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Globalization and the Sustainability of Human Health

An ecological perspective

Anthony J. McMichael, Bert Bolin, Robert Costanza, Gretchen C. Daily, Carl Folke, Kerstin Lindahl-Kiessling, Elisabet Lindgren, and Bo Niklasson

The last half-century has seen momentous and accelerating changes in humankind's economic activities, political relations, and social and demographic profile. A prominent feature of this change is the increasing scale of human impact on Earth's natural biophysical systems: the climate system, stratospheric ozone, biodiversity, terrestrial and marine food-producing ecosystems, and the great cycles of water, nitrogen, and sulfur (Meyer 1996, Vitousek et al. 1997). These systems sustain the conditions on which life depends, and their weakening may therefore have profound long-term implications for human population health (McMichael 1993, Last 1997).

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The health risks posed by today's large-scale anthropogenic environmental changes add a new, ecological dimension to the topic of environmental risks to health

Much of the recognition of how these unprecedented large-scale environmental changes may jeopardize human health has emerged, albeit tentatively, during this current decade. For example, the First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), published in 1990 (Houghton et al. 1990), paid scant attention to the risks to human health that are a consequence of climate change, although it dealt in detail with the potential impacts of farms, forests, fisheries, water catchments, and other systems. In contrast, IPCC's Second Assessment Report (IPCC 1996) gave a much more detailed consideration to the potential health impacts of climate change. The report noted that "The sustained health of human populations requires the continued integrity of Earth's natural systems."

This latter statement invokes an unfamiliar idea. The dominance of urbanism and individualism within modern Western culture has diminished people's awareness of the dependence of continued good health on the natural world. We tend to focus instead on immediate, local, tangible influences on personal health, thus viewing health primarily as an individual asset to be transacted within the health care system and enhanced by prudent individual behavior (supplemented by regulatory protection). The ethos of modern epidemiological research, with its predominantly reductionist approach to studying disease causation by cataloging proximate risk-factor behaviors and exposures, has reinforced this individual-centered view of health and disease (Loomis and Wing 1990, Pearce 1996).

There are, however, important influences on health that operate at the population level—some of which do not translate directly into individual-level factors. An awareness that the health of a population reflects ecological circumstances has long been applied by ecologists to nonhuman, especially wild, species (Anderson 1982, Odum 1992). To understand these larger-scale ecological influences on human health, scientists must think in terms of the experiences and dynamics of human populations and their interactions with the surrounding world. Such population-level influences can be of a biological, social, or environmental kind.

For instance, the level of "herd immunity," which reflects the proportion of individuals that have acquired immunity to the infectious disease in question, is a well-documented population-level determinant of disease risk (Fine 1993). Although the infectious disease can be observed at both the individual level (i.e., as affected cases) and the population level (i.e., in the disease incidence rate), herd immunity is exclusively a property of the population. In the social domain, Wilkinson (1996) points out that "looking at health from the standpoint of society rather than of individuals can lead to a radically different view of the determinants of health." He and others have shown that interpopulation differences in health indicators (e.g., average life expectancy) appear primarily to reflect differences in the extent of within-population income inequality: At any level of per capita income, less equal societies have lower life expectancy (Kaplan et al. 1996, Wilkinson 1996). Income inequality is itself a property of the population, affecting such things as social cohesion (i.e., the quality of civic institutions, social networks, and within-community interaction) and the provision of social services. These social contextual conditions affect community morale, patterns of antisocial behavior, levels of chronic stress, and access to health care, all of which influence the population's overall level of health. Finally, ambient environmental conditions often affect whole populations. For example, the accumulation of endocrine-disrupting organic chemicals may affect reproductive biology and the risks of certain cancers (Colborn et al. 1996, Toppari et al. 1996, Swan et al. 1997, Davis 1998), and climatic fluctuations, such as El Niño events, influence regional outbreaks of mosquito-borne and other infectious diseases (Bouma and van der Kaay 1996, Colwell 1996).

The increasing awareness of such larger, contextual influences on human health comes particularly from the infectious disease realm. For example, it is now known that several decades of widespread use of antibiotics has resulted, via simple Darwinian evolution, in an escalating problem of antibiotic resistance in infectious organisms (Cohen 1994, Livermore 1998). Antibiotic-resistant tuberculosis in the United States has, for example, risen from around 1–2% of total tuberculosis cases in 1950, to 3–5% in 1970, to over 30% in New York City in the 1990s (Iseman 1995). The widespread rise of childhood asthma in modernizing populations may largely reflect changes in childhood hygiene and domestic environments that have altered immunity-shaping exposures to microbial antigens early in life (Newman-Taylor 1995, Rook and Stanford 1998).

