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## **PUBLIC PARTICIPATION AS A MEANS OF HEALTH PROMOTION: REDUCING HUMAN VULNERABILITIES TO GLOBAL CHANGE**

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### ***Abstract***

*Underlying such imminent public health concerns as improper nutrition, contaminated water, (re)emerging infections, abounding chronic diseases, rising drug use, growing inequalities and perpetual in-access to care are three on-going global processes: urbanization, environmental change and globalization. While worldwide efforts are underway to identify disease patterns associated with each isolated process, cumulatively, these global trends pose a far deeper challenge to human well being than any individual epidemiological association. The global nature of these changes suggests that supranational forces increasingly drive social, economic, and environmental determinants of health. Yet social services remain the responsibilities of nations, communities and individuals. This shift of power away from local communities contrasts the central premise of health promotion: control over health determinants is associated with improved health status. In this paper, I draw on trans-disciplinary research to develop an integrative framework conceptualizing cumulative effects of urbanization, global environmental change, and globalization on community health. I then apply this framework to health promotion and to research methodologies. Through these applications, I demonstrate that within the context of global trends, a health promotion approach to urban planning and social policy– involving public participation and empowerment– could improve immediate and long-term health potential.*

By 2025, sixty-one percent of the world’s people are predicted to live in large cities with growing urban slums and insufficient public health infrastructure (19). At the same time, trends suggest that continuing economic globalization will contribute to rising levels of inequality, with declining health statistics for many populations (24). Meanwhile, environmental scientists have discovered that human activities are no longer affecting only localized areas, but that humans are inducing global-scale changes to the Earth’s biophysical systems, thus threatening human survival (16). While the World Health Organization’s foundational public health framework, *Health for All in the 21<sup>st</sup> Century*, stressed the importance of health-sustaining local conditions (29), new awareness of global-scale economic, environmental and demographic processes has created challenging new areas for health research.

Multiple research initiatives into global-scale changes are underway, and a paradoxical picture is emerging: although national and municipal governments are responsible for public health, supra-national economic, demographic, environmental and political processes are increasingly driving health determinants (17). An emerging question, then, is how can we most effectively and most equitably achieve community health amidst on-going global changes? Global change is defined here to include globalization, global environmental change, and urbanization (see Appendix A, Table 1).

Several limitations and obstacles challenge researchers in this field and are central to this paper. First, although global changes do not occur in isolation, almost no research yet considers the cumulative or convergent effects of these changes (21). Second, most public health research relies on average measures of physical illness or death, which do not measure human potential for well being or depict uneven vulnerabilities. Third, exposure to hazards is often equated with illness without considering human capacity for adaptation (15), and without taking into account non-linear effects, interactions, or lags. Finally, although global-scale change implies a shift of power away from localities (26) and health promotion research strongly links empowerment with health (28), the health effects of this shifting power has yet to be investigated.

The objective of this paper is to address these limitations by drawing on trans-disciplinary research, and, in so doing, conceptualize cumulative effects of global change on community health. Through this discussion, a three-ring conceptual framework is developed (see Appendix B, Figure 1). The outer ring (representing global changes) and the inner ring (signifying health determinants) are first examined individually, and then interactions between these two rings are examined. Following, the middle ring—denoting controllability and adaptability—is added, exploring its role in mediating health effects and in enhancing health potential. This framework is then applied to health promotion and future research. In its applications, a key role for public participation is unveiled: empowering communities and facilitating adaptation may offer both immediate and long-term promise of achieving health for those most vulnerable to global change.

### **Global Change and Community Health: Developing a Conceptual Framework** *Cumulative Global Change: The Outer Ring*

By the third decade of this century, it is predicted that: (a) well over half of the world's population will live in urban areas (9); (b) climate change will take effect with more frequent and intense heat waves in urban areas (21); (c) globalization activities will increase (3). The outer ring of Figure 1, therefore, represents these three convergent and interacting sources of global change: globalization refers to various interrelated economic, technological and cultural processes of global interconnectedness; global environmental change refers to human-induced global scale changes to the Earth's biophysical systems; urbanization refers to a mega-trend away from rural toward urban living (see Table 1).

