows us to identify “hot spots,” compare locations, and organize trends and projections. Below, we will examine each of these elements in turn.

**HEALTH RISKS**

Health risks are related to several factors. Population distribution is certainly a fundamental factor. Figure 2.3 shows the global population distribution, highlighting the fact that in terms of sheer numbers and density of potential patients, East Asia, South Asia, and Europe are likely foci of concern.

---

### Figure 2.2

*The Global Health Landscape*

Source: Institute for the Future
Whether increased population density per se raises or lowers health risks is an interesting question. While urban populations generally enjoy better health than rural ones, this is likely due to a number of confounding factors such as education, wealth, and access to care rather than an intrinsic benefit of crowding; indeed, crowded conditions are likely to facilitate spread of disease, beget competition for scarce resources, increase exposure to pollutants, and raise stress, all of which have clear negative health impacts.

Exposure to diseases, of course, is another basic determinant of health risk. Figure 2.4 shows exposure to malaria. While there are a few similar maps like this for major causes of death and disability around the world, there’s an urgent need for more. Given good underlying data and careful design, not only are these powerful and easily understood displays of complex data sets, but by overlaying these maps on each other or on that shown in the previous figure, they also allow for quick estimation of hot spots where populations and risk factors intersect.

Of course, there are many sources of health risk besides pathogens. Several that we’ve already mentioned include structural factors such as poverty, lack of education, lack of access to health care, and the multidimensional impacts of armed conflict and population displacement. Overlaying maps of these risk factors could help target interventions, whether direct medical inputs, educational campaigns, logistical improvements, or investments, for maximal effectiveness. The flip side of these risk factors forms a fairly good list of our next topic, health inputs.
HEALTH INPUTS

Health inputs span a range from resources closely linked to health care, such as numbers of doctors, nurses, and hospital beds, to those with a wider focus, such as education for women, good roads, and information infrastructure. This reflects Rudolf Virchow’s observation that “medicine is a social science, and politics is nothing but medicine on a large scale.”

One of the most protean of inputs is, of course, money. This is particularly important when we take into account disparities in global wealth (Figure 2.5). Funding obviously enables all kinds of goods and services, and the “champagne glass” distribution of income and wealth goes a long way toward explaining health disparities. One consequence of this is what has been characterized as the 10/90 gap: only 10% of research funding goes toward problems causing 90% of the global disease burden. Another index of this bias is the observation that of nearly 1,400 new drugs developed between 1975 and 1999, only 16 were for tropical diseases or tuberculosis. Because of this failure of market forces to address urgent health needs, public-private partnerships (PPPs) and innovative business models are beginning to spring up to improve access to health inputs in developing countries. Examples include organizations such as OneWorld Health, a nonprofit pharmaceutical company, and PATH, a catalyst for global health that collaborates with both public- and private-sector partners.

But money isn’t the whole picture. Recent research shows that health outcomes depend even more steeply on education than on wealth. In particular, educating women turns out to be one of the most effective ways to improve health outcomes. This is illustrated by our case study of health outcomes that are disproportionate to wealth in Kerala, India (see Appendix I).
As is well known, the United States spends far more per capita on health care than any other country, yet our health outcomes lag behind those of many other countries. Thus, it’s not just about how much money you spend, but how well you spend it and the quality of the underlying social support and infrastructure. Sheer numbers of hospital beds, nurses, or doctors aren’t enough; the system as a whole must be effective, coordinated and efficient. Indeed, as seen in Figure 2.6, when one looks at cost-effectiveness, the United States ranks alongside Brazil, Indonesia, and Yemen—and lags behind countries such as Mexico, Paraguay, China, Algeria, Saudi Arabia, and Oman.

Not incidentally, looking at opportunity costs helps bring into focus some of our collective priorities and choices. Figure 2.7 shows the amounts that would need to be spent to supply basic health care, clean water, nutrition, sanitation, or education to those who don’t have them, compared with how much we spend on a variety of other items of arguably lower priority. Exercises like this make starkly visible the otherwise hidden consequences of some of our spending decisions.
HEALTH OUTCOMES

While health inputs recognizably span a broad range, traditional measures of health outcomes have generally been defined fairly narrowly through figures such as life expectancy, infant mortality, disease prevalence, and complications (either of disease or of health care). In the last two or three decades, however, the definition of health outcomes has broadened beyond physiological measures to include more complex indices of physical, mental and emotional functioning, sense of well-being, and satisfaction with care.29

While the literature of health outcomes studies has grown commensurately, resource constraints and the complexities of data collection, cleansing, and analysis have unfortunately meant that there is still a relative dearth of global comparative data sets on health outcomes. The best known series in the field is probably WHO’s annual World Health Report, which includes statistics for outcomes indices such as life expectancy at birth, fertility rate, and neonatal mortality rates. As we’ll come back to later, while these are valuable sets of data, it would be ideal to have subnational figures for which the unit of analysis is smaller than a country.

