

## Environment and health: an overview

Michael McCally

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In the 1980s biologists began to observe startling declines in frog populations around the world, even in isolated and relatively pristine environments. It appears that no single factor is responsible. Rather, the health and reproductive success of amphibians is being damaged by an increase in the intensity of ultraviolet (UV) light (because of thinning of stratospheric ozone), traces of globally distributed toxic chemicals, competition from introduced predator species and infections caused by virulent fungi and bacteria.<sup>1,2</sup> The declining health of frogs, birds and thousands of other organisms may be one of the clearest indications of environmental threats to human health. Although local environmental tragedies of climate change, species extinction and deforestation have marked every period of human history, today's environmental degradation is rapidly creating an unprecedented global crisis driven by population growth and industrialization.<sup>3-7</sup>

For the first time, human beings are altering the basic operations of the Earth's atmosphere, geosphere and biosphere. In a recent essay, 4 prominent biologists noted with concern that "human alteration of Earth is substantial and growing. Between one-third and one-half of the land surface has been transformed by human action; the carbon dioxide concentration in the atmosphere has increased nearly 30% since the beginning of the Industrial Revolution; more atmospheric nitrogen is fixed by humanity than by all natural terrestrial sources combined; more than half of all accessible surface fresh water is put to use by humanity, and about one-quarter of bird species on Earth have been driven to extinction."<sup>8</sup> In 1992 the *World Scientists' Warning to Humanity*<sup>9</sup> was endorsed by more than 1600 scientists from 70 countries, among them 104 Nobel laureates, including most of the science prize recipients. The warning cited clear evidence of a growing environmental crisis.<sup>9</sup>

Ten years ago Alexander Leaf wrote about the potential effects of global environmental change on human health.<sup>10</sup> This essay in *CMAJ* introduces a series of articles that continue Leaf's initial exploration. In each article, the authors will present a brief state-of-the-science review of their topic, an interpretation of the problem, and suggestions for medical and public health responses. The intent of the series is to examine the links between environmental change and human health and to suggest programs and policies that will protect both health and the environment. These essays do not address environmental hazards for which the association

with disease is well understood, such as environmental lead poisoning, particulate and ozone air pollution, radon and tobacco smoke. Instead, these papers will focus on global environmental changes precipitated by human activity and their likely role in emerging health problems.

From a biomedical standpoint health is viewed as an attribute of the individual. The fields of medicine and public health acknowledge environmental causes of illness and assign risk to specific exposures. In the past decade, biologists, ecologists and physicians have developed the concept of ecosystem health. This idea recognizes that humans are participants in complex ecosystems and that their potential for health is proportional to the health of the ecosystem.<sup>11</sup> An ecosystem-based health perspective takes into account the health-related services that the natural environment provides (e.g., soil production, pollination and water cleansing) and acknowledges the fundamental connection between an intact environment and human health.<sup>12</sup>

Environmental degradation exaggerates the imbalance between population and resources, increases the costs of development, and worsens the extent and severity of poverty. Population growth and the "corporatization" of agriculture and forestry have forced poor people onto land that is the least productive and ecologically the most fragile. In crowded or poor countrysides, people often abandon traditional and sustainable land use practices in favor of short-term survival strategies such as farming on steep slopes and living in areas threatened by flood or drought. The need for farmland, fuel wood and timber for export results in deforestation, which in turn increases soil erosion, flooding and mud slides and reduces agricultural productivity. In short, interactions between poverty, population growth and environmental degradation impede sustainable economic development and worsen population health.<sup>13</sup>

The problems resulting from environmental change pose new challenges for traditional public health science.<sup>14</sup> The health effects of global change are often indirect and difficult to assess, and the quality of evidence for the health-related outcomes of global environmental change varies widely.<sup>7</sup> For example, the prevalence of malaria has increased worldwide, but no clear relation to climate change has been established. Similarly, exposure to UV light (especially UVB) increases skin cancer and cataract formation, but large studies across geographical areas with different levels of UV exposure have not been performed. Further-

more, the health science necessary to understand global environmental change is increasingly interdisciplinary and requires collaboration among meteorologists, chemists, biologists, agronomists, biologists and health scientists, over long periods. Organizing and funding such science is difficult. Finally, the science of global change frequently relies on computer models to suggest the direction of change, but politicians and policy-makers are loath to commit resources to predicted but unproven future outcomes.

