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Health and the Environment: The Scientist's Responsibilities

PANELISTS

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Our health is affected by our surroundings—the purity of the water and air, and the safety of our workplaces. But whereas it was once possible to consider the environment in local terms—the air above our city and the water in the nearby river—today it must be defined as the whole planet and its enveloping atmosphere. The climate is warming. Environmental changes have gone global, and actions in one region impact on others. For example, long-lasting pollutants that enter the rivers and sea from the industrial cities of the northern hemisphere are ending up in the breast milk of Inuit women whose diet is rich in fish and sea mammals. Forest fires in Indonesia are creating smogs well beyond the nation's borders to rival the "pea-soupers" of 1950s London or Los Angeles. And, as with so many health threats, the disease burden from pollution is borne disproportionately by the poor, the least empowered to control their environments.

Although many of the growing environmental threats are global, environmental researchers believe that prompt human action can still have a profound impact in reducing those threats. Current investment in technologies, modes of transport, energy, housing and fuels at local, national and international levels can reduce emissions of pollutants. The responsibility on researchers is to present policy-makers with the best possible evidence about potential hazards to human health and the environment, and to lay out a clear set of options for change.

I. New challenges, new responses

Fresh environmental problems are emerging daily, said Eric Dewailly: newly discovered contaminants, newly identified interactions between compounds, even interactions between pollutants and genes that vary between people. If environmental health scientists can meet the challenges they face, the potential benefits to public health could be greater than in many branches of medicine, he argued. Many environmental health problems are preventable, either in the short or long term.

But the challenges are formidable. The science itself is complex and must be translated into policy on local, national and international levels. Dewailly illustrated his point with an example. He described how his team investigated the extent to which Inuit women's breast milk has become contaminated with pollutants called polychlorinated biphenyls, or PCBs, from their high intake of fish and mammals from the Arctic. Although such foods are highly nutritious and healthier than many of the alternatives, it is important to inform people of the risks from PCBs, so that they can make informed choices about how to balance those risks with the benefits of their diet.

The team worked with local communities, and, with their public health mandate, had advised people what they could do about breast feeding and how much of each type of food was safe to eat. The work has also led to international campaigning by Inuit leaders to accelerate the ban on PCBs. The science has influenced the policy at each level, said Dewailly.

Environmental health science requires approaches that are relatively new to biologists. Some of the challenges are technical—for example, how to measure volatile compounds, or complex interactions between compounds, in matrices that may have as many as 200 variables. People's exposure to environmental factors must be measured in the real world, not a controlled laboratory, and must take account of differences between individuals.

There are also issues that affect the research manager. Multidisciplinary teams are key to solving some of the key problems in environmental health; Dewailly's team, for instance, includes an engineer and a psychologist. But the scientific establishment is still wary of funding multidisciplinary work and the most respected journals rarely publish it. Research leaders must be committed, determined and prepared to advocate for change within the scientific establishment.

Environmental scientists must have good communication channels with policy-makers. All those involved should be clear about the likely timeframe for change. Some problems, such as the contamination of the foodchain with industrial pollutants, will take decades to solve because of the compounds' very long lives. Other problems can be dealt with much more quickly, as Dewailly went on to show with the following example.

His team, like John Spengler's (1) at Harvard School of Public Health, had investigated the risks of nitrogen dioxide poisoning in indoor iceskating rinks. The problem had first come to Dewailly's attention seven years earlier, when he had been a duty public health officer. "I was called from the emergency room by a [clinician] saying, 'I have five guys here with pulmonary edema and there is something strange: three of them are in black and white shirts, and they have skates.'" If a rink relies on a propane-fuelled machine to resurface the ice, NO^2 can accumulate in potentially dangerous amounts if the rink is poorly ventilated or badly maintained. The research that followed examined the nature of the problem and its scale, and led quickly to the establishment of guidelines on safe practice for skating rinks. Public health authorities and researchers had maintained close contact throughout. Dewailly argued that this practice should be followed in all environmental health investigations.

Global priorities and responsibilities

But perhaps the biggest responsibility for environmental health researchers is to keep sight of the priorities. Dewailly listed a few: "Megacities, coastal zones, internationalization, globalization." And key to all of these, he said, is to ensure that environmental health science serves all the world's populations, poor as well as rich. International cooperation will become more and more important, said Dewailly, as all populations are exposed to toxins and, with global trade, risks such as dietary contaminants respect no borders. As with other health threats, the populations of developing countries bear a greater burden than those of the wealthy nations. They are often exposed to higher levels of environmental toxins than in industrialized countries, but without the resources to act to control them. For example, DDT exposure is still very high in malarial regions where the pesticide is still sprayed to deter mosquitoes. A recent study by Dewailly's team in one malarial region had found levels of DDT 300 or more times higher in young men than would be normal in the US, and sperm counts were lowest in those with the highest levels of exposure. This "extreme exposure scenario" gives cause for concern.