These three processes neither function in isolation, nor do they simply act simultaneously; rather, they are additive and interactive. Direct interactions exist between each pair of processes, so that each pair is, in some way, mutually driven. For example, urban

residents tend to consume higher per capita fossil fuels than their rural counterparts (13), and fossil fuel consumption is the main cause of predicted planetary climate change (31). Thus, urbanization underlies predicted global environmental change. Conversely, biodiversity losses, such as deforestation, are associated with migration to urban centres (7), and thus global environmental change underlies urbanization. Likewise, technological globalization drives urbanization as transnational intensification of agriculture and declining demand for agricultural labour lead to urban migration. Urbanization, in turn, brings people into close contact, facilitating the spread of ideas and information and thus contributing to globalization (9). Moreover, links between globalization and global environmental change exist in both directions: globalization drives global environmental change as transnational corporations settle in locations with lax environmental standards and emit persistent pollutants (16); global environmental change, such as freshwater decline, could motivate further deregulation of trade markets as countries with declining resources seek out new reservoirs. Finally, indirect and cumulative interactions also exist. For example, the combination of globalization and urbanization, is leading to rapidly growing urban waste production (10). Whether wastes—namely plastics—are burnt or buried, persistent pollutants are created in their synthesis and re-enter the Earth's systems in their disposal, leading to global environmental change.

Although minimal research is yet available on the interactions between globalization, global environmental change and urbanization, these three global-scale processes are mutually driven, and there is growing evidence that they will converge in time (e.g., by 2030) and in space (e.g., in urban areas). Likewise, effects are likely to be felt disproportionately by those least able to move or adapt to their changing environments because of lack of resources, skills, rights or political voice. Therefore, these three global sources may also converge upon certain economic sectors (e.g., those with least livelihood security, such as transient labourers) or certain social groups (e.g., people who are impoverished) (21). This convergence could have profound implications for health determinants, and thus for urban planning and health promotion.

### ***Changing Health Determinants: The Inner Ring***

Global change and health research to-date is limited predominantly to physical health effects. For example, studies link ozone depletion with skin and eye diseases, land-use changes with vector-borne diseases, urbanization with infections, and globalization with changing life expectancies (17, 16). However, the World Health Organization (WHO) suggests that health is a complete state of well being determined by multi-faceted social, economic, cultural, physical and political factors (28). A more holistic approach, therefore, might be to measure the effects of multiple sources of change on broad determinants of health: the inner ring of Figure 1.

Health determinants are divided into three main categories based on an expanded version of the WHO categories (30). The first is social, economic, political and cultural factors, and these include such determinants as social status, social support networks, education, security, treatment and acceptance in society, employment, income, social workplace factors and level of socio-economic equality. The second is environmental and ecological factors, and these include such determinants as water quality, air quality, housing, workplace safety, sanitation, waste disposal and road conditions. The third is psychological, behavioural and biological factors, and

these include such determinants as self-esteem, coping skills, personal behaviours and health practices, nutritional and medical history, gender, age and genetics.

Like the global changes previously discussed, these three groups of health determinants are interactive and mutually reinforcing, and each contributes to human potential for health. For example, an environmental change that results in adverse workplace conditions might lead to feelings of depression amongst workers. This could result in high employee attrition rates, reducing social support networks amongst remaining employees, and thus causing further depression. In this case, an environmental effect triggers a psychological effect, which then triggers a social effect that feeds back upon the psychological effect. Therefore, an impact on one health determinant can have direct and indirect effects on others. It is noteworthy, however, that while the inner ring depicts three interactive groups of health determinants, the ‘weight’ or importance given to each category will vary across time and space.

