Chapter 7. Environment and Health
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(Also forthcoming as an article in Environment Magazine in late 2000/early 2001.)

PROBLEM

A principal factor driving concern about environmental quality is its connection to human health. Directly through noxious pollutants and indirectly through natural environmental processes, many different human health problems are linked to environmental factors. Given near universal human pre-occupation with its improvement, health has been the foundation behind much of the environmental research, legislation, and control efforts undertaken around the world in recent decades. Thus, it is abundantly clear that health is important in the environmental arena. What is less clear, however, is how important environmental factors are in the health arena. How much ill-health can be attributed to environmental factors and, conversely, how much health improvement can be achieved by reasonable control efforts over environmental factors compared to other approaches? And which are the most important environmental factors in this regard?

BACKGROUND

This memo focuses on what we know about the current and potential future environmental determinants of human health. To do so clearly, it is valuable to devote a little space defining what is meant by these terms, since they are often used in quite different ways in different contexts.

Health

By health, I refer to the loss of healthy life years suffered by people either through premature death or by incurring disabling illness and injury. Thus the currency of ill-health is time, something potentially allotted to each human equally no matter where they are born or live, unlike almost all other resources. This is predicated on the belief that every person, whether the poorest beggar in Dhaka or the richest executive in Denver, has the right to the same number of healthy life years. It assumes, furthermore, that if it were not for uncontrolled risk factors, such as poor nutrition, dirty water, air pollution, tobacco smoking, and unsafe sex, everyone would live out the same maximum life expectancy as occurs in the richest, most enlightened, and cleanest
societies. The degree that any group does not indicates its extent of ill-health. Thus, I will not address here the more subtle measures of ill-health, such as anxiety, inequity, or discomfort. Nor do I treat the numbers of deaths themselves as a useful measure. Death is easy to measure but since everyone dies, it tells us little without reference to the age at which it occurs. Nor does death tell us anything about the disability experienced by the still living through illness and injury. This lost-time approach fits with the old saying that the purpose of public health is to have everyone die young, at as old an age as possible.

Compared to an accounting of mortality alone, focus on lost healthy years of life reveals a quite different landscape of important diseases and risk factors, a landscape with profound policy implications.

Environment

In traditional medical terminology, every component of disease that is not genetic is environmental, the classic distinction between 'nature' and 'nurture.' It thus encompasses social risk factors such as crime, child abuse, and war, as well as behavioral factors such as diet, smoking, and sexual practices. Such an inclusive definition may be useful for some purposes, but here I take a more restricted one that fits the public's view of what constitute environmental factors. Only counted, therefore, are those measurable physical, chemical, or biological agents passing through environmental pathways to stress humans. In contrast to one common use of the term by the public, however, I do not distinguish between those agents set into motion by human activities and those that are entirely natural. The pastoral myth is strong in our culture as a belief that if something is natural it must be safe or, even, benign. People seem to wish to forget that most of humanity has spent most of history trying to protect itself from natural forces and agents and that the majority of the world's population today is still quite vulnerable to them. Thus, in addition to stopping industrial pollution, environmental health also involves protecting ourselves from natural phenomena at all scales, from hurricanes to arsenic atoms and everything in between.

Physical, chemical, and biological agents, however, can be set into motion by a wide range of phenomena, including global change processes such as industrialization, urbanization, economic integration, climate change, biodiversity pauperization, etc. Thus, while I restrict the definition of environmental health risk factors to measurable insults on humans, I adopt the increasingly common practice of examining in the broadest way possible the risk factors leading to these insults.

Determinant

Determinant is the most difficult term of the three to define. The best definition is a practical one: the degree to which a risk factor is a determinant of a disease is the degree to which the disease would be reduced if exposure to the risk factor were
reduced or eliminated. Thus, the degree to which poor water quality is a determinant of diarrhea is simply the difference in diarrhea burden (in terms of lost years of healthy life) in a group of people who shifted from dirty to clean water and changed nothing else. In reality, however, such simple experiments are not readily available for most environmental risk factors and the strength of a determinant must be estimated more indirectly, and thus with more uncertainty.