Dewailly acknowledged the scale of the problems facing developing countries, but was also optimistic that the science of environmental health will help to reduce the problems, as it tackles increasingly complex questions with the support of a highly motivated public.

II. A widening agenda: three "waves" of threats and responses

Like Dewailly, Anthony McMichael believes that the agenda for environmental health is broadening and becoming more complex. Until recently, it focused on important, but localized, exposures to inanimate chemicals. Today, he said, the importance of infectious diseases as environmental hazards has

also become clear. After a period in which these threats were somehow forgotten, they have returned strongly onto the agenda, said McMichael. Researchers have also realized the impact of social and economic factors on the spread of infectious diseases. Among the most important of these social factors are urbanization, patterns of land use, patterns of trade and long-distance population movements.

McMichael outlined three different "waves" of environmental hazards and the consequent social responses to them, which have tended to follow each other as industrialized societies have become wealthier in the past 200 years or so. The patterns can be compared with patterns in wealth distribution, first described by the economist Simon Kuznets. Wealth distribution changes as a population grows richer: at first, income disparities widen, then reach a plateau, then start to lessen. With threats to the environment, a comparable set of stages exists, argued McMichael. He explained: first, in a low-income society, come the "traditional" environmental problems, such as household refuse. The traditional way of dealing with them is simply to push them out of the locality into someone else's backyard, and only as societies grow richer do they build reliable systems for waste disposal.

Second, with economic development, comes an intermediate set of contaminants, including some air pollutants and heavy metals such as lead, cadmium and mercury. Because their impact is less obvious than the first category, a higher level of education, awareness and income is usually needed in a society before public pressure will force governments to control them. Yet that level is eventually reached and action is taken, as in most industrialized countries today. Many developing countries, by contrast, still use leaded gasoline in cars and have no safe disposal policies for heavy metals.

Third comes the newest set of problems: those that are regional or even global, such as greenhouse gas emissions and ozone depletion. These problems are the result of increased economic activity around the world, combined with population growth and urbanization. Likewise, their solution requires global action. So far, however, global responses have clearly been inadequate: even the wealthiest and best-educated societies are struggling to agree on remedial policies and have not made serious commitments to preventive strategies.

McMichael stressed that global environmental problems coexist and interact with each other, and should not therefore be studied in isolation. For example, as ecosystems on land and sea are impaired, food production is affected, and this in turn alters trading patterns. Meanwhile, global climate change is also affecting regional food yields.

As a recent chair of the Health Impacts assessment group of the Intergovernmental Panel on Climate Change, McMichael focused his talk in more depth on issues to do with temperature rises, including those over the

past 150 years. There has been an increase of between 0.3°C and 0.4°C in the past 25 years alone. "The climatologists are now convinced that most of the rise over the last quarter century is attributable to human action, to our changing of the composition of the lower atmosphere by emitting greenhouse gases," he said. Over the coming century, the central estimate by the IPCC is that mean temperatures would rise by approximately another 2.5°C. "But that could go a good deal higher—or lower." The estimates remain uncertain, but, he said, "It's quite clear that many of the ecological systems that human well-being and health depend on would not be able to cope with a sustained temperature rise of this kind over the coming century."

Modelling different scenarios

To illustrate some of the potential consequences of global warming, McMichael reported on his team's studies of the effects of heat waves in London over the past decade. The concentrations of major air pollutants had been shown to rise as temperatures rise above the high 20s Celsius, trapped in the "heat island" of the capital. The team estimated that half the excess mortality during these London heat waves was attributed to these pollutants. The other half was attributed to heat stress. Although heat waves are likely to bring the most dramatic effects, there will also be more minor, but widespread, consequences of a general rise in temperatures. These include earlier peaks in the pollen season and therefore earlier onsets of hay fever and asthma, and a greater risk of waterborne diarrheal diseases in areas prone to flooding. A change in the distribution of insect-borne diseases such as malaria and dengue fever is also possible. Some reduction in the winter seasonal peak in death rates would also occur in temperate zone countries.