Such examples underscore the important role of the larger-scale structures, circumstances, and experiences of populations as determinants of health. They suggest that health risks should be considered in terms of ecological relationships and collective experiences rather than solely in terms of the summation of individual exposures or characteristics. Although, ultimately, it is individuals who contract a particular disease, their risk of doing so is influenced, often greatly, by the social–ecological context in which the population lives (Frenk et al. 1997).

Challenges to an individual-centered view of health

The dominance of the individual-centered perspective on human health is currently coming under challenge from two quarters. First, epidemiologists are giving greater emphasis to studying disease causation within a broader social context, including consideration of population-level phenomena (Pearce 1996). Some of the impetus for this new focus reflects the growing influence of social epidemiology (Breilh 1995). The stark declines in life expectancy in the countries of Central and Eastern Europe during the 1970s and 1980s, for example, testify to the importance of broad social and economic influences on health (Bobak and Marmot 1996), as do the observations that intensification of excessive alcohol intake contributed to the dramatic fall in life expectancy in Russia during the socially turbulent early 1990s (Leon et al. 1997) and that the social class gradient in heart disease mortality has widened markedly in Britain since the 1970s (Marmot 1998).

As the world becomes more interconnected economically, technologically, and culturally, transcendent influences on human health are emerging (Frenk et al. 1997). Life expectancy has risen over the past half-century in all regions of the world (WHO 1998). Infant mortality has declined widely in response to oral rehydration therapy, extended vaccination programs, improved water supplies and sanitation, increased maternal literacy, and antibiotic use (WHO 1998). Meanwhile, urban diets in most countries are "westernizing"; many infectious disease organisms are circulating more widely (Wilson 1995, Greenwood and De Cock 1998); transnational industries, responding to increasing deregulation of trade and investment, are seeking lower-cost labor; and persistent chemical pollutants in air and water are contaminating geographically distant populations of plants, animals, and humans (McMichael 1993, Meyer 1996). These large-scale changes are reshaping the profile of world health (Frenk et al. 1997, WHO 1998). For example, rates of obesity, cardiovascular disease, diabetes, and "western" cancers are rising in urbanizing populations in the developing world (WCRF 1997, Shetty and McPherson 1998, WHO 1998); there are diverse, escalating costs to health from the proliferation of cars in cities (Fletcher and McMichael 1996); and new and various familiar infectious diseases are increasing (Roizman 1995, Wilson 1995).

The second stimulus for a population-level perspective is the realization that global environmental changes have major implications for human health. In particular, it is anticipated that changes in stratospheric ozone concentration, world climate, biodiversity stocks, food-producing systems on land and sea, and freshwater supplies will have mainly adverse affects on health (McMichael 1993, Epstein 1995, Last

1997). Some putative early evidence of the adverse health impacts of climate change has been noted in the recent shift to higher altitude of malaria, dengue fever, or their mosquito vectors in highland regions around the world, a shift that is often associated with movements of alpine plants and shrinkage of glaciers (Epstein et al 1998). Milder winters may also enhance the survival of disease vectors, as recently experienced in Sweden with tick-borne encephalitis (Lindgren 1998). Increases in skin cancer incidence over the coming century due to anticipated trajectories of stratospheric ozone depletion have been forecast with the use of integrated modeling (Slaper et al. 1996), although such increases have not yet been observed. The loss of biodiversity, with associated increases in invasive species and disruption of ecosystems, has wide-ranging implications for the spread of infectious diseases and the loss of important genetic and phenotypic materials from nature (Grifo and Rosenthal 1997, McMichael and Bouma in press).

Some of these global environmental changes would also confer some health benefits. For example, in Southeast Asia, forest clearance for the extension of agriculture has been associated with reductions in malaria transmission because of mosquito (*Anopheles dirus*) habitat destruction, as has also happened with *Anopheles darlingi* in South America (WHO 1997, Gomes et al. 1998). Under climate change, temperate-zone countries would experience milder winters and, hence, a reduction in the seasonal excess of cardiovascular mortality. Moreover, although mosquito-borne infectious diseases may spread into warming fringe areas, transmission may be curtailed in those established endemic zones that become excessively hot and dry. Perhaps increased exposure to ultraviolet radiation would lessen the incidence of certain autoimmune diseases (McMichael and Hall 1997).

The sustainability of health: A systems-based view

The health risks posed by today's large-scale anthropogenic environmental changes add a new, ecological dimension to the topic of environmental risks to health. Thus, the problem is no longer one of localized environmental pollution and its immediate toxicological hazards; rather, it refers to the altered life-supporting functions of whole biophysical systems at global and regional levels and within a longer time frame. Therefore, it has become necessary to consider the consequences of environmental change for the sustainability of human health. As with conventional economic performance indicators, such as GNP, growth rates, and employment levels, current population health can be readily measured with stock-taking indices that integrate recent past experience, such as life expectancy, infant mortality, and the prevalence of disabling disease. However, given the finite nature of the earth and the complex nonlinearity of its major systems, these measures of recent performance provide limited information about future performance. A major challenge, therefore, is to conceptualize and assess the sustainability of population health (McMichael in press) as, increasingly, is done for economic activity (Arrow et al. 1995).