The need for more comprehensive outcome data sharpens as health care providers, payers, regulators, and donors all begin to focus more on paying for performance (P4P). Defining and refining metrics for the results of health care has a long history and rich literature, but much room remains for additional innovation, particularly in complex global settings.

HEALTH OPPORTUNITIES

As we’ve indicated in Figure 2.2, health opportunities can exist in relationship to risks, inputs, or outcomes—or the spaces between them. Huge classes of opportunities directly concern unmitigated risks (such as lack of education for girls and women; inadequate inputs, for example, workforce shortages; or suboptimal outcomes like high rates of major depression. Addressing these would represent a tremendous boon to global health. Naturally, these opportunities are not equally open to all; some are more suited to small, local stakeholders; others to larger transnational groups that can realize economies of scale; and still others to public-private partnerships that can leverage economies of scope. Government agencies, professional groups, academic clinicians, private sector corporations, NGOs, patient advocacy groups, and entrepreneurs, among others, all have a place in this opportunity ecosystem.
Most health-related data is collected using political units of analysis (especially country-by-country), for understandable reasons, and in the post–9/11 world, we’ve become even more concerned with national boundaries and border crossings. Yet health and disease don’t necessarily respect political borders.

To be sure, some health inputs do differ between political jurisdictions. For example, economic and legal policies and protections, access to health care, and levels of resources often obey political boundaries. All play a role in determining health outcomes. Therefore political boundaries do matter. They matter in that policies have both direct and indirect effects on health outcomes. However pathogens and people do cross boundaries in ways that state-sponsored policies do not. Just think of SARS and the manner in which the pathogen very quickly emerged from rural China to have a very dramatic global impact. National policies also had differential impacts on the spread of the disease which China’s early policy of secrecy and denial prevented early detection and containment of the outbreak. SARS is a perfect example of how transnational migration, environmental effects, and different national and international health policies interact to structure the contours of local and global epidemics.

Indeed, as observed by Anthony So of Duke University, some health problems arise precisely because geopolitical borders allow some forces through but not others: “In one case, the product—tobacco—readily crosses borders, but consumer protections lag behind. In another case, the expectations of life-saving treatment readily crosses borders, but access to the essential drugs lags behind.” This can be generalized to epidemics, undocumented immigrants, or environmental hazards, which all cross borders; and access to treatments, legislation to protect environments and people, and national traditions of health and medical education, certification, regulatory cultures, and health policies which generally don’t. Given this selective porosity of geopolitical borders and the apparent decline of the nation state, we may have to rethink approaches to health in light of globalization.
POPULATION MIGRATION

A major example of a border-crossing force in health is movement of people. As shown in Figure 1.1, whether as tourists, economic migrants, parts of ethnic networks, or displaced populations, soon nearly a billion people will cross national borders each year, blurring attempts to define health risks and outcomes using traditional units of analysis. While the vast majority of these border crossers do so by choice, an important at-risk subgroup of roughly 50 million people is displaced each year by famine, war, or other catastrophe. An even greater number of individuals compose the “internally displaced” that do not cross political boundaries and are often invisible to aid agencies. Such displaced populations are almost certain to increase as more people live on marginal lands routinely threatened by drought, flooding, famine, pollution, or war (even in the United States, as illustrated by Hurricane Katrina’s flooding of New Orleans).

Many of these networks of leisure, aspiration, family connection, oppression, and catastrophe are like invisible currents that, if mapped, could yield important insights. Already we see important ethnic networks that support new forms of globalization and business development, such as the ethnic Chinese diaspora in Southeast Asia, the United States, and beyond. Whether Hmong in Minnesota, Arabs in southeastern Michigan, or East Indians in Silicon Valley, patterns of “brain drain” also imply patterns of “gene flow,” disease susceptibility, and cultural practices that belie traditional national boundaries.

EPIDEMICS

Another major border-crossing force in health is disease—germs clearly don’t respect political boundaries and “cholera needs no passport,” as illustrated in Figure 3.1. Indeed, “a central feature of emerging and re-emerging epidemics such as HIV, malaria, and tuberculosis is their transnational nature. . . . No one country can undertake effective public health actions in isolation.”

State-centric paradigms are clearly unable to deal with issues such as the spread of diseases that originate within national borders but transcend international boundaries and affect the security of people worldwide.”

ENVIRONMENTAL HAZARDS

Environmental pollutants and plumes clearly follow prevailing winds, underground aquifer flows, or other nonpolitical boundaries. In some cases, these are natural hazards, such as huge dust storms that occasionally blow from Asia to North America, leaving both a visible trace on satellite photos and a health impact in terms of increased respiratory symptoms in areas as far inland as Denver.
In many other cases, the environmental hazards are man-made. In the United States, for example, 6.5 billion pounds of toxic chemicals are released each year—including roughly 100 million pounds of recognized carcinogens—and more than two-thirds of Americans live in areas of increased cancer risk due to toxins, incurring a risk of approximately 740 extra cancers per million people. As a result of chemical contamination, the water systems for more than 20 million people violate EPA standards. Names such as Three Mile Island (nuclear power plant accident in central PA, 1979), Love Canal (leaching of chemical wastes into back yards in upstate New York, 1978–1979), and Times Beach (the largest civilian exposure to dioxin in the United States, requiring evacuation of the town in 1985) are indelibly associated with environmental health insults in the United States.