McMichael argued that a key role for environmental epidemiologists is to develop scenario-based models—not to provide long-range forecasts, because that would be impossible, but to provide policy-makers with indications of the possible range of outcomes from climate change. He gave some examples of projections under a *range* of scenarios of the impact of climate change on factors relevant to human health, such as malaria and water shortage. (Figure 3.1) These may assist national governments and international bodies in formulating policies.

Taking responsibility

For example, said McMichael, it has been possible to model how climate change might affect the transmission of the malaria parasite and its vector, the mosquito, in different levels of humidity, temperature, and so on (2). With the "business as usual" scenario, taking no action to reduce greenhouse gas emissions, the number of people at risk from malaria would increase. If emissions

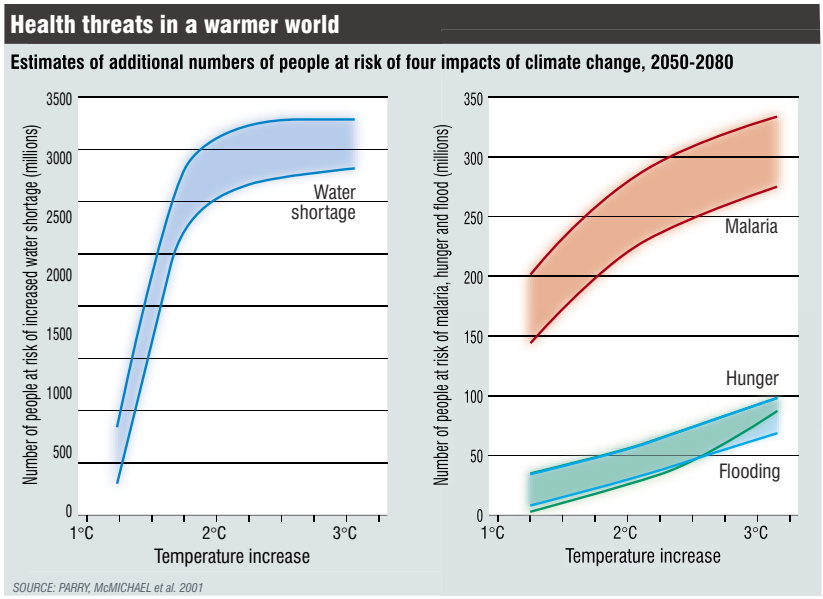

Figure 3.1

are deliberately limited by specific amounts, the numbers at risk would be lower.

Environmental epidemiologists must recognize that their role in influencing policy-makers is crucial. "If it's not going to be public health scientists such as us that address these questions on behalf of the policy-makers and the public that want answers, who else is going to do it?" McMichael asked.

III. Act now with existing tools

Devra Davis agreed on the need to look forward into the future—but with the emphasis placed firmly on the near term. While most research on greenhouse gas emissions focuses on the long-term impact on climate, Davis and her colleagues have focused instead on the short-term impacts on health. They have shown that, if fossil fuel emissions are reduced now, with existing tools, the emissions of particulate air pollutants could be sharply reduced, especially in developing countries. Worldwide, they estimate, some 8 million deaths could be avoided between now and 2020 by immediate use of tools that already exist.

To begin, however, Davis offered a personal tale—from the past. Brought up in Donora, Pennsylvania, one of the classic steel-producing towns in America, she had read in the newspaper after she left home for university that Donora had been polluted. Was this the same Donora she'd grown up in? she asked her mother. Well, said her mother, did she remem-

ber how they'd had to wash the walls every week, how they often drove with headlights on in the daytime, and how nobody really wore white? Yes, said Davis, she did. "I guess today they'd call it pollution, but then, it was just a living," her mother had said.

Airborne particulates and the risk of death

Today, it is not a living; it is a recognized threat to health. The scale of the danger from pollutants such as lead and diesel particles is now relatively well established by work conducted by teams of researchers at Harvard in today's cities around the world. "You can do all the models you want about what's going to happen in 2050 and 2100," she said. "But next year, I can tell you approximately how many children are going to be admitted to the hospital with asthma and how many are going to die."

Some people believe the risks from air pollutants to be trivial, said Davis. They confuse the fact that the relative risk for any given air pollutant may be small, but because there is no escape from breathing polluted air, the risks to the population exposed can be considerable. Because everyone has to breathe, the collective risk is significant. Her team has begun working with colleagues in Chile, Mexico and Brazil to ask what the outcome will be if there are no changes in fossil fuel use in the cities of these countries for the next 20 years. "What if Santiago, Chile continues to put lead in its gasoline, continues to use diesel buses? What if the United States continues to ship its excess cars to Latin America, where cars that we ban in this country get recycled in Sao Paulo?" And what if there are real changes? The researchers are looking at the potential outcomes if policy-makers take specific steps now.

