



GLOBAL ENVIRONMENTAL CHANGE, CLIMATE CHANGE AND HEALTH

An Introduction | BY TONY McMICHAEL



Photo: Bernd Decker

► **The health of any human population reflects, in a basic sense, the conditions of the social and natural environments.** Human societies, over the ages, have both benefited and suffered from human-induced changes to local environments. Over the past quarter century there has been a growth in scientific interest in environmentally-related illnesses including such things as toxin-related cancers and reproductive disorders, and air pollution-related respiratory and cardiac disease. Today's unprecedented global environmental changes, caused by massive human pressures on natural systems, pose various risks to human population well-being and health.

There is much contemporary discussion about "global change". The various social, economic, cultural, technological and political changes entailing connections among human societies around the world comprise the modern phenomenon of "globalisation". Economic globalisation, for example, refers to the increasingly integrated and

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FOCUS: HEALTH

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EDITORIAL

In the past months, the European summer turned into a heat ordeal. Many thousands of people died in France, provoking a national crisis. Prior to this, a heat wave struck India, officially causing the deaths of more than 1300 people. In both cases, the extreme heat was the primary cause for mortality. The secondary reasons were differing – presumably in India, poor and hard-working people could not afford to stay in the shade, whereas in France, elderly people did not receive timely help, partly because of social isolation.

Environmental and socio-economic factors interact in a complex manner to influence human health. Some evidence suggests that we will witness such extreme events more frequently in the future as one outcome of global environmental change. How do these changes affect human health directly, but also: what do they mean for, e.g., food production or the spread of vector-borne diseases? Formal research in the domain of health and GEC has gathered momentum during the last year. This edition of UPDATE presents texts by some of the most distinguished scientists in this field of research. Something can be said for all of their articles: there is an underlying tone, a signal for the urgent need to intensify research in this domain. It comes with putting stress on the importance of several disciplines working together to move beyond empirical findings towards scenarios for the future.

While Tony McMichael gives a comprehensive introduction into the theme complex of GEC and health, Pim Martens explains why we urgently need future scenarios and a much more complex scientific approach. Carlos Corvalan and Diarmid Campbell have provided us with an informative article about the activities of WHO in this field and Kristie Ebi gives us an insight into Public Health Adaptation to Climate Change. Paul Epstein talks about his 'Health Futures Project' which involves the business and financial community. Finally, Thomas Krafft, Surinder Aggarwal and Tania Wolf have collected facts on urban health in Delhi.

And indeed, this is a new, and challenging road ahead of us. IHDP has accepted this challenge together with the Earth System Science Partnership, which is setting up a new joint project on health and global environmental change. This project will assess past, current and future health impacts of GEC, elucidate the particular health-related upstream drivers for GEC and seek to harmonise mitigation and adaptation strategies and policies. The Earth System Science Partnership, with its many international networks of scientists and links to policy fora, can contribute significantly to this emerging research domain as part of its mission to promote a sustainable global future.



THE EDITOR

liberalised (deregulated) worldwide systems of markets, capital flows and trading. "Global environmental change" (GEC) refers to human-induced changes in the large-scale biophysical and ecological systems that comprise the planet's life-support systems. They result from an historically unprecedented situation: the aggregated environmental impact of humankind, reflecting population size, economic activity and technology choices, is now so great that it is beginning to alter aspects of the Earth System.

For example, we are increasing the atmospheric concentration of energy-trapping gases, thereby amplifying the natural "greenhouse effect" that prevents the Earth freezing. During the twentieth century, world average surface temperature increased by approximately 0.6°C and around two-thirds of that warming has occurred since 1975. Other main types of GEC include stratospheric ozone depletion, biodiversity loss, land degradation, over-fishing, disruption of elemental cycles (e.g., nitrogen, sulphur and phosphorus), depletion of freshwater supplies, urbanisation, and the global dissemination of persistent organic pollutants. In human health terms, this means that, increasingly, the health of human populations is influenced by changes from beyond the boundaries of that population's living space. Further, the likelihood of adverse inter-generational impacts on human health is much increased.

The global scale of these changes makes for an important difference from the many other familiar environmental concerns, which mostly relate to localised toxicological or microbiological hazards. The advent of GEC signifies that we have begun to live beyond Earth's capacity to supply, absorb and replenish. That is, we – especially the industrialised nations – are increasingly operating in "ecological deficit", and there is an urgent need to understand the possible consequences for human societies. Paramount among these is the potential impact upon human health.

HOW CAN GLOBAL ENVIRONMENTAL CHANGES AFFECT HUMAN HEALTH?

The several main types of pathways by which GEC can affect health are shown in Figure 1 (*see next page*). There are three pathways of increasingly more complex and less direct character, moving from top to bottom. At the top, there are some examples of how changes in basic physical environmental conditions (e.g. temperature extremes, or the level of ultraviolet irradiation) can affect human biology and health directly. The other pathways, in the middle and lower half of the diagram, illustrate processes of increasing complexity, including those that entail interactions between environmental conditions, ecosystem functioning and human social and economic conditions. Illustrative examples are given.

STUDYING THE ACTUAL AND POTENTIAL HEALTH IMPACTS OF GLOBAL ENVIRONMENTAL CHANGES?

We now better appreciate that global environmental changes jeopardise the well-being and health of human populations. The risks are greatest for those who, for reasons of geographic location or level of social and economic resources, are most vulnerable.

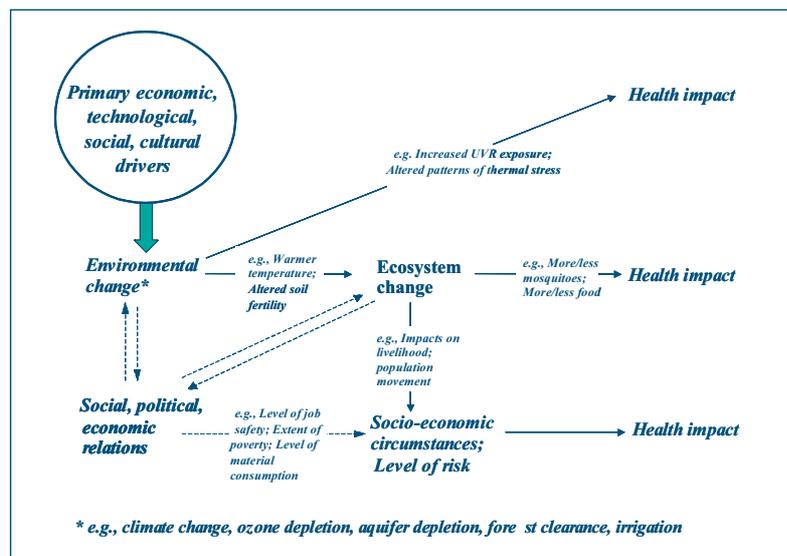


Fig. 1. Main types of pathways by which global environmental changes can affect human population health. (Italicised items, located on arrows, are illustrative only.)

These environmental changes bear, directly or indirectly, on the primary determinants of human health – food production, freshwater availability, stability of microbiological environment, climatic conditions, physical safety, well-human being, and social security. To practitioners of conventional research on environmental conditions and health, this is a novel domain of concern and enquiry. It adds to the ongoing problems of local toxicological exposures, locally-circulating infectious agents and other physical environmental hazards a new, larger-scale, layer of environmental influences that operate via disturbances to ecological conditions and to life-support processes.

Research activities are most fully developed in relation to climatic influences on human health. Over the past decade there have been advances on three research fronts.

1. Empirical studies of the causal relationship between climatic variations or trends and health outcomes.
2. Studies seeking evidence of health impacts of the past quarter-century of (predominantly anthropogenic) climate change.
3. Estimations of the likely range of health impacts of foreseeable climatic-environmental scenarios over the coming decades.

Examples of each of these three categories, below, illustrate the spectrum of research tasks. Note, however, that the available examples are skewed towards studies of relatively straightforward causal relationships. There is much in this topic area that is complex, systems-based, somewhat unpredictable, or frankly non-quantifiable.

Empirical research into causal relationships has included studies of how thermal stress affects mortality in diverse populations; of how high temperatures and air pollution jointly affect cardio-respiratory morbidity and mortality; of how climatic variability (especially that associated with the approximately half-decadal El Niño Southern Oscillation, ENSO, cycle) affects outbreaks of mosquito-borne infectious diseases; and of how climatic variations affect rates of food-poisoning and diarrhoeal disease.

The search for early evidence of health impacts has been stimulated by the persuasive documentation of changes in many non-human physical and biotic systems over the past two decades in association with, and now attributed to, regional warming. Birds, bugs and buds are responding to earlier spring-time weather; ice-caps, glaciers and sea-ice are diminishing. Of course, detecting and attributing changes in human health outcomes is much more difficult: our culture (behaviour, technology, etc.) buffers us against direct exposure to environmental change, and there is a diversity of concurrent influences (confounders) on any particular health outcome. Nevertheless, there have been reports in the past several years of plausibly climate-related changes in various infectious diseases – tick-borne encephalitis in Sweden, cholera in Bangladesh, malaria in certain highland regions of eastern Africa. It

is also becoming evident that the tempo of extreme weather events is increasing in many parts of the world, with resultant increases in human death, injury, infectious disease and mental trauma. The persistent decline in global per capita yields of cereal grain over the past half decade may also reflect, in part, adverse climatic influences on regional agricultural production.

The techniques for conducting scenario-based health risk assessments have been the focus of effort and controversy over the past decade. Most of the published research has been in relation to vector-borne infectious diseases, particularly malaria and dengue fever. Typically, the estimates of future health risk have referred to three decadal time slices: the 2020s, 2050s and 2080s. The “exposure” comprises the gridded estimates of future climate scenarios, particularly location-specific average annual temperature and average monthly precipitation.