Globally, other locales have become synonymous with environmental issues. Minamata disease was caused by seafood-related mercury poisoning from a plastics plant in Japan, affecting thousands of people over three decades with “cat-dancing disease.” In terms of numbers of victims, the Bhopal disaster of 1984 was the worst industrial accident in the history of the world, with thousands dead and roughly half a million injured by the accidental release of forty metric tons of methyl isocyanate from a Union Carbide pesticide plant. And the worst industrial hazard in terms of border crossing was undoubtedly Chernobyl in 1986, which affected the Ukraine, Belarus, and Russia most intensely, but spread radiation throughout the northern hemisphere, as seen in Figure 3.2. In areas exposed to the radioactive fallout from Chernobyl, the diagnosis of childhood cancers is 15 times that in the United States, and the incidence of thyroid cancers among children has increased 50–100 fold since the disaster.33

Fortunately, a more positive type of border-crossing force also exists—international treaties. United Nations Environmental Programme agreements such as the 1992 Basel, 1998 Rotterdam, and 2001 Stockholm Conventions regulating transborder movement of hazardous wastes and disposal in developing countries, prior informed consent in trade, and persistent organic pollutants, respectively, exemplify the international perspective and cooperation required to effectively deal with the hazardous materials. Likewise, the ISO 14000 environmental standards and the 1997 Kyoto Protocol regarding greenhouse gas emissions suggest possible models for cross-border environmental health agreements. Although such agreements are difficult to broker and may require painful sacrifices, they’re critical for us all. As Jared Diamond reminds us, “rapidly advancing along this non-sustainable course, the world’s environmental problems will get resolved, in one way or another, within the lifetimes of the children and young adults alive today.”34

Figure 3.2
Border-Crossing Forces: Radioactive Fallout from the Chernobyl Disaster

Source: www.cmc.ec.gc.ca/~arqidor/ctbto/Chernobyl.gif
CLIMATE CHANGE

Global warming and other large scale weather-related phenomena clearly have cross-border health effects. Short-term hot, cold, dry, or wet spells are everyday causes of increased mortality and morbidity. But an apparent increase in weather extremes and “hundred-year” storms, floods, and heat waves such as the one that killed tens of thousands of people across Europe in August 2003 has raised concern even among those not predisposed to apocalyptic thinking.

And although less immediately perceptible, longer-term climate changes will likely have an even more profound impact on human health through a variety of mechanisms related to changes in ecologies and habitats. For example, rises in temperature may reduce grain yields in the tropics by up to 30% in the next 50 years, putting large populations at risk for malnutrition. Another mechanism involves changes in the distribution of disease vectors such as mosquitoes. Indeed, based on climate models, malaria incidence could rise by perhaps 25% to 500 million cases per year by the end of this century, and we’ll likely see increases in the geographic range of other mosquito-borne diseases such as dengue, West Nile, and encephalitis both in the United States and abroad. As shown in Figure 3.3, climate and ecological zones near the United States–Mexico border clearly spill across the geopolitical boundary, suggesting that diseases linked to these might, too.

CULTURAL BELIEFS AND PRACTICES

Cultural practices, health beliefs, definitions of health and disease, religious prescriptions, and other health-related behavioral guidelines also cross boundaries. Imagine, for example, a map of North America showing the prevalence of beliefs and practices around various forms of complementary and alternative medicine (CAM), faith healing, or folk remedies—a patchwork of areas with ties to almost every other continent. These types of maps would draw upon ethnographic research to highlight the dynamic and changing nature of cultural practices to avoid overly rigid notions of culture that have informed health policies of the past, often in problematic ways.

Thus, we propose that redrawing maps to reflect these new boundaries of risk and opportunity will give us a more accurate basis for understanding global health issues and for thinking about relevant trends. In the next decades, in an increasingly transnational world, these new “weather maps” of health risk and opportunity will be key tools of decision support in health and business. We now turn to exploring this conceptual landscape and the emerging tools of geographic information systems.
While display and analysis of health-related geospatial data goes back at least to John Snow’s famous map of cholera cases near the Broad Street pump in London, in the last few years there has been dramatic progress in a set of computer-based tools that come under the rubric of geographic information systems, or GIS. Cutting-edge research is still the realm of specialists, but the software-mediated automation of once-laborious manual processes has begun to put reasonably sophisticated display and analysis of geocoded data on the desktops of nonspecialists. And while an exhaustive review of mapping methodology is far beyond our intent here, we think it useful to highlight some of the strengths, as well as some pitfalls, of mapping and GIS, and to describe some anticipated developments that will likely impact the way we think about global health issues in the decades ahead.
STRENGTHS OF MAPPING AND GIS

Because so many factors in health have a strong geographic component, mapping is a natural tool for understanding them better. As we’ve discussed above, populations have a specific (and shifting) geographic distribution, as do pathogens and disease vectors. Other health risks such as malnutrition, lack of access to care, or structural factors such as poverty and governmental corruption also have patterns that may change, with time constants ranging from fast (for example, crop failure from a sudden weather event or eruption of armed conflict) to slow (for example, changing patterns of eating or health practices). Similarly, health outcomes can often be linked to geographic locations, leading to the concept of a therapeutic (or toxic) landscape, as exemplified by Eugene, Oregon (or Chernobyl).