It is important for scientists to anticipate the potential consequences of environmental change.<sup>15</sup> Serious environmental problems are often unknown or unrecognized. The stratospheric ozone hole produced by chlorofluorocarbons, although anticipated, was discovered by accident.<sup>16</sup> At the time of the first major international conference on the environment, held in Stockholm in 1972, global warming, acid rain and tropical deforestation were not recognized as major problems. Explanations of the decline in amphibian populations, cancer outbreaks in fish and the bleaching of coral reefs are still inadequate today. Furthermore, change in natural systems may be sudden and nonlinear. For example, fish populations that have remained stable during long periods of intense harvesting may suddenly collapse.

Global environmental issues at this special moment in history are unique in their scope and consequences, and discussion of them may be emotionally and politically charged.<sup>17</sup> Global change may seem so remote from our daily lives that we become indifferent to the litany of environmental apocalypse. We may not perceive the actual degradation of the Earth.<sup>18</sup> Some of us distance may ourselves from the discussion because we find it frightening or overwhelming. As a result, policy-makers and politicians are not pressed to confront the consequences of the continuing expansion of human enterprise. For example, climate change produced by the accumulation of greenhouse gases, primarily carbon dioxide, seems increasingly certain. The 1995 second report of the Intergovernmental Panel on Climate Change concluded that "man's impact on climate is discernible," and many climate scientists believe that we are already experiencing global warming effects.<sup>19</sup> But it is difficult for us to acknowledge that industrial carbon dioxide — invisible, odourless and nontoxic — is a pollutant. International political leadership has only recently begun to seek solutions to the global issues of climate change, toxic pollution, species loss and deforestation.

Two recent developments have drawn renewed attention to the health risks of persistent organic pollutants (also known as POPs): the identification of medical waste as a significant source of toxic pollution and the emergence of the new toxicological field of endocrine disruption. Medical waste incineration is a major source of the dioxin and mercury released into the environment. Almost all humans have measurable residues in their tissues of chlorinated hydrocarbon chemicals, including pesticides, polychlorinated biphenyls (PCBs) and dioxin. In some cases these levels approach the threshold of public health concern.<sup>20</sup> Pressured

by advocacy organizations, the health care industry has begun efforts to better manage medical materials and waste. The second development is the emerging toxicological field of endocrine disruption. Endocrine disruptors are a class of chemicals, including many of the persistent organic pollutants, that imitate or block hormones. These chemicals produce a variety of reproductive and neurodevelopmental disturbances in wildlife, laboratory animals and humans, often at very low doses. Endocrine disruption, currently the object of renewed study by government, industry and academia, offers a new toxicological paradigm that may supplement carcinogenesis as the outcome of concern.<sup>21,22</sup>

Public concern about environmental degradation in both rich and poor nations is developing into a broad environmental health movement.<sup>23</sup> But to argue, as some do, that the quality of human existence is improving because life expectancy is increasing and child mortality is decreasing in many parts of the world is to miss what McMichael has called the "essential newness" of environmental change.<sup>14</sup> The carrying capacity of the Earth may appear adequate at this moment in history, particularly for those of us in affluent countries. Economic development and improved access to public health programs have produced expected improvements in less developed countries. Although the world's population has increased fourfold in the last 150 years, the food supply has kept pace. But can we support another approximate doubling of the population by 2050, from 6 billion to 10 or 12 billion, the high-fertility forecast by the United Nations?<sup>24</sup> Will the food supply remain adequate? What are the health consequences of global warming and climate change?<sup>25</sup> What are the consequences of loss of biodiversity, forests and marine life?<sup>26</sup> Science has only begun to address these questions.

To protect the health of populations we must develop systems of food, energy and industrial production that can be sustained over generations. We also need value systems of stewardship, precaution and prevention to guide environmental protection and health promotion. Finding solutions to the threats posed by environmental change is the major health challenge of the next century.<sup>27,28</sup>

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*Dr. McCally is with the Department of Community and Preventive Medicine, Mount Sinai School of Medicine, New York, NY.*

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**Correspondence to:** Dr. Michael McCally, Department of Community and Preventive Medicine, Mount Sinai School of Medicine, New York NY 10029; fax 212 360-6965; michael.mccally@mssm.edu