Formal research is evolving in this domain. Both the concepts and the methods extend well beyond those available in standard textbooks (see Aron & Patz 2001; Martens & McMichael 2002, Aguirre *et al.* 2002), and there is not yet a large cadre of researchers fluent in the issues and the appropriate methods. There are, however, a number of oncoming younger researchers engaging in this topic area, including those now undertaking doctoral research. This will become a major domain for health sciences research over the coming decade – and a major input to the international discourse on sustainability.



REFERENCES to this article are included on the IHDP website at www.ihdp.org/update0303/references.htm



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THE STUDY OF ENVIRONMENTAL CHANGE: CHALLENGES TO POPULATION HEALTH RESEARCH

By PIM MARTENS

► To detect or estimate the population health impacts of global environmental changes is difficult. Not only is the impacts research contingent on various assumptions, simplifications and projections made by scientists working “upstream” on the environmental change process per se, but the category of outcome – a change in the rate of disease or death – is one that usually has multiple contending explanations. If malaria ascends in the highlands of eastern Africa, regional climate change is just one contending explanation – along with changes in patterns of land use, population movement, increased urban poverty, a decline in the use of pesticides for mosquito control, or the rise of resistance to anti-malarial drugs by the parasite.

Furthermore, these environmental changes entail unusually large spatial scales. They also entail temporal scales that extend decades, or further, into the future. Some entail irreversible changes. While some direct impacts on health would result – such as the health consequences of increased floods and heat waves due to global climate change, or increases in skin cancer due to ozone depletion – many of the impacts would result from the disruption of the ecological processes that are central to food-producing ecosystems or to the ecology of infectious-disease pathogens. That is, many of the causal relationships are neither simple nor immediate.

However, the great majority of public health researchers are empiricists by training and tradition, studying the past and the present via direct observation. By definition, empirical methods cannot be used to study the future. To the extent that the advent of global environmental changes obliges scientists to estimate future impacts, should current or foreseeable trends continue, then empiricism must be supplemented by integrated assessment modelling. Epidemiologists, whose primary task is to identify risks to health from recent or current behaviours, exposures or other circumstances, are not much oriented to asking questions about health impacts several decades hence.

Yet, these contextual difficulties aside, population health scientists must find ways to estimate the potential health consequences of current social and environmental trajectories. Not only is this an interesting scientific task, but – crucially – it will assist society to seek a sustainable future. Clearly, elucidating these risks to population health from environmental changes such as long-term changes in global climatic patterns, depletion of stratospheric ozone and biodiversity loss poses a special research challenge – conceptual and methodological.

CONCEPTS

A fundamental characteristic of this topic area is the pervasive combination of complexity and uncertainty that confronts scientists. Policy-makers, too, must therefore adjust to

working with incomplete information and with making ‘uncertainty-based’ policy decisions.

COMPLEXITY AND SURPRISES

Predicting the impact of a changing world on human health is a hard task and requires an interdisciplinary approach drawn from the fields of evolution, biogeography, ecology and social sciences, and relying on various methodologies such as mathematical modelling as well as historical analysis. When even a simple change occurs in the physical environment, its effects percolate through a complex network of physical, biological and social interactions, that feedback and feed forwards. Sometimes the immediate effect of a change is different from the long term effect, sometimes the local changes may be different from the region-wide alterations. The same environmental change may have quite different effects in different places or times. Therefore the study of the consequences of environmental change is a study of the short- and long term dynamics of complex systems, a domain where our common sense intuitions are often unreliable and new intuitions have to be developed in order to make sense of often paradoxical observations.

UNCERTAINTIES

The prediction of environmental change and its health impacts encounters uncertainties at various levels. Some of the uncertainties are of a scientific kind, referring to deficient understanding of actual processes – for example, knowing whether or not increased cloud cover arising because of global warming would have a positive or a negative feedback effect. Some of the uncertainties refer to the conceptualisation and construction of mathematical models where the specification of linked processes may be uncertain or where key parameter values are uncertain. For example, what is the linkage between changes in temperature, humidity and surface water in the determination of mosquito breeding, survival and biting behaviour? Some uncertainties are essentially epistemological, referring to what we can and cannot reasonably foresee about the structure and behaviour of future societies, including for example their future patterns of emissions of greenhouse gases. And, finally, there is of course the familiar source of uncertainty that arises from sampling variation, and which leads to the need for confidence intervals around point estimates.

VULNERABILITY AND ADAPTATION

Human populations vary in their vulnerability to health hazards. A population’s vulnerability is a function of the extent to which a health outcome is sensitive to climate change and of the capacity of the population to adapt to new climate conditions. The vulnerability of a population depends on factors such as population density, level of eco-

conomic development, food availability, local environmental conditions, pre-existing health status, and the quality and availability of public health care.



Photo: WHO/TDR/Crump

Children sleeping under malaria protection nets

Adaptation refers to actions taken to lessen the impact of the (anticipated) climate change. There is a hierarchy of control strategies that can help to protect population health. These strategies are categorised as: (i) administrative or legislative; (ii) engineering, or (iii) personal (behavioural). Legislative or regulatory action can be taken by government, requiring compliance by all, or by designated classes of, persons. Alternatively, an adaptive action may be encouraged on a voluntary basis, via advocacy, education or economic incentives. The former type of action would normally be taken at a supra-national, national or community level; the latter would range from supranational to individual levels. Adaptation strategies will be either reactive, in response to observed climate impacts, or anticipatory, in order to reduce vulnerability to such impacts

RESEARCH METHODS

Next to the conceptual challenges we have to face, the assessment of the risks to population health from global environmental change requires several complementary research strategies. Research into the health impacts of these environmental changes can be conducted within three domains, and there are a variety of methods than can be used within each domain. The three categories of research are:

- (i) The use of historical and other analogue situations which, as (presumed) manifestations of existing natural environmental variability, are thought likely to foreshadow future aspects of environmental change. These empirical studies help to fill knowledge gaps, and strengthen our capacity to forecast future health impacts in response to changing environmental-climatic circumstances.
- (ii) The seeking of early evidence of changes in health risk indicators or health status occurring in response to actual environmental change. Attention should be paid to sensitive, early-responding, systems and processes.
- (iii) By using existing empirical knowledge and theory to model future health outcomes in relation to prescribed scenarios of environmental change. This is referred to as scenario-based health risk assessment.

CONCLUSION

The advent of global environmental change, with its complexities, uncertainties and substantial displacement into the future tense, brings new challenges and tasks for science, public and policy maker. The world cannot afford to sit back and await the empirical evidence. The luxury of unhurried scientific curiosity must, here, be replaced by a more urgent attempt to estimate the dimensions of this problem – the health consequences of global environmental change – and then feed this information, with all its imperfections and assumptions, into the policy arena. Consideration of human health impacts is a crucial, even central, issue in the emerging international discourse on “sustainable development”.



This article is extracted from: Martens, P. & McMichael, A.J. (eds.) (2002). *Environment, Climate Change and health: concepts and methods*. Cambridge University Press, Cambridge.



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DIMITAR MISHEV †

Dimitar Mishev passed away in February 2003. He was founder and director of the Solar-Terrestrial Influences Laboratory at the Bulgarian Academy of Sciences. He also led the Bulgarian National Coordination Center for Global Change which was founded in 1997. His leadership and commitment to the human dimensions of global change for IHDP in Bulgaria and in Central and Eastern Europe will not be forgotten. Our sympathies go to his family and to all his colleagues.

NEW HEALTH CONCERNS

What WHO does in the face of a changing global environment

BY CARLOS CORVALAN, DIARMID CAMPBELL-LENDRUM

► Traditionally, environmental health concerns have focused on microbiological and toxicological risks to health from local exposures, such as air pollution or contaminated waters. Historically, the scale of environmental health problems has expanded from household (e.g. indoor air pollution), to neighbourhood (e.g. domestic wastes) to city (e.g. urban air pollution) to region (e.g. transboundary contamination), and now to global level (e.g. climate change). Large-scale and global environmental hazards to human health include climate change, stratospheric ozone depletion, loss of biodiversity, changes in hydrological systems and the supplies of freshwater, land degradation and stresses on food-producing systems (see figure). Appreciation of this scale and type of influence on human health requires a new perspective which focuses on ecosystems and on the recognition that the foundations of long-term good health in populations relies in great part on the continued stability and functioning of the biosphere's life-supporting systems. It also brings an appreciation of the complexity of the systems upon which we depend.

Some global environmental threats to health are easier to describe and quantify than others. It has been recognized for several decades that the release of chlorofluorocarbons and other atmospheric pollutants depletes stratospheric ozone, which in turn increases human exposure to ultraviolet radiation, causing skin cancer and cataracts. The recognition of direct effects on human health was a major stimulus to the Montreal Protocol, which acts to reduce emissions of pollutants that weaken the ozone layer. Although this international agreement is proving highly effective in reducing risks in the long-term, UV radiation remains a health hazard. The World Health Organization, and partner organizations – through the Intersun project – have developed and promote the UV Index, a tool to inform and educate the public about sun protection.

Other global environmental trends, such as climate change, have a range of more complex interlinkages with health. These include direct impacts, such as temperature

related illness and death; the health impacts of extreme weather events; the effect of air pollution in the form of spores and moulds. Other impacts follow more intricate pathways such as those that give rise to water and food borne diseases, vector borne and rodent borne diseases or food and water shortages. A first quantification of health impacts based on four selected health outcomes, for which the current evidence is strongest, is described in Box 1. The complexity of these links necessitates more detailed research and evaluation. Other examples of WHO work in this area include workshops addressing needs of Small Island States, and work in Europe to assess early impacts of climate change

on health. WHO and partners are publishing this year a book on climate change and human health, specifically addressing risks and responses and a set of methods to assess vulnerability and adaptation options.

There is growing concern about the health consequences of biodiversity loss and change. An important consequence for humans is the disruption of ecosystems that provide nature's goods and services. Biodiversity loss also means that we are losing, before discovery, many of nature's chemicals and genes, of the kind that have already provided humankind with enormous health benefits. There are also well founded concerns about the need to understand and assess the impacts of modern food biotechnology on human health. WHO, UNEP and Harvard University are collaborating in a forthcoming publication addressing Biodiversity and Health.