One advantage of mapping over the display of information in charts or tables is almost too obvious to require mention—“the greatest strength of GIS is that its product is a picture.” It is much easier for most of us to comprehend spatial distributions in a two-dimensional graphical map than to pick out patterns from a list or table of numbers. Whether used for everyday driving, presenting TV weather reports, or finding the way along a hiking trail, maps are a familiar and powerful medium for concisely and vividly conveying large amounts of data regarding distance, direction, contiguity, area, and similar real-world attributes, as amply illustrated in the work of data display experts such as Edward Tufte.

And, again as illustrated by TV weather map animations, maps are also a powerful technique for showing how parameters evolve over time, whether the required level of analysis is quite general (“that hurricane is approaching land pretty quickly”) or quite specific (“given this likely storm path, where exactly should we place emergency resources given the predicted wind speeds, consequent tidal surges, flooding risks, and likely damage to health and property?”). Indeed, the ability of maps to accommodate a wide range of levels of interest and scrutiny—from holistic to finely granular—is one of their strengths; it may be sufficient to know simply that “Nevada is above and to the right of California,” or it may be important to know that “Reno is actually west of San Diego.”

These basic strengths of mapping are increasingly augmented by powerful software tools that enable users to rapidly create superior solutions to problems that previously could be addressed only with laborious calculations, such as optimizing delivery routes or fleet management, drawing boundaries to create service districts (whether for voting, location of fast food restaurants, or delivery of health care services), doing “what if” simulations of the spread of a toxic plume or epidemic, or the effects of opening or closing a neighborhood health clinic.
To refer back to our notion of health risks, inputs, outcomes, and opportunities, in the last few years, rapidly evolving GIS tools have begun to enable us to operationalize this framework by displaying, overlaying, and manipulating geospatial health information. Doing so has helped to uncover disease ecologies and geographies of risk—for example, that women’s work in many developing countries exposes them more to water and thus malaria and schistosomiasis, or the correlation between the spread of HIV and trucking routes in Africa. Explicitly displaying the geographic or spatial dimension of disease ecologies is a major trend that will only increase as GIS tools become more powerful, which will in turn enable more sophisticated health and market research and deployment of resources.

CHALLENGES AND PITFALLS OF GIS

While GIS holds out tremendous promise, one index of how rapidly the field is evolving is the number of challenges and methodological questions that remain. Many of these are common to other approaches to data analysis, but some have particular twists when applied to health mapping; below we highlight a few.

Data Availability

As we’ve already indicated, perhaps the biggest obstacle is availability of data—there is simply not the quantity and quality of subnational, near-real-time, granular data on health risks, inputs, and outcomes that we’d like. To be sure, excellent data sets exist and serve as exemplars for future GIS applications, but maps such as the one for malaria risk (Figure 2.4) are still the exception rather than the rule. Even at the national level, significant data deficiencies exist often in the poorer areas arguably most in need of this information (Table 4.1). Collecting, cleaning, and updating more detailed data at the provincial, county, and city levels for major areas of interest will require prodigious funding and effort, but could likewise yield outsized rewards.

While there are no easy shortcuts to acquiring such data, gradual improvements in public health and information technology infrastructure will eventually expand both the quantity and the quality of data. In addition, this incremental trajectory may be punctuated on occasion by innovative uses of connective technologies, as demonstrated in our case study of Voxiva’s harnessing of cell phones for biosurveillance (Appendix I). Alternatively, it may be possible to piggyback collection of health data onto surveys or census efforts focused primarily on other topics. Finally, it may be possible to find more easily measured proxies for variables of interest, such as using nighttime lighting

<table>
<thead>
<tr>
<th>WHO Region</th>
<th>Useable data</th>
<th>Complete coverage</th>
<th>Total countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>4</td>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>The Americas</td>
<td>32</td>
<td>14</td>
<td>35</td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>7</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>Europe</td>
<td>48</td>
<td>39</td>
<td>51</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>4</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>22</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>World</td>
<td>117</td>
<td>66</td>
<td>192</td>
</tr>
</tbody>
</table>

as a marker for GDP per capita or female literacy as an indicator of child health outcomes.

**Statistical Issues**

Even if data were plentiful and of high quality, several analytical issues deserve mention. Although health maps are primarily graphical in format, they’re not immune to issues that affect nongraphical statistical analyses. For example, maps not only can lie, they must—every map inherently conveys only a partial picture of reality, abstracting and highlighting some features and suppressing others. Another basic issue is that of inappropriately extrapolating from an aggregate finding to an individual case. For example, a map may show an area of higher or lower risk for premature death, but this doesn’t at all preclude an individual living within that area from defying the odds.