Confusing to many scientists as well as members of the general public is that the determinants of a disease burden normally add to more than 100%, sometimes much more. Thus, it might be quite correct to say that diarrhea in Mexico is caused 30% by dirty water, 50% by poor sanitation, and 40% by malnutrition. This is because the size of each determinant is calculated as if everything else remains the same. This does not imply, however, that eliminating all three determinants would reduce the diarrhea burden by 120%, i.e., by more than Mexico started with! Indeed, it is more likely that it would be decidedly less than 100%, because there are other determinants not mentioned here. Our definition remains intact, nevertheless, because eliminating each determinant alone would produce the change indicated for it. Together, however, they interact, sometimes in complicated ways. The implication for policy discussions is that the sum of risk determinants is intrinsically open-ended, i.e. they cannot be judged by whether they add to more than 100%. Indeed, it is a blessing in a way when we have determinants adding to much more than 100% because it offers several ways of attacking the problem.

Given these definitions, what then can be said about the current state of environmental health in the world and where it is heading?

Today's World

Judged by the number and scale of news coverage, action groups, research efforts, regulatory actions, monitoring programs, and control expenditures, the biggest environmental health problems in the world would seem to lie in the industrial world. This is understandable since the major emergence of environmental health awareness as a political and economic force occurred in the context of industrial and urban pollution in developed countries. Judged from the perspective of actual ill-health, however, the real environmental health risks lie elsewhere. (Figure from Smith, et al., 1999)
The first figure shows the burden of disease (lost healthy life years) in the world as a whole according to major region. Adjusted for population, it shows two trends, one well known and other perhaps less well known. First, it shows the trend in general ill-health from poor to rich countries. In Sub-Saharan Africa, for example, about 210 days of healthy life per year are lost every year for every man, women, and child, a huge burden that falls to a large extent on children under five as it does in most developing countries. In the established market economies (Western Europe, Japan, Australia, New Zealand, Canada, and the USA), by contrast, only 45 days per year are lost per capita, much better than other parts of the world but still indicating room for improvement. Also shown in the figure, however, is that the fraction of the health burden due to environmental factors also tends to decline with economic development. In other words, not only are people in richer countries, including the USA, healthier than other countries, their health status is less dependent on environmental factors than those in poor countries. The major reasons are the huge burdens of environmentally related diseases borne by developing-country children in the form of diarrhea, respiratory infections, and, to a lesser extent, adverse birth outcomes and other factors leading to death in early infancy. These problems exist in developed countries, but at much lower levels. The other major environmental disease in developing countries, malaria, hardly exists at all today in developed countries.

The scale of childhood diarrhea, acute respiratory infections, and malaria as global environmental health issues is sharply illuminated by the following short list of the fraction of the total global burden of disease of all types represented by these largely environmental childhood diseases in just two regions, Africa and South Asia:

<table>
<thead>
<tr>
<th>Region/Disease</th>
<th>Acute Respiratory Infection</th>
<th>Malaria</th>
<th>Diarrhea</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Asia</td>
<td>2.4%</td>
<td>0.2%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>1.2%</td>
<td>0.8%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Source: WHO, 1999

Thus, for example, over 4% of the entire world burden of disease is borne mainly by just one relatively small population group (children under 5) in just one country (India) in the form of just three environmental diseases. Globally, more than 15% of the burden of disease is due to these three conditions alone.

The Environmental Risk Transition

A way to think about the global processes that have led to the situation represented by the figure above is encapsulated in what has been called the environmental risk transition. This framework is represented in the second figure (below) showing the transitions in environmental risks that tend to occur as economic development proceeds.
In the poorest societies, household risks tend to dominate due to poor food, air, and water quality. The major risks existing in developing countries today are of this type -- malaria is attributable to poor housing quality, diarrhea to poor water/sanitation/hygiene, and acute respiratory diseases to poor housing and indoor air pollution from poor quality household fuels, although all are of course influenced by other factors as well (malnutrition in particular). (Figure from Holdren and Smith, 2000)

The economic development that helps make it possible to bring these problems under control unfortunately tends to create another set of problems that operate at the community level. These include urban outdoor pollution, as noted on the figure, but also other negative aspects of urbanization, industrialization, and agricultural modernization, such as toxic chemicals, hazardous waste, pesticides, and motor vehicle hazards.

As these are brought under control, a new set of problems tend to be created at the regional and global level through long-term and long-range pollutants such as acid-rain precursors, ozone-depleting chemicals, and greenhouse gases.