### ***Effects of Global Change on Health Determinants: Interactions between Inner and Outer Rings***

Interactions *within* each of the inner and outer ring are delineated above. Applying this framework to guide intervention and research, however, requires further consideration of the implications of global change for human health: that is, the interactions *between* the inner and outer rings of Figure 1. Because these are multiple, highly complex, and practically unstudied, mapping out all global change pathways is beyond the scope of this paper. Nonetheless, evidence suggests that global changes affect local health determinants both individually and interactively. While each process drives health determinant changes, these three sources act simultaneously with additive—and possibly synergistic—effects on health conditions. Additive effects of global changes on health are mostly undocumented; yet, applying a cumulative change perspective may shed light on current challenges to international public health as well as on future adaptation and health promotion.

Globalization affects potential for human health largely, although not exclusively, by affecting social, political, cultural, economic and environmental determinants. For example, globalization is associated with deterioration of education, lowering of wages, suppression of union activities, erosion of civic institutions and cultural practices, rise in impoverishment, loss of non-Western health care, and degradation of environmental and workplace conditions (17). As well, studies suggest that while economic growth and technological advancement associated with globalization have resulted in improved health and longer life expectancy for some populations, economic globalization has significantly enhanced global, regional, and national inequalities (17, 16, 27). Unequal socio-economic distribution, particularly in combination with social and political exclusion of certain groups, is associated with decreased social cohesion, loss of social capital, and increased violence (27). Ripple effects are then likely from one changing health determinant to a myriad of others. Therefore, despite improvements in aggregated “health” statistics, globalization is exacerbating inequalities and deteriorating health determinants in many areas.

Likewise, global environmental changes are affecting life-supporting planetary systems; therefore, they are predominantly—although, again, not exclusively—altering environmental and

ecological determinants. Direct pathways from environmental changes to altered morbidity rates are currently under study: climate change is predicted to lead to increased average temperatures in some areas, and thus rises in heat-related illnesses; biodiversity loss has led to invasions of disease-carrying vector species and associated disease outbreaks. As with globalization, indirect pathways also exist. For example, changes in climate and food-producing ecosystems, both environmental determinants, threaten food security, a social determinant, and nutritional status, a biological determinant. Global environmental change is, therefore, predicted to have overall adverse effects on health (15).

Moreover, urbanization is associated with changes to all three groups of health determinants. It is linked, for instance, with drug use, unsafe sexual practices, violent behaviour, dietary changes, and sedentary lifestyles—all behavioural determinants (7). For growing urban populations living in shantytowns or on flood plains, with inadequate shelter, sanitation or water, urbanization has meant deteriorating environmental conditions. These environmental determinants combine with the social determinants of high population density and inadequate public health infrastructure to create optimal conditions for outbreaks of new and resurgent infections (22). Another profound effect of urbanization is loss of traditional rural lifestyle and culture, and subsequent loss of social support (11). This then spills over to impact self-esteem, coping capacity, identity, diet and livelihood (23). While urbanization is linked with new opportunities for wealth creation and better access to health care for some people, it has also led to disintegrating health conditions and further impoverishment.

Three decades ago, epidemiologists predicted that developing world cities would undergo a transition in disease patterns away from infectious, maternal, and childhood diseases to chronic diseases of lifestyle and aging. This prediction was based on prior experiences of developed countries in which a similar transition occurred as urbanization and “modernization” led to improved care, state-of-the-art public health systems, and increased opportunities for wealth. However, although highly urban, many developing countries have not experienced this transition; rather, they are caught in a state of mixed morbidity with both resurgent infections and degenerative diseases. As well, poverty, wealth and inequality are all on the rise (9).

One way to reconcile this flaw is to examine the effects of urbanization cumulatively with the effects of globalization and global environmental change, two relatively recent phenomena. Included in this dialogue, then, are reduced social spending, lack of access to health care, growing impoverishment, growing inequalities and insufficient public health infrastructure, all of which are associated with globalization. As well, global environmental changes might further affect health potential: immune suppression is associated with ozone depletion and organic pollution; pathogen habitat creation is associated with land use and climate changes; and food and water insecurity is predicted with declining freshwater and food-producing ecosystems (17). From a cumulative change perspective, the effects of urbanization in this example might have interacted with the effects of global environmental change and globalization so that the overall impact on health determinants was more severe than the sum of the effects of each individual process. The epidemiological prediction was made, though, before fully comprehending the convergent effects of recent global processes.

