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Patient: Earth

Take a dose of each to relieve the health effects of global environmental change.
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This Update issue was first conceived by IHDP’s health advisory group at the IHDP Open Meeting in 2009. Since then, questions about the links between global change, health and the environment have become more critical to human well-being. For example, extreme events in different parts of the world (e.g. H1N1a), made the global community aware of how rapidly emergent diseases can be widely transmitted virtually anywhere. While the natural science and medical communities have had a head start in drawing together the connections between health and the environment, it has become increasingly apparent that the IHDP community has a key role to play in addressing health as a cross-cutting issue.

As a starting point, we invited a group of renowned scientists to contribute their thoughts and work on three themes: Firstly concerning areas of research where IHDP’s community could contribute at the conceptual level; secondly, on examples of research already taking place in various regions; and thirdly, to suggest emerging topics which need to be addressed. This issue opens with a paper by Pim Martens and his colleagues, who introduce a novel conceptual framework for globalisation and health, further identifying various policy areas (e.g. the Millennium Development Goals) where research needs to be done. Loraine Elliott reminds us that our research needs to be situated within a framework of ethics and governance. She makes a strong link to the research agenda of IHDP’s Earth System Governance Project. An issue that is vexing governments everywhere is to find new and better ways of detecting disease outbreaks as early as possible. On this front, Alexandra Ziemann et al. describe a European initiative to develop tools for syndromic disease surveillance. Ursula Oswald Spring’s contribution is directed at public policies to enhance health security in the context of global change and social science research.

The next group of papers give substance to the ideas and issues raised through research carried out in various regional settings. Manuel Caesario and his colleagues describe various projects in Amazonia where they have been working for a number of years on vector-borne diseases that are spreading as a result of deforestation, land use change, and the lack of cross-border cooperation, which further exacerbate the impacts on human health. The major health challenges caused by internal human migration are addressed by Jennifer Holdaway and her colleagues, with a focus on the rapid social and economic changes taking place in China. Dhaka, Bangladesh, is the setting for the paper by Oliver Gruebner et al., as megacities have long been of interest to the IHDP community (cf. Urbanization and Global Environmental Change Project - UGEC). This contribution focuses our attention on their health implications. Nowhere are the impacts of climate change being felt as immediately as in the Pacific Small Islands States, where Sarah Lovell studies health governance and reports on some of her findings.

The last three papers take us in new directions, calling for broader ways of thinking across regions, the crucial role that health literacy plays, and calling for social scientists to take up a more prominent role in global change and health. Osman Sankoh and Yazoume Ye discuss the potential of a demographic surveillance system for two of the regions of the world where Malaria is endemic and having the greatest impacts on human health. Kristine Sorensen’s focus on health literacy focuses on sustainability and equity. From his years of experience in senior positions in Ministries of Health in South Asia and the World Health Organization, Abdul-Sattar Yoosuf completes this collection with an argument that the IHDP community needs to have a greater say in global change and human health.

IHDP, along with the other global change programmes (IGBP, DIVERSITAS, WCRP), have endorsed the Earth System Science Partnership Joint Project on Global Environmental Change and Human Health (GECHH) to spearhead research on global change and human health. We hope this issue of Update stimulates the IHDP community to embrace the challenges identified by its contributors, as well as others not mentioned, and to play an expanded role in the GECHH Project.

Thomas Krafft, Gabriela Litre, Mark W. Rosenberg, and Lucilla Spini
Globalisation and human health complexity, links and research gaps

P. Martens, M. Huynen, S. Akin, H. Hilderink, C.L. Soskolne

Introduction

Achieving health for all has become a common international goal. In our attempts to realise this goal, we have to recognise that our (future) health increasingly depends on the processes of globalisation. In the past, promoting good health had been identified as one of the key elements for achieving a sustainable form of globalisation (Lee 2003). The link between global mobility and the spread of infectious diseases is perhaps the best-known health effect of globalisation. However, it is only one of the many possible health implications of the globalisation process. Because the pathways from globalisation to health are various and mediated by a multitude of factors, a clear conceptualisation of the context is required.

Conceptual framework for globalisation and health

As the world around us is becoming progressively interconnected and complex, human health is increasingly perceived as the integrated outcome of its diverse determinants. A recent analysis of existing health models concluded that the nature of these determinants and their level of causality can be combined into a basic framework that conceptualises the complex multi-causality of population health (Huynen et al. 2005a; Huynen et al. 2005b).