Simplistically, this historical process can be seen as a sequential housekeeping effort. First societies push problems out of the house into the community and then out of the community into the wider global environment. Not illustrated well by this particular
diagram, however, is an important characteristic of this sequence - absolute human health risk decreases substantially at each stage. Thus, those societies still experiencing substantial household environmental risks have much lower overall health status and a higher environmental portion of disease than those in the community or global stages, as shown by the regional breakdowns in the first figure.

This is not to say that even the richest societies do not have residual household and community environmental risks. Nor is it to say that some of the poorest societies are not contributing also to global problems. Portrayed by the environmental risk transition concept behind the figure, however, are the major trends.

**Interactions among Regions**

The regions of the world represented in the two figures above, however, do not exist independently. They co-exist in time and, increasingly, in space because of environmental processes that shift risks from one place to another. This is increasingly important as one moves to the right in the second figure. In addition, societal processes leading to increases in trade, tourism, migration, communication, transport, media coverage, drug smuggling, the internet, and so on are truly shrinking the world.

These processes lead to increasing environmental health interactions of several sorts. Consider here only two:

- Although highly industrialized countries have contributed most to greenhouse-gas emissions and thus to the risk of climate change, it is the health of people at the other end of the spectrum that is most vulnerable to the changes that might occur because of global warming and the resulting climate change. Although climate change is likely to cause more economic damage in rich countries, such as the USA, because of the value of the threatened infrastructure, it is likely to cause much more health damage in poor countries because of their general vulnerability to environmental stress and lack of supporting infrastructure. Thus, the villagers of the third world are doubly at risk -- both from their own household risks and from the late stages of environmental housekeeping by developed countries, which have pushed risks off to the global level. (The urban poor in developing countries are triply imperiled, since they typically experience the worst community-level environmental risks as well.)

- Although rich countries are not directly threatened by the acute respiratory infections and diarrhea rampant in poor countries, globalization processes do make them increasingly susceptible to other environmentally related infectious diseases. High on this list is TB, which represents a triple threat:
  - It is a strong function of the same kind of poor housing, ventilation, fuel, and other household factors that lead to the more localized environmental diseases that dominate global disease burdens.
- Being the chief outcome of AIDS in poor countries, TB incidence is rising worldwide and now accounts for well more than 2% of the global burden of disease, half of which is borne by South Asia and Sub-Saharan Africa.
- Because there is a no effective vaccine, antibiotics currently represent the only viable medical intervention, but antibiotic resistance is growing alarmingly because TB is so difficult to cure with antibiotics in a reliable manner.

More exotic and popularized diseases, such as Ebola and Lassa Fever, are also examples of environmentally related diseases emanating from poor countries but potentially threatening rich countries. We must be vigilant in watching for such emerging diseases, but it is important to keep in mind that the more mundane "re-emerging" diseases such as TB are vastly more deadly. More people are killed every day from TB than have been killed in a 100 years by such exotic diseases, for example.

RECOMMENDATIONS

Here I first discuss priorities for protecting the environmental health of the US population from its remaining household and community risks before discussing US priorities for addressing the larger world picture.

US Priorities

One of the most profound dilemmas facing decision makers and public health scientists everywhere and in the USA in particular is how to address the apparently growing discrepancy between the scientific and public perceptions of environmental risks. Study after study has shown in the last 20 years that the environmental hazards truly affecting health status in the country are not those receiving highest attention, whether measured by public opinion polls, news coverage, congressional actions, or government expenditure. Indoor air pollution in its various forms receives relatively little attention compared to outdoor sources and yet may account for as much if not more poor health. Hazardous waste dumps, on the other hand, which are difficult to associate with any measurable ill-health, have garnered huge attention and resources. The same chemicals in the form of common consumer products such as household cleaners, pesticides, and fuel (gasoline), account for much more exposure and ill-health and yet are comparatively of little concern.

There are a number of explanations for this difference in perception, the major ones relating to the fact that the public uses a number of criteria other than health risk to establish its concerns. In a world of finite resources, however, there is a real health cost in focusing attention on risks that have little measurable health impact and, at least by default, thus result in poorer funding of interventions that address significant risks.

An option for consideration is to explicitly separate these risks by keeping those hazards with significant health risks within the health camp and to place others perhaps
equally as important for public policy, but less so for public health, in the category of environmental quality improvement along with many other worthwhile programs of this kind, including litter control, wildland preservation, etc.

In the USA, the environmental programs that definitely ought to remain in the health camp at present are:

--Control of household contaminant exposures, including radon, environmental tobacco smoke, allergens, consumer products, lead, wood smoke, etc.