An important problem is that of choosing an appropriate unit of analysis. Is it more appropriate to map health risks, inputs, or outcomes for individual patients, families, physicians, hospitals, counties, states, age quintiles, income segments, or any other grouping? Figure 4.1, a “smoothed” data display taken from work done by Dr. Rudy Banerjee and Dr. Rob Lipton at the University of California, Berkeley, shows how analyzing the very same data by blocks, block groups, or census tracts can yield either one or two apparent hot spots (in this case, of density of assaults in a metropolitan area).

Yet other issues are the “small number problem” (if a geographic area or “cell” of interest contains only a small number of cases, it can be hazardous to draw conclusions); and “spatial autocorrelation” (the tendency of neighboring units of analysis, such as zip codes, towns, counties, or states to be similar to each other). For both of these problems, one or more of a number of corrective techniques need to be applied; the technical details aren’t our main focus here, but the point is that as with any analytic technique, care and nuance need to be used when mapping to avoid misleading results.
Thus, while many applications of GIS fall into well-known categories (for example, shortest route, redistricting, plume prediction), the specific details of each case are important. Because geospatial data analysis is still an emerging and rapidly evolving discipline, we’re still exploring issues of how best to represent, manipulate, and attribute meaning to the data.

Choosing the right variable can be challenging since “individuals live their lives in a number of overlapping settings” and it’s not always obvious which variables to extract for analysis. Both clinical judgment and statistical analysis may be required to decide which variables of health risk, input, or outcomes are most appropriate for any particular research question. Mapping place of residence of cancer patients, for example, may not be revealing if carcinogen exposure is occurring at work; whereas mapping place of work might dramatically show up a “hot spot.” Or mapping levels of stress for patients with HIV may show a pattern that actually reflects a confounding variable, such as poverty or urban blight, rather than an effect of the disease itself. This is related to the issue of mistaking correlation with causation—a map showing a pattern of correlation between two variables, such as cancer rates and distance from an industrial site, is not proof that one causes the other.

We can also hope to see a greater adoption of dynamic, or time-series, data display. Rather than snapshots of static data, this will provide more of a “video clip” of data evolving over time. Examples might include display of the spread of chemical plumes; of either rapid-onset epidemics such as SARS or gradual-onset ones such as HIV or obesity; and migrations of populations, outcomes, and even opportunities. Such dynamic displays will help enable real-time decision support which can bring the power of maps to the point of decision—information where and when it’s most useful.

THE NEW CARTOGRAPHY OF HEALTH

What this all adds up to is a potential efflorescence of public health, with both real-time and real-place, geocoded data sets. With increasing ability to gather multi-modal data—clinical findings and diagnoses; environmental parameters, including remote sensing and biosurveillance data; health supply inventories, reimbursement transactions; consumer purchasing; traffic patterns and so on—we can envision creating weather maps of risk and opportunity. To use other metaphors, these would outline watersheds of shared risk and opportunity and help stakeholders, policymakers and individuals do a new kind of orienteering—navigating the landscape of risk and opportunity.
On an individual level, consider your daily commute, whether to and from work, around town, or on a business trip or vacation. Currently, those trips are determined almost exclusively by geographic expedience—picking the fastest route, avoiding traffic or bad weather, minimizing waits—with little regard for health risks. This is entirely understandable because most clouds of health risk are currently invisible—we simply don’t have readily accessible “microclimate” information about air quality, toxic plumes, statistically dangerous road intersections, areas with current microepidemics of flu or psychological stress, or neighborhoods with a dearth of healthy restaurants. Now imagine having a map or heads-up display that would allow you to see these “rainy” and “sunny” zones. Admittedly, in many cases the additional information may not change the route you actually take. But with the information at least you have a choice, instead of just a guess.

On a societal level, we already use maps to help us evaluate seismic risks and analyze patterns of crime or the availability of resources. At present, however, we navigate our current health landscape largely without such tools, making policy decisions, as our case studies illustrate, as best we can with partial information. As we compile additional and more sophisticated maps of health risk, we should be able to better prioritize, design, and target health interventions, whether community outreach and education, immunization programs, location of health facilities, or allocation of funding, workforce, or other resources. In the future, we will truly navigate complex and shifting landscapes of health risk, inputs, outcomes, and opportunities with an awareness we can only dream about today.
In this report, we’ve outlined the importance of global health, introduced a conceptual framework of global health risks, inputs, outcomes, and opportunities, and reviewed some aspects of GIS. As we look ahead at the potential returns on investment in global health and health mapping, we propose several questions for your organization.

- What regions (not necessarily countries) are likely to be most important to your mission or growth in your business in 5–20 years?

- How might global health issues impact those regions and what might your organization do to help shape those impacts in a positive way? What investigations or actions might you begin immediately to pave the way for those efforts?