Average life expectancies have increased significantly in over 90% of countries in recent decades (WHO 1998). To determine whether these gains are sustainable, it is necessary to assess the extent to which they have derived from durable increases in the stocks of human, social–institutional, and infrastructural capital (e.g., increases in literacy, civic institutions, and quality of health care) and the extent to which they have entailed unsustainable depletion of natural capital stocks via consumption and waste disposal.

For example, consider two components of health gain in developing countries that have had contrasting environmental impacts. On the one hand, reductions in infant and child mortality, which significantly boost life expectancy, have been achieved in poorer countries principally by technical and behavioral interventions that entail minimal environmental impact. On the other hand, much of the improved early-life nutrition that further boosted child survival and adult health has been associated with the Green Revolution, which, over the past four decades, has entailed intensified production methods that damaged much arable land (via chemical fertilizers, waterlogging, and loss of organic content), depleted groundwater stores, and disrupted local ecosystems with pesticides (Repetto 1994, Ehrlich et al. 1995). Meanwhile, in the developed world, the extension of life-extending medical treatment and hospitalization, along with supporting institutional infrastructure, has contributed to an increase in the consumption of energy and materials in these societies.

Moreover, in wealthier countries, gains in life expectancy are now relatively insensitive to further increments in per capita wealth (Wilkinson 1996). Indeed, serial surveys over the last quarter of this century show that the levels of self-assessed well-being have plateaued or declined in western countries, even as incomes have continued to increase (Max-Neef 1995). Gains in material consumption and technology apparently do not ensure gains in health (Arrow et al. 1995). Indeed, if material gains are attained in ways that impair the capacity of the natural environment to provide life-supporting services to humankind, then negative health impacts must be anticipated (Daily 1997). Unsustainable economic activities are therefore likely to impair the sustainability of good health in human populations.

Within this analytical framework, the advent of anthropogenic environmental changes is beginning to refocus thinking about human health and its determinants (Ramel 1992, McMichael 1993). In response to predictions of climate change, for example, assessments have been made of how the food yields of regional agriculture might alter over the coming century (Parry and Rosenzweig 1993) and how the geographic range of vector-borne infectious diseases such as malaria and dengue fever might change (Patz et al. 1996, Martens 1998). Likewise, there is a growing realization that other forms of ecosystem disruption, resource depletion, and loss of biodiversity are all likely to affect human health (McMichael 1993, Epstein 1995, Grifo and Rosenthal 1997).

Ethical and technical challenges

Consideration of the sustainability of human health poses a combination of ethical and technical challenges. These include minimizing environmental damage without compromising the health and well-being of today's populations and balancing the health needs of present and future generations.

These challenges are illustrated by the continuing expansion of world food production. Providing adequate nutrition for today's 6 billion people is already challenge enough to our food production and distribution capabilities. Yet to meet the projected growth in both population size and consumer demand, global food production must approximately double by 2020 (Ehrlich et al. 1995). Hence, now and in the immediate future, there is a need to extract more food from managed and natural ecosystems. Yet, increasingly, major stresses are evident in world food-producing systems, particularly land degradation, declining freshwater stores, and fisheries depletion. Unless radical (presumably transgenic) new technologies emerge soon, increased food production will entail extended irrigation, which is likely to promote certain vector-borne infectious diseases. It would also entail further destruction of natural habitat and therefore of biodiversity (potential sources of pharmaceuticals and genetic resources); reduction of predator populations (via habitat loss and pesticide use) that would otherwise suppress rodent and herbivorous insect pests and rodent and insect vectors for infectious diseases; and continued "extensification" of agriculture as human populations expand into marginal terrain, where they may encounter infectious disease reservoirs and vectors (such as primates, rodents, and insects) in their natural habitat (Daily 1997). The challenge is to achieve a balance between feeding today's world, sustaining food-producing systems, minimizing ecosystem disruption, and minimizing exposure to new or amplified infectious diseases.

The pursuit of good population health as a social goal makes little sense unless it is sustainable over future generations (King 1990). Just as short-term economic growth can be achieved by imprudent degradation of the natural resource base, thereby jeopardizing future economic conditions (Arrow et al. 1995), so it is plausible that current improvements in human health may be gained by modes of socioeconomic development that jeopardize the good health of future generations. There is debate among economists, with some maintaining that maximizing wealth accrual today, even if it causes environmental degradation in the short term, will ensure the ability of future generations to discover, innovate, or substitute—and thereby restore the environment (Beckerman 1992). Other economists perceive great risks to human economies from irreversible changes to nature's infrastructure (Arrow et al. 1995, El Serafy 1996). By analogy, it seems reasonable to argue that unrestrained economic activity that yields further short-term gains in health, but that incurs substantial environmental damage, would diminish the prospects for sustained good health in the future.