Therefore, while each global change (outer ring) is linked with changing health determinants (inner ring), the cumulative effects of global change may prove more severe than the sum of any isolated predictions. As well, exploring why developing-world cities did not undergo the predicted epidemiological transition associated with urbanization is key to understanding factors that enable and disable adaptation: thus, the middle ring.

### ***Introducing Adaptability and Controllability: The Middle Ring***

While global changes are acting cumulatively upon local health determinants, humans are not passive in this process; a change in health determinants alone is not sufficient to cause ill health. The middle ring of Figure 1, therefore, demonstrates that controllability/ adaptability play a central role in mediating the effects of changing health determinants and in building health potential. Four interactive relationships between the inner and middle rings demonstrate this centrality. First, changes to health determinants affect health potential, usually by changing exposure levels to hazards. Second, ability to adapt to and control changing health determinants mediates effects of these changes. Third, health determinants can likewise influence adaptability. Fourth, sense of controllability and personal adaptability directly improves well being. Thus, adaptability and controllability encircle all other health determinants as well as human health potential.

Most global change and health research, however, centres on hazards posed by environmental change (15), uncovering life-saving information, but not accounting for human adaptability. Failing to take into account human adaptability, whether through innovation, technology, medical discovery, or behaviour change, could lead to prematurely translating exposure to hazards into probability of illness (8). For example, although ozone depletion is linked with increased exposure to ultra-violet rays, once processes were understood, public education on sun dangers led to adaptive behaviours, thus significantly reducing initially high sun-related illness (18).

A less reductionistic means of assessing health effects is to employ a “vulnerability approach” that defines vulnerability in terms of two components: (a) external stress/ exposure to hazards and (b) internal adaptability/ capacity to cope with change (5, 8, 12, 18, 21). For the most part, changes to health determinants involve the first component, exposure to hazards. However, the second component, adaptability, can mediate the effects of this exposure. Furthermore, the centrality of adaptability to human well being is analogously supported in two highly relevant bodies of research: human security and health promotion.

Drawing on vulnerability sciences, human security research defines vulnerability as an inherent state at one end of a continuum, at the opposite end of which is human security (4). According to the Global Environmental Change and Human Security (GECHS) Science Plan, human security is achieved when and where individuals and communities live with three basic conditions: (a) the options necessary to end, mitigate, or adapt to threats to their human, environmental, and social rights; (b) the capacity and freedom to exercise these options; and (c) the opportunity to actively participate in attaining these options (14). Adaptability, therefore, is key to moving along the continuum from vulnerability to security (4).

Likewise, the Ottawa Charter of Health Promotion defines health promotion as a process of enabling people to take control over and improve their health. Health promotion is founded on the belief that people and communities must be able to take control over health determinants, realize aspirations, satisfy needs and change or cope with their environments in order to reach their health potentials (28). Studies show that degree of control and capacity to take action, especially during times of stress, are highly correlated with level of health (1). Both actual and perceived controllability is associated with reduced physical symptoms of stress, and belief in personal efficacy contributes to individual adaptability. Furthermore, belief in collective efficacy is associated with community adaptation, empowerment and social change (2), and public participation and empowerment are essential for community health (1).

In bridging the GECHS continuum concept with health promotion theory, vulnerability and low potential for achieving health share one end of the continuum while human security and high potential for health share the other. Like vulnerability and security, health potential is an inherent state. For example, regardless of mortality rates at any static point in time, a community lacking conditions necessary for health—e.g., no access to water or sanitation—has lower potential for achieving health than one with health-supporting conditions. Represented in the middle ring of Figure 1, then, adaptability, a major component of which is controllability, is key to achieving both human security and health.