In order to differentiate between determinants of a different nature, we will make the customary distinction between institutional, socio-cultural, economic, and environmental determinants. These determinants operate at different hierarchical levels of causality. The chain of events leading to a specific health outcome includes both proximal and distal causes—proximal factors act directly to cause disease or health gains, while distal determinants are set further back in the causal chain and act via intermediate causes (WHO 2002). In addition, contextual determinants also play an important role. These can be seen as the macro-level conditions shaping the distal and proximate health determinants; they form the context within which the distal and proximate factors operate and develop. Figure 1 shows the wide-ranging overview of the health determinants that can fit within this framework.

In the past, globalisation has often been seen predominantly as an economic process characterised by increased deregulated trade, electronic communication and capital mobility. However, it is now increasingly perceived as a more comprehensive phenomenon shaped by a multitude of factors and events, that is reshaping our society rapidly. Based on the work by Scholte (2000), Held et al. (2000), and Rennen & Martens (2003), we define globalisation as ‘a process characterised by a growing intensity, extensity and velocity of institutional, economic, socio-cultural and ecological interactions, resulting in trans-border processes and effects (Huynen et al. 2005b). For the focus of the conceptual framework, the following important features of globalisation are identified:

- **Global governance structures**: globalisation influences the interdependence among nations as well as the nation state’s sovereignty leading to a need for new global governance structures.
- **Global markets**: globalisation is characterised by worldwide changes in economic infrastructures and the emergence of global markets and a global trading system.
- **Global mobility**: global mobility is characterised by a major increase in the extensity, intensity and velocity of movement and by a wide variety in ‘types’ of mobility.
- **Cross-cultural interaction**: globalising cultural flows result in interactions among global and local cultural elements.
- **Global environmental changes**: global drivers of ecosystem change include global climate change, loss of biodiversity,
global ozone depletion and the global decline in natural areas.

Based on Figure 1, it can be concluded that these features all operate at the contextual level of health determination, influencing distal health determinants. In turn, the changes in distal factors have the potential to affect the proximate determinants and, subsequently, health.

Globalisation and health: concepts and approaches

As illustrated above, causality in human health is multi-factorial, and many population health problems are invariably embedded within a global context. McMichael (1999) and Schrecker et al. (2008) for example, argue that a global approach toward population health and epidemiology should not ignore the importance of individual level proximate risk factors, but should indicate the importance of studying these proximate causes in their broader context (Colwell 2004).

As our attention moves to multiple levels of the causal matrix of health determinants, there is an increasing interest in multilevel and systems-approaches (Pearce & Merletti 2006; Pearce 2004; McMichael et al. 1999; Martens 1997; Colwell 2004; Wilcox & Colwell 2005). Populations are not simply a collection of individuals, but are shaped by, and shape, the systemic context within which they operate. Risk factors for disease do not operate in isolation, but occur in a particular population context; in fact, in multiple nested contexts. Upstream forces play an important role in global health research (Sreenivasan & Benatar 2006). The more upstream or larger context factors may have greater impacts, but their effects are non-linear and less predictable (Philippe & Mansi 1998). Various terms have been used to describe broader approaches to population health, such as eco-epidemiology (Susser 2004; Martens 1998; Soskolne 2008; Ladd & Soskolne 2008), the ecological perspective on health (McLaren & Hawe 2005), the social-ecological systems perspective on health (McMichael 1999), and a bio-complexity approach to health (Wilcox & Colwell 2005).

The majority of literature addressing population health as an interacting system of many different factors concerns research into communicable diseases. Disease transmission depends on contextual factors such as environmental change and cultural practices affecting landscapes, communities and population densities. These factors, in turn, interact with the host-pathogen biology via evolutionary ecological processes to contribute to the re-emergence of communicable diseases. Parkes et al. (2005), among others, urge new systems-based approaches to address communicable diseases. They argue that the worldwide re-emergence of infectious diseases (e.g. SARS, Nipah virus, Lyme disease, HIV/AIDS, malaria) demonstrates that the rate and scale of global change in agriculture, trade demographics, species translocations and invasions, microbial adaptation, and other complex factors have outstripped our ability to understand and respond to emerging infectious diseases, and exposes the serious limitations of approaches that fail to engage with the wider context from which infectious diseases emerge. For example, the risk of highland malaria moving to higher altitudes depends on the interplay between regional climate change, land-use change, population movement, agricultural practices (e.g. pesticide use, irrigation systems), public health programmes (e.g. monitoring and treatment) and socioeconomic status (Lindsay & Martens 1998).