Increasing pressures of agricultural and livestock production are stressing the world's arable lands and pastures. Land change – damaged by erosion, compaction, salination or chemicals – has impacts on health. From a health standpoint we need also be concerned about desertification. Again in this case through complex pathways, which include increased poverty, we observe impacts related to nutrition, population displacement, water- food- and vector borne diseases, and air pollution. WHO addresses all the above in its contribution to the health components of the Millennium Ecosystem Assess-

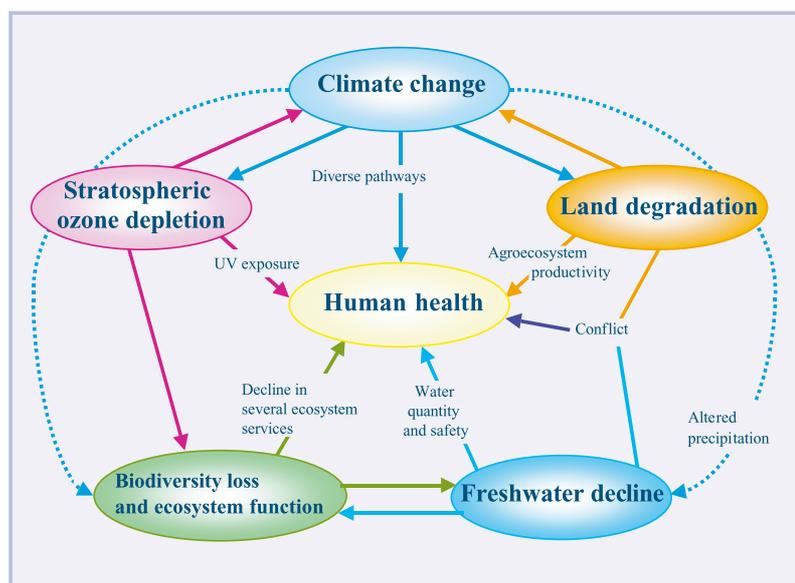


Fig. 1. The interlinkages and impacts of global environmental changes on human health (Source: Reference 1).

ment, which is an extensive study of the linkages between the world's ecosystems and human well-being.

In most developing countries, the health sector has a major task in combating specific diseases that carry a very large burden, such as HIV/AIDS, TB and malaria. In addressing global environmental change, WHO and its partners face two major challenges. The first challenge is to keep the health sector well informed on environmental risk factors and their management to protect health. These include not only the better known traditional hazards (such as indoor air pollution from the use of biomass fuel, or lack of safe drinking water), or modern hazards (such as urban air pollution or chemical and radiation hazards), but also emerging hazards such as global environmental change. The second challenge is to ensure that agreements on global trends (such as the UN conventions on biodiversity, desertification, climate change, stratospheric ozone depletion and others) take full account of health implications. Both aims are best achieved in the context of a framework, such as that in figure 1, that recognizes the interlinkages between all of these global changes, and their combined effects on human health.



REFERENCES to this article are included on the IHDP website at www.ihdp.org/update0303/references.htm



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The Millennium Ecosystem Assessment:

www.millenniumassessment.org

The Intersun Project: www.who.int/peh-uv

The views expressed in this article are those of the authors and do not necessarily reflect the position of the World Health Organization.

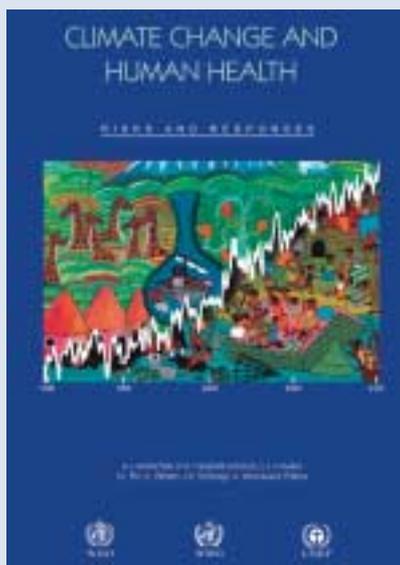
This article draws on material prepared for the book *Climate Change and Human Health: Risks and Responses*. McMichael et al (eds), World Health Organization, Geneva, 2003, to which the authors have contributed. See separate information about this book in this issue.

Climate Change and Human Health Risks and Responses

Over the ages, human societies have altered local ecosystems and modified regional climates. Today, the human influence has attained a global scale. This reflects the recent rapid increase in population size, energy consumption, intensity of land use, international trade and travel, and other human activities. These global changes have heightened awareness that the long-term good health of populations depends on the continued stability and functioning of the biosphere's ecological, physical, and socioeconomic systems.

The world's climate system is an integral part of the complex of life-supporting processes. Climate and weather have always had a powerful impact on human health and well-being. But like other large natural systems, the global climate system is coming under pressure from human activities. Global climate change is, therefore, a newer challenge to ongoing efforts to protect human health.

This volume seeks to describe the context and process of global climate change, its actu-



al or likely impacts on health, and how human societies and their governments should respond, with particular focus on the health sector.

A.J. McMichael, D.H. Campbell-Lendrum, C.F. Corvalán, K.L. Ebi, A. Githeko, J.D. Scheraga and A. Woodward (Eds).

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PUBLIC HEALTH ADAPTATION TO CLIMATE CHANGE

Effective adaptation can reduce the burden of disease attributable to current climate variability and future climate change | BY KRISTIE L. EBI, IAN BURTON, JOEL SMITH

► **Projected climate change, including both changes in long-term mean conditions and in climate variability and extremes, is expected to have primarily negative impacts on public health.** The highest concentration of adverse impacts is expected to occur in developing countries. Even in the absence of climate change, improving population health in low latitude regions presents a long-term challenge. Billions of people lack adequate nutrition, access to clean water and sanitation, and a viable public health system. In many developing countries, diseases such as HIV/AIDS, tuberculosis and malaria are endemic and increasing. The worldwide burden of disease is large, with significant negative impacts on the length and quality of life. Climate change is an additional challenge that could work for, or against, efforts to control climate-sensitive diseases, such as pathogens transmitted by vectors and health impacts from extreme weather events (e.g., severe storms and drought).

There are many obstacles to the rapid reduction of greenhouse gas emissions. Even if rapid reduction could be achieved in the near-term, atmospheric concentrations will be slow to stabilize because of the long residence time of the anthropogenic greenhouse gases currently in the atmosphere, and the inherent inertia in the climate system. This slow stabilization has committed the world to decades of climate change. Countries, regions, communities, and individuals will have to implement new adaptation strategies, policies and measures if they are to reduce the potential negative impacts of both current climate variability and future climate change. Countries that have, or can acquire, sufficient capacity to adapt (e.g., strong public health systems) will be able to reduce the severity of impacts.

Adaptation to climate change is not new. Climate has always been changing, albeit more slowly. Historically, humans have always adapted, with varying degrees of success, to climatic changes. However, the history of adaptation offers limited lessons for current climate projections because medical knowledge, socioeconomic systems and technology have all changed radically in recent times, and because the climate is set to change at an unprecedented rate [1]. The challenge is to develop and deploy a capacity for more rapid medical, social and technological adaptation, and to ensure that this capacity is broadly distributed. The adaptation now needed is new in that it has to anticipate climate change challenges, and to operate at global and local scales.

VULNERABILITY

Vulnerability is a key concept for both the public health and climate change communities, although different conceptualizations of this term have caused confusion. The climate change adaptation community tends to view the vulnerability of a system to an external stress, or stresses, as a function of exposure, sensitivity and adaptive capacity (i.e., the ability of the system to cope with those stresses by reducing its exposure and/or sensitivity) [3]. Within this framework, vul-

nerability is the damage that remains after autonomous adaptation takes place. In the public health sector, vulnerability is associated with the current (or baseline) state. In this view, vulnerability is a function of exposure to an agent and the exposure-response relationship between that exposure and a particular health outcome. Vulnerability includes adaptation only to the extent that measures currently in place affect the exposure-response relationship (e.g., estimates of the impact of a heat wave on the elderly will be influenced by the number of the elderly who used air conditioning or who spent adequate time in air conditioned environments). The combination of the current exposure-response relationship, the extent of exposure, and the preventive measures in place creates a vulnerability baseline against which the effectiveness of future policies and measures can be measured by changes in the burden of disease. Vulnerability changes over time with the implementation of effective interventions.

There are encouraging signs of convergence between these communities. For example, the climate change adaptation community is taking a wider view of vulnerability that more closely approximates the public health perspective.

ADAPTIVE CAPACITY AND COPING CAPACITY

In the climate change adaptation literature, adaptive capacity and coping capacity are conceptualized as functions of a series of determinants such as the range of available technological options, the availability of financial resources and their distribution across the population, the stock of human and social capital, the structure and efficacy of critical institutions, and the responsiveness and capability of the governance and decision making process [3]. It is useful to differentiate between the adaptation strategies, policies, and measures that are theoretically possible in the future (adaptive capacity; i.e., the development of a malaria vaccine), and those that can be immediately implemented (coping capacity; i.e., provision of bednets to populations at risk for malaria). Adaptive and coping capacities change over time as adaptation measures move from being theoretically possible but not attainable (because of the lack of resources, technology, etc.), to being possible, to being implemented (at which point they become part of the adaptation baseline).