#### *Effects of Global Change on Adaptability: Middle-Ring Interactions with Outer and Inner Rings*

Furthermore, studies suggest that global changes (outer ring) are eroding adaptability (middle ring) both directly and indirectly (via inner-ring effects). At the same time, local resistance implies that universally perceived loss of community control is not inherent in global change (3). Nonetheless, adaptability and sense of control are inextricably linked to human health and highly affected by global change; thus, examining the interactions between global changes (outer ring), adaptability (middle ring), health determinants (inner ring) and health potential (centre) is necessary in conceptualizing the complex pathways of change.

The global scale of current economic, environmental, social, cultural, and demographic processes is creating a need for transnational solutions, and thereby instilling a sense of paralysis amongst individuals and communities. Such feelings of powerlessness can occur prior to measurable changes in local health determinants and are associated with inability to cope and lowered immune functioning (2). One study found that in New Zealand, two effects were felt unevenly on Maori, Pacific people, women, children and people with disabilities after fifteen years of market liberalization and deregulation, privatization of the public sector, and declining social assistance. The first was increased poverty and unemployment; the second was decreased ability to exercise political power or affect public discourse (26). Global-scale change is therefore directly affecting local sense of control over health determinants.

These processes also indirectly affect adaptability and controllability: global change (outer ring) impact health determinants (inner ring), and changing health determinants (inner ring) then impede adaptability (middle ring). For example, Wheatley (1997) investigated a First Nation's community in Canada in which conflicting media and government reports on river

mercury levels led to a complete ban on sustenance fishing. This ban led to social disruption, reflecting feelings of hopelessness at the loss of lifestyle, self-esteem and traditional values. However, further study suggested that it was not only the breakdown in traditional roles and relationships associated with environmental degradation, but also the consequent loss of control and lack of power to change the situation, that led to social disruption. In this case a global environmental change affected an environmental determinant, which then affected a number of social determinants. At the same time, the altered environmental condition for which the community had no responsibility led to a declining sense of controllability, thus further impacting potential for well being.

Significant time and space lags between global changes and health effects contribute to this reduced sense of control, as community health may be adversely impacted by the actions of distant generations or regions. For example, the actions of people living in the United States (four percent of the world's population) create 25 percent of global carbon emissions, which are cycled into ocean systems and are re-released into the atmosphere over a period of about one hundred years. Consequently, predicted temperature rise is likely to result in a sea level rise, inundation of agricultural lands and, assuming no adaptation, food insecurity and malnutrition. Pacific Islanders, on average, produce one quarter of the carbon dioxide emissions attributable to the average person worldwide; yet, island nations are highly vulnerable to health consequences associated with sea level rise because of their size, proximity to the oceans, dependency on coastal areas, and lack of resources to adapt. Future generations living in many Small Island States—distant spatially and temporally from sources of climate change—are therefore likely to experience disproportionate effects (20).

There are signs, however, that global processes are not inherently linked to reduced controllability. The current anti-globalization movement, for instance, demonstrates resistance to global change-induced feelings of powerlessness: various local groups have joined together to demand a voice in global decision-making processes (9). Likewise, Small Island States who were initially not considered in international climate change assessment efforts, have successfully secured priority in the Third Assessment Report of the Intergovernmental Panel on Climate Change (20). These signs of resistance suggest that urbanization, global environmental change and globalization are not universalizing feelings of powerlessness. Despite substantive literature linking controllability with improved health, though, the effects of such reclaimed sense of control are yet unknown (28).

Nevertheless, for many populations, global changes (outer ring) are impacting community health by eroding health determinants (inner ring) while simultaneously shifting control away from local bodies (middle ring). Piecing together these complex and interactive pathways of change is a necessary first step in integrating health promotion efforts.

### **Applications for Health Promotion**

The framework in Figure 1 is intended not only to conceptualize effects of global change on human well being, but also to guide health promotion. Its three rings suggest a means of bridging three potential levels for promoting health amidst global changes.