--Control of outdoor air pollution where doing so is more effective than controlling indoor or localized exposure sources of the same pollutants.

--Applying very stringent criteria in judging any proposed new product or activity that will affect large numbers of people, for example new consumer chemical products, household materials, and additives to food or fuel.

--Inducing much stronger and more uniformly applied restrictions on occupational hazards, which tend to be much larger than those imposed on the general public and, in contrast, often have demonstrable impacts on health.

International Options for the USA

There are two general categories of international policy options that the USA needs to consider - those that reduce environmental health risks imposed on other countries and those that reduce the environmental health impact on the US population.

- The most important component of the first category is addressing the US contribution to greenhouse gases. Should, as many scientists fear, a change in climate result, there will be significant health risks imposed on other parts of the world. There are a number of actions the USA might take to ameliorate this risk, of which perhaps several stand out:

  - Find ways to seriously reduce its own greenhouse gas emissions.

  - Join the rest of the world in regimes designed to reduce overall emissions.

  - Push to include health as one of the criteria by which greenhouse gas reduction measures are evaluated worldwide. Studies show that significant improvements in environmental health status can be achieved as part of greenhouse gas mitigation measures, but only if health considerations are explicitly included in the strategy from the start.
• Through better housing, education, nutrition, emergency response systems, etc., work to reduce the vulnerability of the poor in developing countries to environmental stress of all kinds, including that due to climate change.

• Assist developing countries to reduce the burden of those diseases thought to be most enhanced by climate change so that enhancement starts from a lower base and absolute increases are less. Recent studies have shown that relatively modest annual investments started today, for example in vaccines, clean fuels, and malaria control, can potentially make big differences in the incidence of climate-change-related diseases by 2020, for example. Even if climate changes do not occur, these investments will be valuable -- a no-regrets policy.

• All the actions in the first category would not only act to reduce the big diseases of developing countries, but also to reduce the incidence of TB and other infectious diseases that potentially threaten the USA. Thus they serve to address US direct interests as well. In addition, however, the USA should consider

• Providing more clout (economic and political) for efforts to develop vaccines for TB, malaria, dengue and other major environmentally mediated diseases that today mainly affect developing countries but in the future could seriously threaten the USA. Because of the relatively short-term economic outlook of the private vaccine industry, vaccines are unlikely to be developed for such "orphan" diseases in spite of the huge burden they impose on world health.

• Using its clout to move the world development community (World Bank, UNDP, UDAID, US private foundations, etc.) to consider environmental health criteria more explicitly in their loan and grant programs as part of poverty alleviation, energy policy, and other major development efforts.

Finally, the USA can greatly assist in addressing the environmental health hazards that threaten it and the rest of the world by directing a greater proportion of international health research and development efforts toward environmental health problems with serious global burdens, as well as those of special scientific interest. Since the USA health-related research enterprise is such a large fraction of the total global effort, even rather small shifts in emphasis in the USA can greatly expand the overall size of such efforts in today's world.

**BOTTOM LINE(S)**

• Environment is no longer a major determinant of ill-health in the US or other developed countries.
• Public opinion and policy are not well focused on the environmental health risks that do remain in the US.
• Environment remains an extremely important determinant of health in LDCs and thus the world as a whole.
• Relatively little attention is paid globally to these environmental health hazards in LDCs.
• US domestic and international research and aid policies are partly to blame for this lack of attention and can thus be part of the solution.
• The greatest threat to US health from climate change will probably come through impacts in LDCs on infectious disease that spread globally
• The need to curb greenhouse-gas emissions provides dramatic opportunities for win-win or no-regrets strategies that improve health as well.

BIBLIOGRAPHY [1-20]
2. HOLDREN, J.P. AND K.R. SMITH, ENERGY, ENVIRONMENT, AND HEALTH, IN WORLD ENERGY ASSESSMENT, J. GOLDEMBERG, ET AL., EDITORS. 2000, UNITED NATIONS DEVELOPMENT PROGRAMME: NEW YORK.
5. MCGRANAHAN, G., ET AL., CITIZENS AT RISK: FROM URBAN SANITATION TO SUSTAINABLE CITIES. 2000, LONDON: EARTHSCAN.
10. NRC, GRAND ENVIRONMENTAL CHALLENGES. 2000, NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES: WASHINGTON, DC.