ADAPTATION

The importance of adaptation is recognized in the United Nations Framework Convention on Climate Change and is the focus of a number of activities, such as one of the Working Groups of the Millennium Ecosystem Assessment and the UNDP/Global Environmental Facility project to develop an Adaptation Policy Framework. Government agencies at all levels, international organizations, civil society, non-governmental organizations, and the private business sector are all grappling with how to facilitate the process of implementing effective and efficient adaptation strategies, policies, and

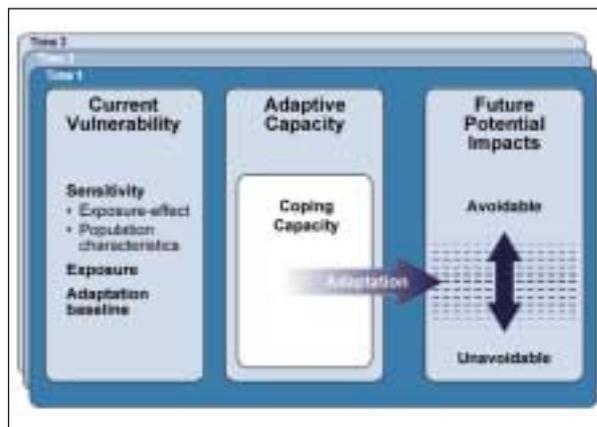


Fig.1. shows this conceptualization of vulnerability, adaptive capacity, and coping capacity.

measures. These activities have the following underlying assumptions [1]:

- Adaptation matters. Adaptation to climate change will increase in importance to policymakers and the public as evidence regarding unacceptable climate impacts continues to accumulate. In this context, adaptation signals the possibility of desirable, timely courses of action that respond to current impacts and that anticipate future impacts.
- Adaptation should focus on pragmatic strategies, policies, and measures that aim to prevent possible adverse impacts, and to take advantage of opportunities that arise. The current focus of research on whether (or not) near-term impacts from climate change are likely should shift to the search for measures to achieve some control over the more dire consequences expected.
- Modern levels of wealth, technology, and social organization provide a basis for substantial improvements in adaptation to climate change. The greatest difficulties are likely to be encountered in the developing countries, especially the least developed, because poverty, lack of development, and inequity are obstacles to adaptation.

PUBLIC HEALTH ADAPTATION TO CLIMATE CHANGE

Strategies for public health adaptation to climate change might necessitate a diverse range of modifications to public health systems. These changes can be organized into two categories:

1. Known public health preventions that will need to be deployed in different ways or in different locations, as outlined below. Knowledge gleaned from experience must be coupled with political and institutional action if change is to be widespread or lasting.
- Modify existing prevention strategies. With a changing climate, lessons learned from current intervention programs may be applicable in other situations or in other regions. The intensity of particular disease surveillance programs may need to be increased in some areas and decreased in others in response to climate change. For

example, malaria surveillance should be strengthened in currently non-endemic areas where model projections suggest increases in highland malaria are highly likely to occur in the near-term. In some instances, climate change might demand innovative or large-scale modifications to existing approaches.

- Reinstitute effective prevention programs that have been neglected or abandoned. Historical lessons may be informative for effectively coping with current and future health concerns. For instance, a number of diseases re-emerged after once-successful vector control programs were no longer pursued aggressively, demonstrating the importance of maintaining institutional capacity and vigilance [4].
 - Apply win/win or no-regrets strategies. These might include improvements partially motivated by climate that could enhance efficiency or advance sustainable development goals, and thus render public health systems more capable of confronting challenges.
2. Public health systems in the future could face new risks posed by climate change such as the introduction of a new disease that would require deliberate and planned adaptation. These risks could occur simultaneously with other events that threaten health.

In either category, to effectively and efficiently respond to the challenges that a changing climate will bring, public health needs to move from its current focus on surveillance and response to a more proactive focus on prediction and prevention. Incorporating climate change projections into decision-making for climate-sensitive diseases would be a good first step. In addition, models need to be developed to better understand the various drivers of climate-sensitive diseases, from climate to demographics to economics. Systems-based models help put climate into perspective with other drivers of disease, allowing decision-makers a better understanding of when and where actions will need to be undertaken. Some of these models could be the basis for early warning systems, such as those under development for malaria. It also would be helpful for the public health community to develop scenarios of how the burden of disease might change over time with changes in these various disease drivers, with the goal of identifying system vulnerabilities that could be addressed by targeted implementation of specific adaptation options.

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REFERENCES to this article are included on the IHDP website at www.ihdp.org/update0303/references.htm

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A MARSHALL PLAN FOR THE EARTH

► Paul R. Epstein is Associate Director of the Center for Health and the Global Environment at Harvard Medical School. He is spear-heading the ‘Health Futures Project’ that involves health scientists, ecologists and economists from the scientific, the international and the business community.

Q: *What led you to initiate the ‘Health Futures Project’?*

What led us to initiate this project is growing concern with the magnitude of the impacts of climate change. We underestimated the rate at which climate would change. We also underestimated the biological, ecological and economic impacts of global warming and the associated extreme weather events. The good news is that we may have also underestimated the economic benefits of initiating the clean-energy-transition. Our involvement with the Swiss Reinsurance Company, who is the primary donor of this project, is based on the awareness of the financial community that the magnitude of impacts is far beyond of what was projected even several years ago. Extreme weather events cost about four billion dollars in the eighties and about 40 billion dollars in the nineteen nineties. The UNEP projections are that the costs could rise to 150 billion dollars a year within this decade if current events continue. Climate is now seen as a major area of exposure and the life and health consequences alone, and as a result of damage to infrastructure, property and casualty, are mounting. We need to understand the nature and number of the risks, as well as the opportunities for developing corporate responsibility and corporate consciousness. Moreover, public policies encompassing new regulations (the “sticks”) and incentives (the “carrots”) are needed to push and pull new technologies into the global marketplace and allow businesses to function in a sustainable way.

Q: *So, reinsurers are in the forefront of the business community addressing sustainability?*

They certainly are. Swiss Re, for example, is examining the direct implications – for the magnitude of risks, for opportunities for green business, and, in a larger sense, as a responsible corporate thought leader. Swiss Re has also been a convener of other corporations, holding a series of conferences focusing on greenhouse gas reduction. These meetings have provided venues for evaluating the new risks posed by climate instability, as well as the opportunities with respect to carbon trading, energy efficiency and renewables, and how investments from, for example, Deutsche Bank, can be mobilized for projects for clean development.

Q: *Can you describe the goals of the ‘Health Futures Project’?*

There are two objectives. One objective is to do an assessment of how climate change (warming, more variability, abrupt climate change) may affect our health in the future. We will examine health data, emerging trends and shifting patterns to project health futures. We will consider “surprises” (such as the magnitude of impacts of the recent heatwave,

fires and crop losses in Europe) and the emergence of new types of risks. Next, we will integrate the climate and health scenarios with development trajectories.

The second objective is to convene “stakeholders” – that includes others in the business community, and broadened to include NGOs, UN agencies and nation states. Our partnership with UN agencies, especially the UN Development Programme, will be especially important in this regard. We hope to play a role in stimulating corporate learning and in helping to generate strategic planning – for corporate practices, for appropriate public health policies and for the public policies – at national and international levels – that underlie public health. Ultimately, such discussions will have to examine the architecture of the international financial system.

Q: *What do you mean with “surprises”?*

We’re examining health scenarios related to climate change. Heat waves are one issue that jumps to the fore, given the experience this summer in Europe. Many social issues were at play, but the enormity of deaths (perhaps 11,000 in France and over 1300 in Spain and in Portugal) is indicative of the severe heat wave. Lack of relief at night, a key aspect of global warming, contributed. More such heat waves, with high nighttime and winter temperatures, are projected. One message from this heat wave is that suddenly consequences can occur that are of a different order of magnitude than what we’ve been considering.

We will also consider synergies between warming and air pollution; infectious diseases – some of which are carried by vectors that can also increase their numbers and distribution suddenly; travel hazards, trauma and infrastructure damage; and, finally, how the diseases and pests of wildlife, livestock, crops, forests and coral reefs could affect “nature’s services” and our health and nutrition.

Q: *Who are your partners?*

UNDP is taking a very strong role in this project. We also have partnerships with WHO and UNEP. UNDP has set up a commission that is exploring Public Private Partnerships with corporations. These partnerships can enable the development of sustainable projects and the convening of discussions among corporations, finance ministers, nation states and NGOs as to the magnitude of the potential dangers and health impacts, and the social, ecological and economic impacts of climate change. These partnerships can also form the basis of addressing solutions and the international framework that can make this energy transition the first and necessary step of “Agenda 21” and Sustainable Development.

Q: *Can you elaborate on energy transition?*

Because of the climate crisis, which – as we can tell from changes in polar and glacial ice cover and the biological



responses – is occurring faster than we previously projected, we need the energy transition as the first and necessary change. That will involve development and trade in clean energy sources, energy efficiency and “smart” energy efficiency technologies, “green buildings,” rationalised public transport, retrofitting of infrastructure, and ecological preservation and reconstruction. An investment in these new enterprises can make the clean energy transition the engine of growth for this 21st century and propel us towards sustainable development; a goal that includes fisheries, forests and soils, and how we use Earth’s resources rationally and minimise the wastes and pollution produced. But we must start with the clean energy transition urgently, for the climate is becoming increasingly unstable – and could present us with some very unpleasant surprises.

Q: It’s a big challenge to shift business goals towards sustainable goals.

Yes, that is the biggest issue. How do we really provide the incentives for change? Regulations, alone, are insufficient; they must be complemented by significant funds and other financial incentives To shift business practices and create new

market signals we will need clean development funds – not just mechanisms. The Kyoto Protocol contains mechanisms, rather than funds; and the mechanisms may not move us fast enough towards the goal of 60 to 70% reduction in GHG emissions needed to stabilize the concentrations. Targeted grants are needed; not more loans. After World War II, the Marshall Plan complemented new regulations established at the Bretton Woods Conference, to rebuild Europe and revitalize the world economy. A significant fund today can create markets for fuel cells, solar panels and other clean energy devices and stimulate the economy.

We need a Marshall Plan for the Earth and a “Bretton Woods II” to plan the transition. How we simultaneously address the problems of the environment, energy and the economy can determine how we proceed: unregulated and uncertain or along a more regulated, coordinated path. With the proper incentives and reprogramming, the international financial architecture could make the clean energy transition the foundation for sustainable development.