The outer-most ring depicts global sources of change that, overall, adversely and inequitably affect health. Intervention at this level constitutes mitigating or preventing global change, including such measures as globally conserving natural resources, improving international environmental regulations, equitably reducing carbon emissions, implementing fair trade policies, supporting small-scale agricultural workers, regulating transnational corporations, and so on. The mutually-driven relationship between globalization, global environmental change and urbanization suggests that mitigating one process in isolation may be less effective than considering drivers underlying all three: for example, uneven and increasing human consumption. Furthermore, intervention at this level requires strong and representative global governance. Unfortunately, while these are important long-term strategies, the transnational nature of mitigation, and the time lags involved, often render those most vulnerable least able to affect change.

In such cases, improving inner-ring health determinants tend to take priority, and because health determinants are also interactive, all three categories of determinants should be addressed. While ameliorating ecological and environmental determinants entails such interventions as improving sanitation and water treatment systems, protecting workplace conditions, and constructing safe housing and roads, strengthening behavioural, biological and psychological determinants could mean implementing vaccination, nutrition, addiction, safe sex, and mental health programs. Moreover, improving social, political, cultural and economic conditions, however difficult, is key to promoting health, and includes: increasing access to education and health care, reducing conflict, supporting stable policies and institutions, (re) instating social programs, securing food and water, ensuring reasonable minimum wages, and so on. These inner-ring interventions are most commonly the focus of 'development' projects, as they are concrete, measurable and vital activities. However, it has been suggested that externally initiated development activities with minimal local public participation have had only short-term community benefits (32).

Importantly, then, the middle ring reflects a third level of intervention that may have potentially profound immediate and long-term impacts on all health determinants: empowering, enabling and facilitating adaptation. On a philosophical level, empowering individuals and communities means challenging power imbalances that rob subordinate groups of the capacity to exercise control over their own lives (23). Practically, instilling a local sense of control may involve educating, drawing on local knowledge, facilitating public participation and community development, and providing resources, options and skills to change health determinants and influence decision-making. Such interventions are most challenging in, but of highest priority for, marginalized groups; that is, those groups existing at the periphery of the prevailing society and power structure, whether physically, socially, economically, or culturally, without choice or opportunity (26). Acknowledging long-lasting effects of social history and redressing disenfranchisement, dispossession of lands, and denial of basic human rights are necessary first steps in empowering marginalized populations. Prescriptive health promotion strategies that do not account for the world's diverse people and environments are less likely to be effective than interventions involving local input. Enabling people to improve their own lives affects both immediate well being and future ability to adapt to change.

Some combination involving all three levels of intervention is likely needed. However, those most vulnerable are least able influence global processes, while those with most global power have the least at stake; mitigating outer-ring changes, therefore, may not prove most effective for those likely to bear the burden of global change. Furthermore, while improving inner-ring determinants must take short-term priority in many areas, the middle ring offers both immediate and long-term promise. Facilitating public participation may improve present well being while enabling communities to adapt to changing health determinants over the longer term. This philosophy of empowerment should not only guide health promotion, but should also underlie research methodology.

### **Applications for Future Research**

If the goals of research are to guide policy, to assist in planning and, ultimately, to improve well being, then research and intervention should remain intimately linked. Further application of Figure 1, then, reveals considerations, limitations and potential directions for research.

Understanding the relationship between power and health (i.e., the middle ring) not only provides insight for intervention, but also raises methodological research issues. The act of conducting research, particularly cross-culturally or within marginalized communities, may create power relationships in which external researchers are considered to be experts on local issues. Ironically, research intended to benefit human health could, through its very process, undermine local power and thus oppose its intended effect. Establishing local research partnerships and identifying local research goals may help reduce such unintended effects. Furthermore, local communities should be involved in collecting data, as local knowledge is necessary in order to capture the exposures and reactions of any particular place (6). Such participatory approaches support, ideologically and practically, the goals of global change and health research.

Figure 1 further alludes to several research obstacles: traditional “health” indicators do not represent health potential; human adaptability mediates effects and complicates prediction; mutually driven sources of change are difficult to isolate; multiple, complex pathways further challenge isolating cause and effect; temporal and spatial lags extend beyond most research. Future study of global change effects on human health will, therefore, require innovative, trans-disciplinary research that draws on both quantitative and qualitative approaches.