- How would a global pandemic impact your business and what steps could you take now to both model and mitigate the impact of a dramatic slowdown in trade and global transportation?

- How would a global perspective on corporate social responsibility affect your bottom line? Could your firm’s products and services play an important role in public-private partnerships and what steps would it take to create this type of collaboration?

We look forward to continuing this conversation with many of you in the years ahead.
Public Concerns and the near Future of RFID
KERALA, INDIA: THE PARADOX OF POVERTY AND GOOD HEALTH

How can a region with some of the highest poverty rates in the world achieve health outcomes nearly matching the life expectancies found in much wealthier countries such as the United States? If Kerala, the southernmost state in India with a population of nearly 32 million, were a separate country, it would rank among the ten poorest in the world, with a mere 1% of the per capita income of the wealthiest countries.42

Yet, from the colonial era into the 1990s, this state managed to achieve impressive social and health outcomes, on a par with many industrialized countries. Female literacy stands at over 87%, compared with 54% for the rest of India. Infant mortality rates are an impressive 12 per 1,000 live births (the United States rate is 7 per 1,000, compared with 71 per 1,000 for the rest of India).43 Life expectancies are 76 years for women and 70 for men, compared with 80 and 74 respectively in the United States. Access to health care in Kerala is impressive as well, with nearly 97% of births delivered institutionally. Kerala has a public distribution system for food rations that covers 90% of the population and a strong political commitment to financing social services.

This paradox of low economic development yet strong health and social outcomes was studied by Nobel Laureate and economist Amartya Sen. The roots of both Kerala’s poverty and its excellent public health go back to the early and mid-twentieth century, during India’s emergence into independence. Unlike many other parts of India, the Keralan brand of nationalism did not involve a call for rapid industrialization and growth-led development strategies; as a result, its economy lagged behind that of many other parts of India.

On the other hand, Kerala’s particular mix of liberal and Communist political movements in the 1950s and 1960s resulted in a politics of consensus that gave priority to a broad agenda of social justice and equality for marginal groups that did not emerge in other parts of India. Progressive land reform that rid Kerala of feudal types of land-tenant relations was quite successful at both empowering the poor and compensating landlords. Along with land reform and grassroots empowerment came a commitment to education, health care, and a comprehensive food distribution scheme. Investment in social services such as health and education rose from 15% of the budget in the 1950s to 40% into the 1980s.
Investments in education, in turn, created a well-educated population that was mobile and could seek employment elsewhere in India, in the Persian Gulf region, or around the globe. These migrants provided impressive levels of remittance—almost three times the level of the state budget—contributing in turn to health and social outcomes.44

However, not all is rosy. Spending for education and health care did not leave the regional government with the resources to pursue rapid industrialization strategies embraced elsewhere in India. As a result, the economy continued to stagnate while social and health outcomes continued to improve. In the opinion of many analysts, remittances tended to foster a consumer society without long lasting development effects.45 The view that unions and political organization were excessively strong probably discouraged some investment by multinationals. The first Gulf War in 1991 reduced job opportunities in the Gulf region, and the dot-com bust had ripple effects among Keralans seeking work in Bangalore, India’s Silicon Valley. To the extent that Kerala remains an exporter of primary commodities and manpower, it remains vulnerable to global price and demand shocks and to trade barriers raised by the United States, the European Union, and other importers.

Despite these problems, Kerala provides an important empirical piece of evidence that supports a strong public sector role in preventing extreme poverty and famine. Kerala also shows that, in contrast to more authoritarian regimes in Singapore and China, poverty can be alleviated without denying citizens basic freedoms. Insights from the work of Amartya Sen and others have played an important role in the creation of the United Nations Development Programme’s Human Development Index as a guide to promote investment in these areas. If longer-term issues of job creation and the management of a knowledge economy in the context of rapid globalization can be addressed, it may be possible to extend into the future Kerala’s impressive record of health and social outcomes despite poverty.
Imagine a city where municipal politics have been dominated by a leftist Workers’ Party for the past decade, yet that country’s leading business journal declared that very same city the top city in the country for quality-of-life indicators. This seemingly paradoxical situation is precisely what the city of Porto Alegre has accomplished since the end of Brazil’s military dictatorship in the 1980s.

Porto Alegre, a city of nearly 1.5 million inhabitants, is the largest industrial city in Brazil. Nearly one-third of the population lives in slums and, as in many cities in Brazil, the development of social services was crippled by poverty, population growth, highly unsanitary conditions, rampant street violence, and poor local governance.

On the heels of the new democratic constitution in 1988, the Worker’s Party (whose leader, affectionately known as Lula, is now the president of Brazil) sought to cut the cronyism and extreme income disparity that had flourished under military rule. It placed citizenship rights front and center and, in this context, the notion of participatory budgeting was proposed.

So how does this system work? Participatory budgeting is rather simple in design and is composed of three principles. First, all citizens of the municipality are entitled to participate, and community-based organizations do not have a special status in the process. Second, the rules of direct and representative democracy guide the process. Third, the investment of resources is allocated according to an objective method.