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INTERVIEW BY ULA LÖW

ENVIRONMENTAL DEGRADATION AND HEALTH RISKS IN DELHI

The price of rapid urbanisation | BY THOMAS KRAFFT, SURINDER AGGARWAL, TANIA WOLF

► Despite a long history of urban sanitary reform and healthful-city movements, inhabitants of rapidly growing urban agglomerations in the developing world increasingly are confronted with severe environmental health risks. The rapid urbanisation process experienced by the majority of developing countries during the last few decades has resulted in fundamental changes to the environment and to the social structure and is affected by and also contributes to global environmental change (cf. Fig. 1). While these changes affect all rapidly growing urban areas in one way or the other, in most of the megacities that have grown to unprecedented size, the pace of urbanisation has by far exceeded the growth of the necessary infrastructure and services. As a result, an ever-

increasing number of urban dwellers are left without access to basic amenities and face appalling living conditions. Additionally, social inequalities lead to subsequent and significant intra-urban health inequalities.

A comparison of rural and urban health profiles for selected diseases in India indicates an increasing disadvantage for the urban population, particularly in the megacities. According to recent estimates by the Indian Ministry of Health, the incidence of respiratory diseases in the City of Delhi is 12 times higher than that of the national average. Furthermore, it is the urban poor who suffer most from this new urban penalty. Environmental degradation contributes to both the increase of infectious diseases and the increase of chronic diseases.

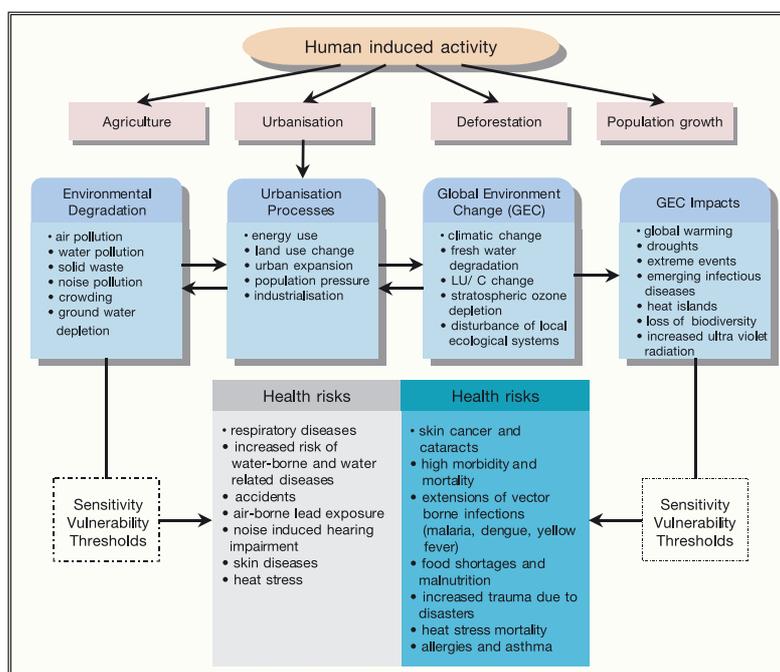


Fig. 1: Urbanisation and Global Environmental Change

Land-use changes resulting from urban expansion often create changes in environmental conditions and in habitat for a number of species, which can trigger the outbreak of diseases. Overcrowding in urban agglomerations provides an easy pathway for the spread of communicable diseases. Large-scale migration to urban areas and integration into a global market where borders are frequently crossed and large distances are easily travelled by a growing number of people, allow the fast movement of infected individuals into previously unexposed populations. The recent outbreak of the Severe Acute Respiratory Syndrome (SARS), and its rapid international spread highlights the vulnerability of large urban agglomerations to new, emerging diseases, in a globalised world.

Despite a still comparatively low urbanisation rate, the urbanisation process in India has developed at a rapid pace since the country's independence. As of the beginning of the 21st century, India has 35 cities with more than one million inhabitants. Three megacities – Mumbai, Kolkata and Delhi – have a population size that has crossed the 10 million mark, with Bangalore and Hyderabad following suit. In the past 50 years, India's capital, Delhi, has been transformed from a modest town with mainly administrative and trade-related functions, to a complex metropolis with a steep socio-economic gradient and severe environmental problems.

URBAN WATER CRISIS

Inadequate infrastructure, rapid population growth, and an increasing water demand has put pressure on the water resources and the water supply system in Delhi. Main sources of drinking water are the river Yamuna, ground water, and open canals that accommodate water from distant artificial water reservoirs, creating continuous political conflict with neighbouring states. There is a constant demand-supply-gap of about 1,000 million litre water every day. Leakages in the aging water supply system account for an estimated 40% loss of drinking water. On average, Delhi's households have access to tap water for approximately 13.5 hours per day. However, there are significant differences in the regional distribution, depending not least on the social status of the respective neighbourhood.

In response to the insufficient water supply, numerous private wells have been dug throughout the city. This has resulted in excessive ground-water withdrawal, and ground-water levels have declined by as much as 20 metres since 1960. The quality of both the groundwater and the surface water is often extremely poor due to intrusions from agricultural and landfill sites. According to a sampling survey by the Central Ground Water Board and the Central Pollution Control Board (CPCB), 58% of 303 ground-water samples were contaminated by bacteria, and 45% were determined to be unsuitable for drinking. Additional risks result from an extremely high concentration of nitrate in the ground water in certain parts of the city. The western parts of Delhi also are affected by dangerously high levels of fluoride due to indiscriminate extraction of ground water, which has led to an accumulation of naturally occurring fluorides in the ground water. In some areas of the National Capital Territory of

Delhi, levels of fluoride are three to four times higher than the desirable limit and are suspected as a cause of fluorosis, a disease of bone and teeth.

In addition, the tap water is often below permissible standards. In a study on tap-drinking water quality in Delhi, more than one-half of the 96 samples taken were found to be biologically contaminated. Out of 310 samples taken from overhead-tanks and 194 samples taken from water filters, 97.4% and 94.5%, respectively, were contaminated with amoeba (*Acanthamoeba*, *Naegleria*, *Leptomyxid*) and aerobic micro-organisms. Only recently the Union Minister of Health has suggested to set minimum standards for tap water quality.

The health consequences of the water crisis for the urban population are severe. For years, Delhi has experienced a high number of cases of water related diseases. Unsafe drinking water accounts for the majority of cases, such as diarrhoea, dysentery, typhoid, etc., which result in a high rate of infant and child mortality. Though there is no comprehensive health data available covering the National Capital Region some reference hospitals provide basic index data. According to data reported by just a small sample of 22 index hospitals under the Municipal Corporation of Delhi 69,139 cases of gastro enteritis, 1,267 of cholera, 285 of dengue and 679 malaria cases were identified in a 12 months period (April 2000 to March 2001).

ASTHMATIC CAPITAL

Delhi has gained a reputation for severe air pollution despite some improvements during the last few years. The combination of a mainly road based and in peak hours often inefficient public transport system, poor compliance with pollution-control norms, low-quality fuel, and outdated vehicular and industrial technologies, has contributed to this situation. Physical factors, such as the presence of elongated low hills in the north-south direction, temperature inversions in the winter months, and dust-blasting westerly winds from the adjoining Rajasthan desert, further exacerbate the prevailing pollution levels. In 2002, road traffic contributed 72% to the pollution load, followed by industry and thermal power plants (20%) and domestic sources (8%). At the beginning of 2003, the number of registered motor vehicles in Delhi was close to 4 million, which is more than the combined number of registrations for Chennai, Mumbai and Kolkata.

In the 1990s, a World Bank study established that the number of people dying in urban India due to deteriorating air quality was rising every year. An alarming number of people, more than 51,000, were estimated to have died prematurely in 36 Indian cities due to air pollution in 1995, as opposed to 40,351 people in 1991 to 1992. Kolkata, Delhi, Mumbai, Kanpur and Ahmedabad account for 66% of these premature deaths. The number of air pollution-related ailments requiring medical treatment and hospital admission, were also estimated to have increased to 25 million cases. The All India Institute of Medical Sciences (AIIMS) estimates based on a comprehensive study that air pollution is thought to cause 40% of emergency hospital admissions for patients with breathing and heart problems in Delhi. The rate of hos-



pital admissions is highest in November and December, which correlates to the months in which Suspended Particulate Matters (SPM) in the air also are highest. The study shows a clear association between particulate air pollution and acute respiratory symptoms.

SOLID AND HAZARDOUS WASTE

Solid-waste management has become one of the most serious environmental issues and a severe health risk. Current municipal-waste generation in the National Capitol Territory of Delhi is 7,000 tonnes per day. The expected range of waste quantity generated by 2021 is 17,000 to 25,000 tonnes per day (TERI 2001). Today, less than two-thirds of the total waste generated is collected on a regular base. Lack of coverage of poor communities, deficiency in the infrastructure network, non-segregation of hazardous and medical waste, inappropriate equipment, and suspicion of the private sector remain some of the issues for efficient and healthy management of waste in the city. Even if reasonable waste-reduction measures (i.e. segregation and composting) are followed, the landfill requirement for solid waste will be 8,000,000 m² by 2021, as incineration is 10 times more expensive than landfill disposal (TERI 2001). Space availability for landfills will remain a major concern in land-starved Delhi.

Hazardous waste in Delhi includes sludge from treatment plants, acid/alkaline slurry, heavy metals, waste oil, and hospital waste. Although biomedical waste forms only a small share in total solid-waste generation (less than 2%), its unsafe collection and transportation methods, along with its disposal in the common municipal landfill sites, makes it a health hazard. Of the total waste generated by hospitals, nearly one-half is biomedical, or infectious, waste. In the city of Delhi alone, approximately 60 metric tonnes of biomedical waste is generated every day, and only a small portion is disposed of in incinerators, which are themselves badly operated (Government of India, Ministry of Environment and Forest & NCT of Delhi 2001).