Quantitative epidemiological studies traditionally entail comparing “health” data from before and after an “exposure.” In the case of global change, however, baseline data does not exist in many areas of the world, and, as discussed earlier, conventional “health” indicators tend to measure disease and death, not holistic potential for health. As well, the multiplicity and complexity of cumulative change pathways oppose isolating single causes and effects, and because sources of change are mutually driven, studying effects of one source in isolation is unrealistic. Furthermore, certain cumulative effects are highly probable—decreasing social support and cultural networks, increasing inequalities and impoverishment, declining public health infrastructure, environmental degradation, risky behaviours, shifting powers away from

local communities and decreasing adaptability—and proving associations between these effects and global changes, after the fact, precludes prevention.

A more proactive approach might be to shift focus away from associating health effects with past exposures to assessing health potential amidst predicted global changes. The aim of such assessment would be to determine current level of well being, likelihood of experiencing altered health determinants as a result of global change, ability to adapt to potential changes, and local areas of concern. The development of a flexible, culturally-sensitive, locally-conducted means of proactively assessing health potential amidst cumulative global change could assist those working in health promotion, development, policy, planning, and research.

## **Conclusions**

Urbanization, global environmental change and globalization appear to be, at least for some populations, eroding health determinants, while simultaneously reducing local control and adaptability. As well, the cumulative effects of these changes may be greater than the sum of their isolated impacts, and these processes may converge in time and space and upon certain sectors and social groups. Therefore, it is evident that global changes oppose current attempts to equitably promote health. However, while studies are on going in many isolated disciplines, little integrative research yet considers the interactions between cumulative global-scale processes and community-level health.

The framework in Figure 1 draws on cumulative change, health promotion, vulnerability science, human security and global change research to conceptualize cumulative effects of global change on human health. Underlying this framework are two related perspectives: (a) achieving health for all requires creating equitable conditions in which every human can attain his or her own health potential; (b) health is not merely an absence of disease but a complete state of well being (28). Thus, Figure 1 relies on socio-ecological health determinants rather than traditional “health” indicators. It also highlights the links between health and power, placing adaptability and controllability as mediating factors between hazards’ exposure and health effects. At the same time, it allows for the exploration of cumulative and interactive effects of global-scale changes.

Applying this framework to health promotion, three levels of intervention emerge—mitigating global changes; stabilizing or improving health determinants; empowering communities and facilitating adaptation—with the last of these offering the most short- and long-term promise for those disproportionately vulnerable to global change. However, much innovative, trans-disciplinary research is needed, and this research should remain closely linked to health promotion. Developing culturally sensitive and locally driven means of assessing health potential amidst global change could proactively inform intervention and policy. Finally, the central role of controllability and adaptability in achieving health and mediating cumulative effects offers tremendous insights into the need for public participation in effective intervention and ethical research methods.

**Appendix A: Table 1: Global Change Components and Definitions**

<p><i>Urbanization</i>  <b>Mega trend towards urban rather than rural living</b></p>
<p><i>Global Environmental Change</i>  <b>Human-induced global scale changes to the Earth's biophysical systems</b></p>
<p><b>Climate Change</b>  Forecasted changes to global patterns of temperature, precipitation and climate variability due to accumulation of heat-trapping greenhouse gases in the troposphere; highly associated with industrialization and fossil fuel burning.</p>
<p><b>Biodiversity Loss</b>  Rapid extinction of plant and animal species due to agricultural intensification, deforestation, land use changes, and desertification; associated with worldwide bioinvasion of non-native plant and animal species.</p>
<p><b>Stratospheric Ozone Depletion</b>  Destruction of stratospheric ozone layer by human-made gases such as chlorofluorocarbons.</p>
<p><b>Freshwater Declines</b>  Depletion of freshwater aquifers and other freshwater sources due to industrial and agricultural demand, amplified by population growth.</p>
<p><b>Impairment of Food-Producing Ecosystems</b>  Increasing stress on world's arable lands and pastures (1/3 of previously productive land is damaged by erosion, compaction, salinization, water-logging, and chemicalization); depletion of ocean's fisheries</p>
<p><b>Persistent Organic Pollution</b>  Worldwide dissemination of various semi-volatile organic chemicals and heavy metals through the lower atmosphere; often condense and immobilize at Poles; bioaccumulate through food chain; e.g., PCBs, DDT, mercury</p>
<p><i>Globalization</i>  <b>Various interrelated processes of global interconnectedness.</b></p>
<p><b>Economic Globalization</b>  Characterized by deregulation of markets in international trade and increased foreign investment; associated with free trade, corporate taxation concessions, investment incentives in relaxed wage and workplace standards environments, powerful transnational corporations, contraction of national public-sector spending, philosophy of neo-liberalism.</p>
<p><b>Technological Globalization</b>  Characterized by development and spread of information, communications technology; worldwide emergence of high-technology industry, transportation, and agriculture.</p>
<p><b>Cultural Globalization</b>  Characterized by globally coordinated advertising, technology and marketing innovations, powerful transnational media groups, global popular culture dominated by the United States and the English language, loss of traditional lifestyles and languages.</p>