The budgeting process is done in three distinct stages. First, the administration develops a budget proposal in March of every year and consults the 16 municipal regions, each with 40,000 to 100,000 participants. The budget presentation allows citizens to compare last year’s budget with the results achieved, effectively creating a space where criticisms and lessons can be aired publicly. Second, community groups set priorities for the coming year, using a five-point weighting system and up to several rounds of consultations or rodadas. An executive committee with representatives from all neighborhoods then adds up the regional tabulations of priorities, assesses feasibility, and lists the first three priorities of the budget.
As a result of this process, data from 1986 to 1996 show dramatic improvements in the following areas:

- Access to water improved from 80% to 98%.
- Access to sewage systems increased from 46% to 85%.
- School enrollment doubled.
- The budget allocated for health increased from 13% to 40%.
- New housing units went from 1,700 in 1986 to 27,000 in 1989.
- The political culture shifted from a protest-based culture to a more civil, negotiated process with less social disruption.
- 30 km of roads have been paved in poorer neighborhoods.
- Balanced budgets have been more frequent.
- Businesses report higher productivity due to fewer sick days and improved morale.

Behind the numbers lie a host of profound improvements. Class divisions have diminished markedly; early on in the process, the business community and upper classes were highly resistant, but over time as the benefits have become clearer, they’ve turned into powerful advocates of the system. On the other side, community-based organizations have become far more professional and experienced in procuring resources and planning social services. New institutions have been created for coordinating with neighborhoods and improving communication between citizens and engineers and technical specialists.

New information systems, better citizen oversight, and a greater stake in the community have created more transparency and willingness to pay taxes. The result was a tripling of city income from 1993 to 1998. Levels of participation in public life far exceed those in the United States. While the system still has significant challenges, it has spread to 70 other municipalities in Brazil and as far afield as Toronto. In 1996, the Second UN Conference on Human Settlements declared Porto Alegre’s budgeting system one of the 40 best urban innovations in the world, and a major UN research center has been formed to study the process and its replication, its impact on democratic participation, and its social effects elsewhere.
In 1942, Egypt experienced one of the worst outbreaks of malaria, with more than 750,000 people infected and 100,000–200,000 dead in three years. The effects of the conditions that caused this epidemic continue to this day, as Egypt is the site of one of the largest man-made epidemics of hepatitis C. How did this come about and what can we learn about the unanticipated consequences of war, globalization, and development? This case study shows that thinking about networks that include only human actors and technological infrastructure can be misleading. Including microbes and nature can help us think about current issues such as multidrug resistance, TB, and globalization in a new light. Our mistake, as Timothy Mitchell argues, is to treat nature as a passive backdrop to human activity.

To understand the roots of the epidemic, we must first “explore” the creation of the first Aswan dam in 1898–1902. The dam was constructed during the colonial era, which was soon to usher in the rise of thinking about modernization as a function of big, techno-scientific projects demonstrating the power of the state. While the Aswan dam changed the course of the Nile so it could be used for hydroelectricity, irrigation and transportation, it also changed the ecological relationship among humans, the state, water, and mosquitoes.

By the time World War II began, irrigation and diversion of the Nile had brought mosquitoes, and in turn *Plasmodium falciparum*, the parasite that causes malaria, to new areas where the population had never been exposed and so lacked immunity. At the same time, large landowners and industrialists had displaced large numbers of rural poor. When nitrates were diverted from fertilizer production to military purposes, agricultural productivity dropped, leading to a rise in malnutrition and reduced immunity. Coupled with the influx of mosquitoes and increased movement of planes, trains, and automobiles that allowed mosquitoes to travel to new habitats, malaria exploded. As Mitchell demonstrates, a complex network of hydraulics, chemical production, mobility, politics, and etiology all worked to create a health catastrophe.

The story goes further, to include the rise of American philanthropy as intimately connected to the importance of malaria as a global health issue. During the early twentieth century, with funding from the Rockefeller Foundation, Dr. Fred Soper pioneered the use of military-style eradication campaigns against yellow fever, malaria, and other parasites in Brazil. When World War II broke out, he became a consultant to the War Department and adapted these techniques to attack louse-borne typhus fever in Egypt, Algeria, and Italy, using the recently developed insecticide, DDT.

While all of these campaigns were successful to a degree, their focus on “man vs. disease” neglected the underlying social conditions that put particular individuals at risk for infection in the first place. The Rockefeller Foundation, Mitchell argues,
learned the wrong lessons from the eradication campaign in Egypt, inadvertently damaging ecosystems by extending DDT spraying programs to Sardinia that were later adopted by the World Health Organization as global policy.