UNHEALTHY HABITAT

The hyper-urbanisation without a commensurate growth in basic infrastructure and housing has led to the proliferation of unhealthy squatter settlements in Delhi. Close to three million people inhabit these settlements, which are largely scattered over peripheral urban precincts. In addition, another one million live in slums (areas designated under the Slum Areas Act), which are authorized and unauthorized colonies comprised of permanent structures with very basic amenities.

The majority of informal/illegal settlements in Delhi are located close to environmentally degraded settings, such as water bodies, open drains, the river bed, the rail-line corridor, solid-waste disposal sites, and unauthorized industrial clusters. Environmentally hazardous locations, coupled with inadequate environmental infrastructure, makes residents in these settlements especially vulnerable to health risks. An outbreak of a cholera epidemic in a cluster of resettlement colonies close to Yamuna River in 1989 resulted in the loss of several thousand lives in less than a week. The outbreak occurred as a result of contamination of ground water with the leachate from the accumulated solid waste of several years, coupled with an unusually heavy Monsoon rain. However, episodic outbreaks of seasonal ailments associated with a lack of environmental infrastructure are typical occurrences in these settlements, which are regularly affected by water logging during monsoon season.

CHALLENGE FOR SCIENCE AND SOCIETY

Vulnerability depends on the level of available material resources, the pre-existing burden of disease, the quality and availability of an appropriate health infrastructure, access to relevant information, and the effectiveness of local governments. Environmental degradation and health risks caused by rapid and uncontrolled urbanisation are not significantly different in many other megacities in the developing world. Since the health impacts range from local and direct (e. g. water and sanitation) to indirect, delayed and regional effects (e.g. air pollution and carbon emission), these problems cross across the local or regional perspective and therefore define an international challenge on a global scale. Apart from implementation of comprehensive action plans, and strict enforcement of environmental legislation and norms, science has to provide sound and reliable information based on new methodological approaches and techniques. Furthermore the necessary changes will very much depend on the empowerment of that part of society which is most affected by the new urban penalty. Recent successful campaigns by the Centre of Science and Environment (CSE; www.cseindia.org) in Delhi have led to first improvements of the air pollution situation. A public campaign under the title "Right to Clean Air", the publication "Slow murder: The Deadly Story of Vehicular Pollution in India" by CSE and a successful legal battle against the Delhi government has finally resulted in the introduction of CNG (Compressed Natural Gas) for public transport in Delhi following a Supreme Court order.



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SCENARIOS AND GLOBAL HEALTH: THE ROAD AHEAD

BY MAUD HUYNEN

► In today's era of globalisation, global environmental change and the subsequent increasing concern for our present and future health, the call for good global health governance becomes stronger and stronger. The world around us is becoming progressively interconnected and complex and human health is increasingly perceived as the integrated outcome of its ecological, social-cultural, economic and institutional determinants. Therefore, it can be seen as an important high-level integrating index that reflects the state -and, in the long term, the sustainability- of our natural and socio-economic environment [1, 2]. Population health is therefore central to the formulation of humankind's sustainable development trajectory. The intergenerational equity implied by 'sustainable development' forces us to think about the right of future generations to a healthy environment and a healthy life. A central question with regard to population health is therefore: given current and anticipated socio-economic and environmental trends, will a sustainable and healthy life be possible for all humans?

To explore possible global health futures, scenarios (i.e. sets of descriptions of pathways to possible futures) could be a useful tool in order to gain insights with regard to (the determinants of) global health and to support the decision-making process. But how well is global health addressed by past scenario studies? Recent research shows that the health dimension is largely missing in 31 existing global scenarios. However, future developments in most of the ecological, social-cultural, economic and institutional determinants of health are adequately addressed in the selected scenarios [3].

Given that health is regarded by many as one of the most important assets of human life and an important component of human security, why has there been so little effort in the past decade of scenario development to explicitly address human health? From the point of view of the global scenario community, projecting the potential health impacts of global changes poses a difficult challenge, in part because the sensitivity and adaptive capacity of exposed populations varies considerably depending on factors such as population density, level of economic and technological development, local environmental conditions, pre-existing health status, and the quality and availability of health care and public health infrastructure. From a public health point of view, exploration of these global, long term and complex risks to human health seems far removed from the tidy examples that abound in textbooks of epidemiology and public health research and it

is difficult to engage epidemiologists and other population health scientists in this unfamiliar domain. As a result, health is only beginning to play a role in global scenario assessments.

We are at the beginning of an exciting journey towards integrated health scenarios, but we have to realize that this expedition will be a difficult one as the road ahead is expected to be bumpy. Two main approaches to develop health scenarios can be distinguished: First, one could develop new integrated health scenarios from scratch. This would be, of course, very challenging, and it will be possible to make use of the expertise already available in the scenario community. The second approach builds on the outcomes of earlier scenarios studies and constitutes of enriching existing global scenarios with a health component. Regardless of the chosen approach, barriers will have to be overcome and important questions have to be answered. The participation of stakeholders is crucial, but which important stakeholders can be identified and how can they be engaged in scenario development? The quantification of important determinants and health outcomes complements the qualitative narratives of possible futures, but are we able to construct appropriate models? However, despite expected difficulties, developing health scenarios is certainly a worthwhile exercise. An integrated set of global health scenarios could provide a useful contribution to the ongoing discussions on the health effects of globalisation and environmental change and can help to stimulate scientists, governments and other stakeholders to take a more integrated approach towards global health in order to find ways to ensure good global health governance, a healthy environment and good health for the future world population.

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Photo: Bernd Decker

Future generations have a right to a healthy environment and life

SOCIAL SCIENCE AND ADAPTATION TO CLIMATE CHANGE

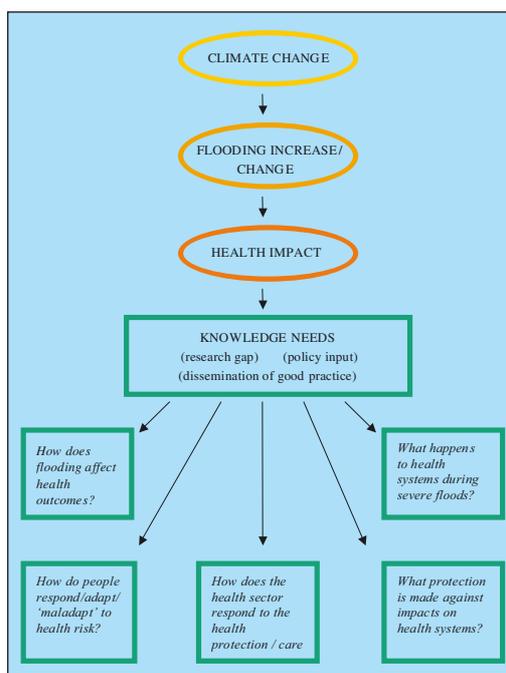
BY FRANZISKA MATTHIES, ROGER FEW, SARI KOVATS

► **Climate change is likely to affect human health through** a range of mechanisms, and via a wide range of diseases and health outcomes. During the last five years there has been increasing attention within epidemiological and public health research to improve the models that are used to project future health risks at more appropriate local or regional level, where such models can be validated with current health data. There is now a pressing need for research on perceptions, behaviour, vulnerability and adaptive response to climate impacts on health at the appropriate scales. Enhancing understanding of how individuals, institutions and health systems cope now and may respond in future to climate-related hazards presents a crucial challenge to social science research. Figure 1 presents the key questions framing an ongoing research project on flooding, health and adaptation funded by the Tyndall Centre for Climate Change Research. This project combines scientific and social scientific perspectives in the analysis of climate health impacts and adaptation processes across the globe. The cCASHh project (Climate Change and Adaptation Strategies for Human Health) has already reviewed current knowledge about adaptive responses to the potential impact of climate change in Europe on heat deaths, vector borne diseases (Lyme disease, TBE, malaria and leishmaniasis), floods, and foodborne disease. For some health outcomes, climate change presents an exacerbation of an existing problem, which can be best addressed by strengthening current public health measures (such as controlling salmonella infections via food hygiene regulation). However, for some outcomes, particularly those associated with climate variability (floods and heat waves), there is relatively little knowledge about health impacts, and health is poorly addressed within current response strategies.

The role of social science in analysis of vulnerability and adaptation to the health impacts of climate change is underlined by the now-widespread recognition among hazard researchers that vulnerability is an inherently social as well as physical condition. Who suffers when floods or heat waves strike is not merely a matter of hazardous location but is a product of social, economic, cultural and political forces that condition who is exposed and how effectively they may be able to cope. An investigation of the 500 heat related deaths in the Chicago heat wave of 1995 showed that the biggest risk

factor was social isolation. In India, those most at risk of dying in heat waves are the rural poor who have no choice but to work outside in temperatures above 40°C.

Likewise the adaptation strategies that are available and accessible to health sector institutions are shaped by a range of structural dimensions including knowledge, funding and political prioritisation. It is important that evidence is now provided to policy makers about the most appropriate and most effective responses needed to reduce the impact of climate change on human health.



Studies of vulnerability and adaptation must be population specific and involve a social science approach

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cCASHh website address:
www.who.dk/eprise/main/WHO/Progs/CASH/Home
Tyndall website address:
www.tyndall.ac.uk

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JOINT PROJECT ON HEALTH A PRIORITY FOR ESSP

► **On behalf of the four programmes and START, a scoping meeting on global environmental change and health was held beginning of this year in Paris, hosted by DIVERSITAS. Participants agreed that a new joint project on health constitutes a priority for their community and represents an exciting opportunity for ESSP. There have been a few IPCC assessments of climate change impacts on health, and there is an ongoing assessment of the link between ecosystem changes and health. There is, however, no long-term research initiative on this topic, and no established international scientific community.**

WHAT CAN THE ESSP CONTRIBUTE ON GEC AND HEALTH?

The ESSP will tap into its many international networks of scientists, and infrastructure (the international programme secretariats). Its main strength is its ability to build networks of scientists, which go across borders and disciplines.