(Note: Definitions adapted from McMichael & Bealgehole 2000)

Appendix B: Figure 1

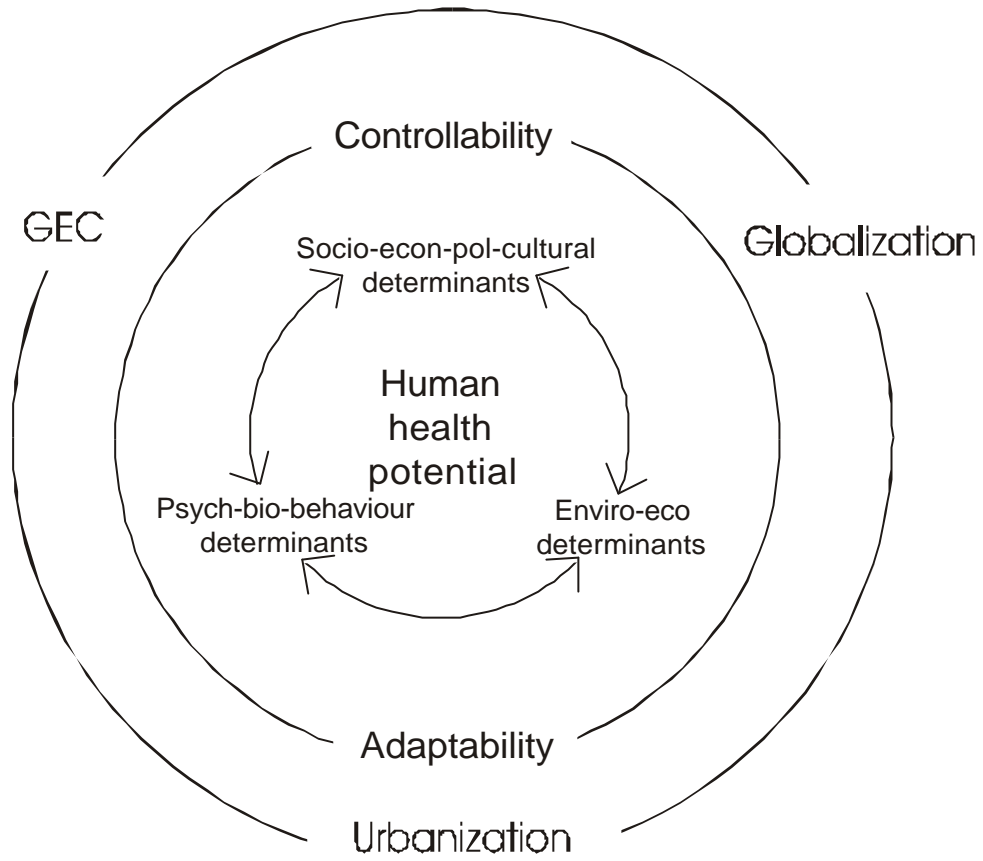


Figure 1: Cumulative Effects of Global Change on Human Health Potential

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