Matching the scales of problem and response

The scale of the contemporary, increasingly global, human enterprise and its environmental impacts has raised wide-ranging questions about the sustainability of economic and social structures (WCED 1987). The unprecedented scale of the erosion of Earth's natural capital is reflected in the large proportion of the earth's total photosynthetic product that is now co-opted by humans and the extent of associated land degradation and biodiversity loss (Pimm et al. 1995, Vitousek et al. 1997). Thus, at the environmental level, contemporary economic globalization is characterized by worldwide changes in biophysical systems and natural resources, while at the social level it entails a contraction of public sector spending, especially on social services, and the widespread persistence of poverty (Schrecker 1997). Both the environmental and the social impacts pose risks to the sustainability of human health.

In the past, human populations could degrade local environments and ecosystems in relative isolation; civilizations rose and fell without affecting distant populations or global biophysical systems (Rees 1996). Now, however, economic globalization, interconnectedness, and mobility make such segregation of environmental degradation and risks to health less likely. Recent examples of globalized health risks include the dramatic worldwide spread of HIV/AIDS, the concentration (not just dissemination) of anthropogenic toxic organic chemicals in animals and humans at sub-Arctic latitudes (WHO 1997), and the recent introduction into the United States and South America, in shipments of used car tires from East Asia, of larvae of the "Asian tiger mosquito," *Aedes albopictus*, which is capable of transmitting dengue fever and yellow fever (Morse 1993).

The high-consuming, energy-intensive lifestyle of developed nations requires continued access to inexpensive imports, the production of which often degrades environmental resources in source countries or diverts traditional agriculture into export crops (McMichael 1996). The legitimate economic aspirations of developing countries, with their expanding populations, will further strain the world's environment and thus increase the risks to population health everywhere. Global growth in fossil fuel combustion, which is seemingly unavoidable, will induce climatic changes and thereby affect human health; continued forest clearance and irrigation exposes rural populations to new infectious organisms; and further pressure on vulnerable agroecosystems will increase malnutrition in food-insecure regions and, indirectly, the health risks among impoverished rural-to-urban migrants. Increasingly, these processes are becoming worldwide in extent, contributing to global functional changes.

The growing awareness that long-term human population health depends on the continued flow of nature's goods and services strengthens the argument for the world community to take concerted action to minimize global environmental change. A further incentive is that acting now to sustain natural capital to reduce future risks to human health should also help alleviate many of the existing public health problems associated with poverty, inequity, and environmental degradation. Thus, the reconceptualization of human health within the sustainability framework enhances the "win-win" attractiveness of prompt, prudent, and preemptive action on behalf of the global environment.

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Biology Reporting Awards

The Awards

The American Institute of Biological Sciences Media Award was established in 1995 to recognize outstanding reporting on research in biology. This year's winners will each receive $1000 and expenses to attend the annual meeting of the American Institute of Biological Sciences, 11–14 November 1999, where the awards will be presented.

The awards are designed to encourage the communication of biology to the public. One award is for print journalism specifically, the other for broadcast journalism. AIBS intends to promote public understanding of how biologists approach their research, collect and interpret their data, and reach conclusions, as well as how the research and its conclusions are relevant to society.

Rules

The awards will be limited to nontechnical journalism. Articles published in newspapers and magazines are elegible for the print award, and stories broadcast on radio and television are eligible for the broadcast award. Both freelancers and staff writers are eligible. Professional scientists writing in their area of research are not eligible. Books and articles in technical journals will not be considered. Articles appearing in *BioScience*, the publication of the American Institute of Biological Sciences, are not eligible.

Biological research is broadly defined to include laboratory and field work, as well as theoretical advances. For the purposes of this award, it does not include testing of medical or veterinary treatments.

Entries will be judged on the basis of clarity, reporting and writing skills, originality, and appeal to the general public.

Applicants may submit a single contribution or a series. Stories must have been published or broadcast betwen 1 January 1998 and 31 December 1998. A series will be accepted if more than half of it appeared between those dates. Applications may be submitted by the journalist or on his or her behalf.

For information and entry form

Send a self-addressed envelope to AIBS Media Award, 1444 Eye St., NW, Suite 200, Washington, DC 20005.

All applications and submissions must be received by 1 April 1999. Submissions will not be returned.

Judges

The award will be judged by a panel of science journalists and scientists chosen by the American Institute of Biological Sciences. The winner will be notified by 1 July 1999.

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