Davis illustrated her points by showing her audience photos of cities and towns under killer smogs. "This is my hometown at 10:30 in the morning, on a day that 18 people dropped dead," she said. Then, a picture of Los Angeles during an episode of air pollution in 1958—today, she said, the air in some cities in China and India would look very similar. "The real question is, if these high levels of air pollution were able to kill people in a short period of time, what do lower levels do to many?" Davis explained that for children, a sustained insult to the lungs by air pollutants could have long-term consequences, preventing them from developing adequate lung capacity and leaving them more vulnerable to infections.

Children facing permanent impairment

All too predictably, air pollution takes its heaviest toll on the world's poorest. "Three out of four of the world's megacities are in the rapidly developing world where they lack the infrastructure that we have." And the young may pay a heavier price than adults. Most of the world's children live in developing

countries, and more children in these countries die of respiratory diseases than of diarrheal diseases.

Davis also showed that air pollutants, particularly particulates, could reach farther and wider from their source than many had imagined. For example, the fires that raged in Indonesia in 1997 polluted the air about 1,000 miles away. Similarly, fires in Mexico caused a shutdown of schools in Georgetown, Texas. Most of the particulate air pollution in cities comes from automobiles. "The point is that particulate air pollution may be generated locally, but it moves globally," she said. "And it gets deep into the lungs. The smaller the particles, the deeper it gets."

As her team had shown in a key paper (3), about 8 million deaths could be avoided worldwide between now and 2020 if countries used existing tools to reduce carbon-fuel particulate emissions. The team is continuing to work with colleagues in Santiago, Mexico City, Brazil and New York to model in detail how existing technology may reduce these emissions in individual cities, and how many deaths may be avoided in each. "We've calculated that there are substantial savings by implementing these policies now," said Davis. "This isn't a question of what's going to happen if it gets hot. It's already hot." What's more, she argued, the cost of preventing the problems will be much lower than the cost of treating them.

IV. The debate

McMichael was challenged to clarify whether he thought his three "waves" of environmental threats, and the responses to those threats, are inevitable. Do all societies in developing countries have to go through all three? No, said McMichael. Swift and efficient action can speed up the control process. "We would hope that in an enlightened world in which there is a regular transfer of knowledge and technology that the developing countries or poorer countries are given the opportunity to leapfrog that intermediate stage," he said. That, indeed, was the subject of much discussion at the Kyoto Conference of 1997: can cleaner forms of energy generation be introduced into China and India before these countries commit themselves wholesale to the old and dirty fuels and irreparable damage to their environments?

Davis argued that it will simply not be possible for developing countries to move through the three waves of threats and to respond to them as slowly as the industrialized world has done. The developing world hosts megacities whose population density is unprecedented, and whose vulnerability to polluted air and water is far greater than anything experienced in the past 200 years in the rich nations. If we were to wait for developing countries to acquire the resources of the developed world before ameliorating these problems, she argued, permanent and irreversible brain damage and ecological harm would have occurred.

Yet there is much to be upbeat about, she argued. For example, China has taken firm action to curb air pollution. Web sites in China now carry clearer public information on air quality than is available in much of the United States. In just a couple of years, she said, China has shut down some 100,000 polluting local enterprises and smelted down 20,000 taxi vehicles that are notoriously polluting.

However, all the panelists warned that nobody should be under illusions about the tough decisions that governments will have to make if there is to be progress. "There are very strong vested interests out there in the world," said McMichael. For example, there are strong corporate interests in maintaining lead in gasoline, he argued. Corporations are continuing to sell it aggressively in developing countries long after the markets for it in most industrialized nations have collapsed. Davis agreed, giving examples of how companies have tried to influence research and public information in favor of protecting their own interests. There appears to be an increasing trend reflecting a multiplicity of actors. "What we're seeing all over the world is that the government role is less important. Multinational corporations are important, and nongovernmental organizations are important. There are profits to be made from introducing cleaner and greener and healthier technologies, and we have to make the health argument clear on the need for such advances as well." There are also changes in the distribution of power within different levels of government. Federal authorities are weakening and local state governments will be taking on increasing responsibilities, as federal funds are reduced and states are charged with the task of doing more with fewer resources. It is all the more vital therefore, she argued, that scientists work closely with decision-makers, the media and those who educate the public. "It will be very important for those who are doing the science to move these issues forward."

This symposium was held on December 7, 2000.

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Further reading

—*www.whensmokeranlikewater.com*