The major goal of this initiative is to provide an international scientific agenda for research on GEC and health for the next 10 years, which will set research priorities (defined by the scientific community), and create a supportive network for communication of results and recommendations.

Below is a list of possible activities which could be undertaken by GEC and health, building on on-going ESSP activities:

1) *Promoting scientific knowledge on GEC and health*

Scientific syntheses (e.g. with SCOPE); case studies; comparative studies; monitoring and mapping to detect trends and patterns and generates hypotheses; models; scenarios; international science conferences.

This new joint project would make all these activities possible by providing a small secretariat for co-ordination/communication activities. It would provide funds for some activities (e.g. workshops). It will not fund research projects directly but could help scientists to obtain funds.

2) *Promoting collection of data for scientific and surveillance purposes*

Facilitate exploitation of existing databases; promote surveillance networks (long term series); promote development of global observing systems; promote dialogue with space agencies; promote intersectoral dialogue on data issues: quality, meaning and consistency of the data collected by the other sectors.

3) *Capacity building*

All activities will endeavour to include all parts of the world. A number of specific capacity building activities will be necessary to contribute to promote GEC and health science. Examples could include seed grants for developing countries scientists and international summer courses for young scientists.

4) *Link with policy fora*

This new project will directly feed into the IPCC Fourth Assessment Report (2007) and the MA reports (2004). These, in turn, formally inform the UNFCCC (Climate Convention), the CBD (Convention on Biological Diversi-

ty), the CCD (Convention to Combat Desertification) and the Wetlands Convention (RAMSAR). This new project will also help to achieve the Millennium Development Goals.

COLLABORATIONS WITH THE OTHER ESSP PROJECTS AND OTHER PROGRAMMES

This new GEC and Health ESSP-project would be linked to the already existing ESSP projects, the Global Environmental Change and Food Systems (GECAFS), the Global Water Systems Project (GWSP) and the Global Carbon Project (GCP), via multiple pathways.

In addition to the ESSP, the World Health Organisation (WHO) was represented at the meeting and expressed an interest in becoming involved. Other partners such as the United Nations for Environment Programme (UNEP) and the World Meteorological Organisation (WMO) may be approached as appropriate.

GOALS OF A GLOBAL ENVIRONMENTAL CHANGE AND HEALTH PROJECT

The ultimate goal is to protect and enhance human well-being and the environment in the face of the threats of GEC.

Specific objectives include:

- a. Assess past, current and future health impacts of GEC
Assess the relationships and mechanisms between GEC and health outcomes. This research will take into account vulnerability, feedbacks and interactions. The results of this research can be applied to the development of adaptation (impact-lessening) measures such as health Early Warning Systems. Importantly, it also bolsters the argument for mitigating the environmental changes, by providing information on the actual or potential seriousness of the impacts.
- b. Elucidate the particular health-related upstream drivers of GEC.

Apply the results of this research to the identification of mitigation measures.

- c. Harmonize mitigation and adaptation
By building on the results of the two above lines of research, facilitate the development of strategies and policies for mitigation and to increase adaptive capacity to global environmental change.
- d. Develop and use new methodologies to explore the tension between particular pathways of economic development, environmental change and human health.

Besides data collection, models and assessments, the development of human health and global environmental changes scenarios is crucial. Also, working in this area requires joining diverse disciplines to examine the issues adequately and to engage effectively with the domains of politics, economics and commerce.

The Earth System Science partnership consists of the four global environmental change programmes WCRP, IGBP, IHDP and DIVERSITAS. The ESSP was established as a consequence of the growing need for truly border-crossing scientific approaches. Websites: www.ihdp.org; www.igbp.org; www.wmo.ch/web/wcrp/wcrp-home.html; www.diversitas-international.org

THE POPULATION-ENVIRONMENT RESEARCH NETWORK:

Experimenting with eNetworking | BY ALEX DE SHERBININ

► The field of population-environment research has expanded rapidly since the 1980s, yet, perhaps reflecting its multidisciplinary nature, the field has suffered from a lack of coherent theoretical frameworks and methodological approaches, and has had relatively weak mechanisms for scientific exchange. The Population-Environment Research Network, a joint project of the International Union for the Scientific Study of Population (IUSSP) and the IHDP with funding from the MacArthur Foundation, was launched in March 2001 to address these gaps. The network, which operates entirely through the internet, seeks to advance academic research on population and the environment through bi-annual "cyberseminars"; monthly news updates; a calendar of events, lists of job/funding opportunities; a members database for networking; and an extensive eLibrary. The network is staffed by a part-time coordinator, and has a steering committee that provides overall guidance.

At the present time the network has 706 members, more than half of whom are from developing countries. Membership is open to researchers from all disciplines. The current membership composition by discipline is about 25% demography/sociology; 14% ecology, biology, and environmental science; 12% geography; 7% economics; 4% political science; 4% public health; and 33% a variety of smaller categories. The regional composition is 38% from North America, 26% from Asia, 14% from Europe, 10% from Latin America and the Caribbean, 7% from Africa, and 5% from Oceania.

The cyberseminars represent an innovative approach for stimulating exchange. Using one or more background papers as a touchstone for discussion, they have sparked lively debates that focus on scientific and policy issues important to the field. Seminar topics have included migration to coastal zones, a scientific statement on population-environment interactions for the World Summit for Sustainable Development (Johannesburg, 2002), migration-environment linkages, and population and deforestation. Each topic has attracted approximately 75 unique contributions by invited panelists, researchers, and interested individuals. This Fall's seminar, scheduled for November, will address health

and environment linkages; another is planned for early 2004 on population, consumption and environment linkages, which will be linked to a workshop to be held in conjunction with the Open Meeting in Montréal, Canada.

The eLibrary is a bibliographic database populated with 1,450 items, including hard-to-find gray literature, conference papers, monographs, journal articles, books, and web published materials. A relatively recent feature is the Population-Environment Collection (PEC), which culls the most recent peer-reviewed journal articles on population and environment from 70 different journals. Apart from the PEC, the eLibrary's emphasis is on freely accessible online materials, since journal sub-

scriptions are prohibitively expensive for many members. Searches can be conducted on several key word fields addressing population and environment substantive areas, study region, methodological approach, and study scale. About 50 new items are added every month.

Feedback thus far has been encouraging. Researchers have contacted the network to indicate that they have found the bibliographic database useful for their research interests. The developers of the SciDev.Net website for science and development contacted the network early on to learn from its experience, and the network is being listed by an increasing number of research resource databases, such as the Social Science Informa-

tion Gateway (SOSIG). Overall, the internet has proven an effective way to help developing country and younger researchers engage with wider networks.

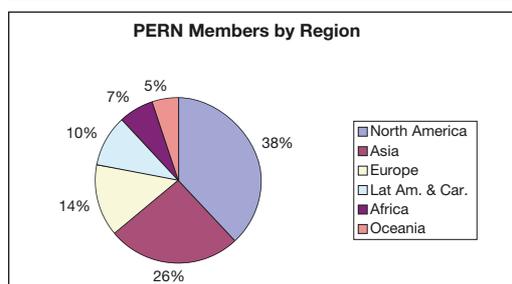
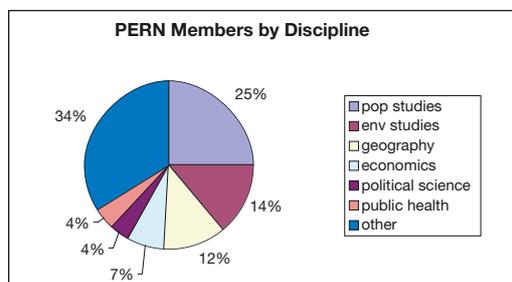


To learn more about the network, or to become a member, please visit

<http://www.populationenvironmentresearch.org>.



ALEX DE SHERBININ is a Senior Staff Associate for Research at the Center for International Earth Science Information Network (CIESIN), Columbia University, and the recently appointed Coordinator of the Population-Environment Research Network.



TRANSITIONS TO A SUSTAINABLE SOCIETY

Introducing the Dutch Knowledge-Network on System Innovation (KSI)

BY JAN ROTMANS AND DERK LOORBACH

► **Sustainable development is a complex and essentially** contested notion and involves a very long time-horizon on global as well as local scales. So far, implementing strategies for sustainable development has been difficult – traditional problem-solving approaches are insufficient. Sustainability problems will have to be addressed through more reflexive, integrated and interactive strategies and processes in which learning and developing are crucial. Such processes can be called transitions: long-term societal transformations that result from the interaction between economic, ecological, technological, institutional and socio-cultural changes (visualized in the figure).

The Dutch government and the scientific community have taken up the challenge of developing strategies to manage such sustainability transitions, which play a key role in the fourth National Environmental Plan (NMP-4, 2002). Four transitions have been selected within the Dutch policy context: the transitions to a sustainable energy-supply system, to sustainable agriculture, to sustainable transport and to sustainable biodiversity and natural resources. This implies a fundamentally new approach towards policies and science for sustainable development, especially because of the focus on the long-term system transformation through interacting innovations. Even though a lot of experience is now being built up, transitions and the management of transitions is largely *terra incognita*. Therefore, a substantial knowledge base has to be built up over the coming decade(s), of both theoretical and fundamental knowledge of scientists as well as practical knowledge of practitioners involved in transition experiments.

In order to develop such a theoretical knowledge base on transitions and system innovations the Dutch Knowledge-network on System Innovations (KSI) has been established: an interdisciplinary network of over 50 researchers from 11 universities and several research institutes in the Netherlands. From different disciplinary backgrounds (a.o. political science, innovation science, integrated assessment, economics, governance, historical, ecological and communication sciences), they have joined forces to develop a new and shared scientific paradigm and accordingly an inter- and trans-disciplinary research program on the subject of transitions and system innovation. Each participant in the network was selected because of his or her knowledge and expertise related to transitions and system innovation (for example process-architecture, integrated systems analysis, mutual learning, uncertainty management, interactive and participative governance, tools and instruments for assessing sustainability). To combine the theoretical and applied research-work of the KSI-network, close collaboration with the practice-oriented organisation NIDO (Dutch National Initiative for Sustainable Development) is taking shape.