In a cruel irony, the effects of these developments continue to this day. As irrigation spread, schistosomiasis, a parasite whose life cycle involves snails, spread with the new water networks. Unfortunately, the cure for schistosomiasis was an injectable drug and poor syringe hygiene during widespread treatment campaigns in the 1970s and 1980s enabled the spread of hepatitis C throughout Egypt. Nearly one in five people have now been infected and hundreds of thousands are at risk for consequent cirrhosis and liver cancer. The complexity of networks of causation and influence in health virtually guarantees unintended consequences.
Throughout this report we have learned of the toll that infectious diseases take on most low-income countries and the threat of emerging or reemerging diseases to even the richest of nations. The loss of over $28 billion due to the SARS epidemic certainly suggests a need for accurate and timely reporting of epidemiological intelligence as well as coordinated responses to outbreaks.

As described by C.K. Prahalad in his recent book, Voxiva works by combining cell phone technologies with computer systems to assist local health workers in reporting health data in an accurate and speedy manner. Paul Meyer, the founder of Voxiva, got his start in the business world by working on Internet services in Kosovo and West Africa in the 1990s. From this experience he learned that there were several major shortcomings in existing IT projects attempting to address the “digital divide”:

- Most projects were pilot-based with little opportunity for scaling up.
- Most projects were focused on connectivity rather than on information flow challenges and the social connectivity of programs.
- Too much focus on the internet and computers as a solution caused many to overlook costs, human resources, and the need for maintenance of programs.
- Mobile phones are becoming more ubiquitous and practical than computers for much of the world.

From these observations emerged a business model that sought to address public health needs while simultaneously earning a profit. Starting with an initial investment by Ben Cohen (of Ben & Jerry’s fame) and a grant from the Markle Foundation, Voxiva developed the Alerta disease surveillance program in Peru with the assistance of the World Bank. Part of the key to Voxiva’s success has been its explicit concern for a social vision, which has garnered trust that other software companies working in this space find difficult to match. Clearly, having a social agenda that builds trust and a brand reputation for integrity means good business for Voxiva.

The problem that Voxiva set out to solve in Peru was the challenge of collecting up-to-date epidemiological data from Peru’s 6,000 clinics spread across difficult terrain. The traditional system involved collecting paper reports in the centralized Ministry of Health, a process that took weeks or months. This unidirectional system did little to inform local health workers who are the basic building blocks of the health care system.
Voxiva addressed these information bottlenecks by equipping all health workers with cell phones or Internet-connected devices that allowed them to both submit information and to receive health alerts and information. A central data collection point was equipped with software that enabled real-time data integration with GIS to create dynamic maps that allowed more rigorous analysis of aggregated information.

The effect of the program was to connect nearly 204,000 individuals in a sparsely populated region to the health reporting system. The system was much more cost-effective and rapid than the prior system (voice mail was almost eight times less expensive than written communications) and the reporting of cases increased threefold. There were fewer data-entry errors since health workers entered the data directly into the system. The start-up costs were also low since the system piggybacked on existing IT infrastructure that allowed it to draw upon local skills for maintenance and upkeep rather than needing expensive and sometimes nonexistent IT technicians.

The system was later extended to work as a Citizen’s Alert system for crime prevention in Lima; established elsewhere to assist in surveillance; and was recently introduced in the United States when the FDA and CDC began exploring its role in detecting blood shortages and disease outbreaks.
BSE (bovine spongiform encephalopathy): “mad cow” disease, probably caused by a type of protein called a prion; the human form of this invariably fatal brain disease is called Creutzfeldt-Jakob disease.

COPD (chronic obstructive pulmonary disease): lung disease primarily linked to smoking and air pollution.

CSR (corporate social responsibility): a growing movement that emphasizes a “triple bottom line” of social, environmental, and economic returns.

DALY (disability-adjusted life year): a measure of disease burden commonly used in cost-effectiveness analysis in which a year of life is given a weight between 0 (death) and 1 (perfect health).

GIS (geographic information systems): software that enables the display and manipulation of geospatial data sets.

incidence: in public health, the rate at which new cases of a disease occur in a given population over a specified period, often expressed as number of cases per 100,000 population per year (contrast with prevalence).

isocline: a line on a map that joins points with the same value of a variable; common examples are the lines showing elevations above sea level on a topographical map or those showing barometric pressure on a weather map.

PPPs: public-private partnerships.

prevalence: in public health, the fraction of a population with a disease or condition. For example, estimates of the prevalence of HIV in Botswana run as high as 25% (contrast with incidence).

SARS (severe acute respiratory syndrome): an illness comprising high fever, cough, or breathing difficulty and close contact with a probable case of SARS or travel to a recently affected area. Caused by a coronavirus; laboratory diagnosis by PCR (polymerase chain reaction) DNA test or a rise in antibodies to SARS in the patient’s serum.

vector: in the context of infectious disease, this represents a carrier of disease (for example, mosquitoes for malaria, or fleas for bubonic plague).

WHO: World Health Organization.
Appendix III | References

22. www.globalforumhealth.org/site/000__home.php.
Appendix III | References

43 (Thankappan 2001)
44 (Census of India 2001)
45 (Parayil and Sreekumar 2003)
46 (Abers 1998)
47 Timothy Mitchell (2002)
49 www.voxiva.net/