The KSI-research program aims at synthesising and deepening our understanding of past, current and future transitions dynamics through the development of theoretical knowledge on the one hand, and practical knowledge on the other, in mutual coherence. The research program is organised in three different sub-programs:

► Research on historical transitions

This program is organised in two areas. The first area is the *construction of a database* with about 40 historical system innovations capturing transitions in a number of domains, including energy, transportation, agriculture, food, housing, and spatial planning. The second area consists of the *exploration of a number of transition themes*, using the database as a resource. Both lines aim to further develop transition theory.

► Research on current and future transitions

This research program aims to systematically analyse and monitor current and future transition patterns for selected transition domains (energy, mobility, water, agriculture, land-use). In-depth analysis will be performed of the individual transitions and underlying system innovations as well as their mutual coherence. Tools and methods such as integrated assessment models and scenarios will be developed to recognise, describe and explain current, and assess future transition patterns.

► Research on the governance of transitions

The underlying rationale of this research line is that during transitions, structural and institutional changes that influence the market-, innovation- and political-administrative systems interact with behavioural changes, but can be influenced so that they reinforce each other. Transition management as well as other policy tools and methods will be developed aiming not to control, but to influence the direction and pace of transitions and system innovation in an evolutionary way.

Recently, the IHDP-IT programme has decided to endorse the KSI network in order to ensure interaction between the different projects and research lines. This endorsement will also provide a basis to internationalise the KSI-network and its research through participation in European and global networks, by carrying out joint research projects and collaborating with international researchers.



JAN ROTMANS is Scientific Director of the KSI-network and Director of the International Centre for Integrative Studies (ICIS) at Maastricht University, The Netherlands. Derk Loorbach is researcher on transitions at ICIS and secretary to the KSI-network; j.rotmans@icis.unimaas.nl; www.icis.unimaas.nl/ksi or www.nido.nu.

IN BRIEF

➤➤➤ **IHDP Secretariat.** This summer did not only bring immense heat to the Secretariat's offices (well over 40 degrees Celsius inside!) but also some new staff members. **Anna Middel**, who worked before in overseas shipping, is our new general office administrator. **Britta Schmitz** will take care of IHDP's financial administration. She has been on a 'family-break' (which is not a break at all, of course) and before that worked for AGFA. **Ula Löw** has been with the United Nations and also worked as a journalist before joining IHDP as the new information officer. **Anja Trauschies**, our librarian, will bring in her extensive experience with library documentation. Welcome on board! We are also happy to receive our Science Coordinators **Debra Meyer-Wefering** and **Maarit Thiem** back from maternity leave. Instead, we wave **Ike Holtmann** goodbye, but thankfully only for the time being. She has left on what? You guess it – maternity leave. Finally, **Puja Sawhney** is leaving us to concentrate full-time on her Post Doctorate at the Zentrum für Entwicklungsforschung ZEF (which is in the same building, so we will still see her). We wish her all the best!



Photo by Debra Meyer-Wefering

Ike Holtmann

YOUNG IHDP RESEARCHERS: FIRST NATIONAL CONFERENCE IN GERMANY

➤ From 20th-22nd of June, 120 young German researchers with a keen interest in environmental research gathered in Hamburg for a IHDP-endorsed conference entitled 'Places of sustainable development'. The main aim of the conference was to allow participants – mostly economists, psychologists, political scientists and sociologists – to exchange experiences on an academic level as well as on best practice in networking itself. A second aim was to raise interest in the international activities of IHDP in general and the Young Human Dimension Researchers in particular. In Germany itself, young researchers interested in environmental aspects have already been well organised. Networks of the respective, above-mentioned disciplines with regard to the environment have existed since the 80s and 90s. However, an inter-disciplinary dialogue about research methods et.al. hardly existed before this meeting. This is one of the reasons why the Hamburg YHDR conference became such a success!

The conference programme featured inter- and trans-disciplinary approaches to research on any one aspect of sustainable development. From problem perception to policy-making and implementation, the merits and shortcomings of participatory approaches were assessed. The small group of practitioners from governmental, non-governmental and business organisations was helpful in keeping discussions grounded in decision-makers' daily experience.

As a result of the conference, a lot of inter-disciplinary learning took place and a number of follow-up projects are on their way. Amongst the most remarkable results is the plan of a joint internet gate by all four networks (where announcements of interest to all four networks can be posted). When evaluating their conference experience in the final session of the meeting, the enthusiastic participants left no doubt that they would like to meet again in the same format in two years' time.

Meanwhile, several of the conference participants will attend the Young Researchers' Day that Jasper Großkurth and others are hosting right before the 2003 Open Meeting of the IHDP in Montréal, Canada.

More information about the conference (in German) and related publications can be found at www.ortenachhaltigerentwicklung.de.



Young researchers within IHDP get organised

Taking Stock and Moving Forward



Open Meeting of the Human Dimensions of Global Environmental Change Research Community

16-18 October 2003

Montreal, Canada

Registrations are still accepted!

Information and Registration:
<http://sedac.ciesin.columbia.edu/openmeeting>

Hosted by: McGill School of Environment
Organised by: International Science Planning Committee,
co-chaired by Peter Brown, McGill School of Environment,
Canada, and Marc A. Levy, CIESIN, Columbia University, USA.
Sponsored by: CIESIN, IAI and IHDP



MEETING CALENDAR

➤➤➤ *September 15 – October 15*

Sustainable Consumption Web-based E-Conference

Organized by the Unit for Social and Environmental Research (USER), Faculty of Social Sciences, Chiang Mai University, Thailand

Join at: www.sea-user.org/e_conference.php

➤➤➤ *7-9 October – Portsmouth, New Hampshire, USA*

Open Science Conference of the Global Water System Project

Contact: www.gwsp.org

➤➤➤ *16-18 October – Montreal, Canada*

Open Meeting of the Human Dimensions of Global Environmental Change Research Community

Taking Stock and Moving Forward

Host: McGill School of Environment

Sponsors: CIESIN, IAI and IHDP

Information and Registration:

<http://sedac.ciesin.columbia.edu/openmeeting>

➤➤➤ *27-29 October – Capetown, South Africa*

South African Conference on Global Change

Information: www.nrf.ac.za/saeon/globalchange/saglobal.htm

➤➤➤ *10-22 November, Piracicaba, Brazil*

IAI Summer Institute on Global Warming and Climate Changes:

Causes, Mitigation Alternatives and International Actions

Information: www.iaisummerinstitutes.iai.int

➤➤➤ *16-19 November – Trieste, Italy*

Young Scientists Global Change Conference

Submission of papers – deadline closed

Contact: kristy@crg.bpb.wits.ac.za

➤➤➤ *1-3 December – Wageningen, The Netherlands*

International Workshop on Transition in Agriculture and Future Land Use Patterns

Information: www.lei.dlo.nl/folder_internet.pdf

➤➤➤ *2-5 December – Morelia, Mexico*

Land Open Science Conference

Information: www.ihdp.uni-bonn.de/Pdf_files/announcements/AugustOSC2.pdf

Contacts: Rowena.Foster@csiro.au or Gregor Laumann: laumann.ihdp@uni-bonn.de

➤➤➤ *4-5 December – Berlin, Germany*

Berlin Conference on the Human Dimensions of Global Environmental Change

Governance for Industrial Transformation

Information: <http://www.fu-berlin.de/ffu/akumwelt/bc2003/>

PUBLICATIONS | NEW BOOKS

Perspectives on Industrial Ecology

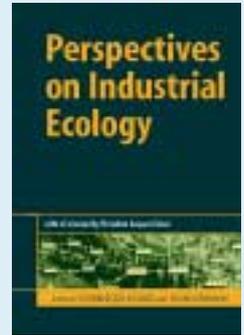
edited by Dominique Bourg and Suren Erkman,

Greenleaf Publishing, Sheffield, UK, 2003; 384 pages;

cloth ISBN 1-874-71946-2;

price: \$75.00

The systematic recovery of industrial wastes, the minimisation of losses caused by dispersion, the dematerialisation of the economy, the requirement to decrease our reliance on fuels derived from hydrocarbons and the need for management systems that help foster inter-industry collaboration and networks are among the topics covered. This book is split into four parts. First, the various definitions of industrial ecology are outlined. Second, a number of different industrial sectors, including glass, petroleum, and electric power, are assessed. Third, the options for overcoming obstacles that stand in the way of the closing of cycles such as the separation and screening of materials are considered, and finally, a number of implications for the future are discussed. Contributors offer perspectives from many disciplines including engineering, ecology, bio-economics, geography, the social sciences, and law.



Industry Genius Inventions and People Protecting the Climate and Fragile Ozone Layer

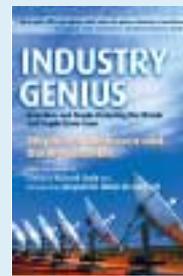
Stephen O. Andersen and Durwood Zaelke

With Forewords by Astronaut Richard Truly and UN Executive Jacqueline Aloisi de Lardere

Greenleaf Publishing, Sheffield, UK, July 2003; 192 pages;

Paperback; ISBN 1 874719 68 3; price:

£14.95 or US\$22.50



This book presents the inventive genius behind technological breakthroughs by ten global companies. Readers will gain understanding and insight into how cutting-edge technology is helping protect the climate and/or the ozone layer, while contributing to the company's

bottom line. Each chapter chronicles the challenge and triumph of invention, introduces the engineers and executives who overcome conventional wisdom, and demonstrates the contribution these companies are making to environmental protection. In full colour and crammed with graphics to illustrate the creative process of technological breakthroughs, the book is accessible and informative. The genius of these ten companies will inspire the engineer, the policy-maker, the student, the environmentalist, the CEO and the investor alike.