The dynamic interaction of these various factors is but one of the many examples of the broader population context in which infectious diseases develop and evolve.

Applications of a systems-based epidemiological approach to non-communicable diseases are rarer. However, such an approach is necessary because social and economic conditions at the population level can explain substantive differences in exposure to individual-level risk factors. Individual “lifestyle attributes”, for example a high-fat/low-fibre diet, can be understood only in the historical, cultural and socio-economic context in which

![FIGURE 1: Conceptual framework for globalisation and population health](Huynen et al., 2005b)
they occur (Pearce & Merletti 2006). Albrecht et al. (1998) apply a complexity approach to coronary heart disease in the Australian Coalfields, resulting in an improved understanding of the dynamic interplay among industrial history, health-disease risk factors, gender promotion, and community responses to both the health problem and the health promotion campaigns.

In our effort to assess the health impacts of global (environmental) change, we have to be aware of the limitations of the traditional reductionist approach; population health and global change cannot be disassembled to their constituent elements and then reassembled in order to develop an understanding of the system as a whole. The individual scientific disciplines can offer only partial analyses and solutions. In order to fully address complex, interconnected, system-based health topics, transdisciplinary approaches are required to facilitate newer modes of science that transcend individual disciplinary boundaries. Although complexity theory has had relatively little influence in the fields of population health and epidemiology, the above shows that the past few years have witnessed a growing recognition of the multi-dimensional and multi-level causation of population health and the importance of a holistic systems-based approach. Epidemiologists are among the latest to grapple with the implications for their discipline, and with the global population health implications of a complex global village. Hence, emergent concepts and methods, as revealed through integrated assessment approaches, are the hallmark of eco-epidemiology. This approach is consistent with the more general complexity thrust in science.

Integrated Assessment provides an integrated systems-based research approach for combining knowledge to enhance our understanding of cross-linkages and pathways under complexity. It provides a structured process for dealing with complex issues, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision-makers. Integrated Assessment models provide structured representations of complex systems, more consistent with a real-world understanding of the dynamics in a causal pathway. Integrated Scenario Analysis permits understanding of where current and anticipated trends will lead; only when we see likely futures can we act to prevent harm by steering away from them. Participatory Methods provide a mechanism for broadening our understanding of complex issues. An extended peer community provides a superior form of quality control under complexity. Only by exploring futures with explicit assumptions can we then identify those structures amenable to interventions that would increase the probability of arriving at more favourable futures. Moreover, to avoid further fragmentation of knowledge relevant to social/ecological sustainability, these tools need application within a larger analytical structure that includes, for example, modelling and scenario methods, which are better suited than multivariate regression for dealing with complex relationships (Greenland & Brumback 2002; Martens 2006).

The international agenda urgently needs to reflect the reality that the globalisation process is an increasingly important (contextual) health determinant. We need to step away from business-as-usual attitudes, sector-based solutions and short-term remedies. These research methods and tools should be tested further because they could be effective for the improved exploration and modelling of human health under global change. Their application in problem-oriented transdisciplinary research encourages the adaptation and adoption of formerly discipline-specific methods into other disciplines, and the development of new conceptual frames. Their continued employment and evaluation are encouraged.
Global health: a priority for the international agenda

Global health research addresses the ways in which globalisation is impacting both health determinants and outcomes (LEE, 2003). This is a rather new, but very exciting research field. The discussed framework provides valuable insights in how to organise the various factors involved in global health. It clearly demonstrates that an integrated approach is needed, drawing upon the knowledge from relevant fields such as epidemiology, sociology, political sciences, (health) education, environmental sciences, law and economics. This will require integrated initiatives organised around the health challenges posed by globalisation rather than around specific research disciplines or policy sectors.

Although further research is required, the international agenda urgently needs to reflect the reality that the globalisation process is an increasingly important (contextual) health determinant. We need to step away from business-as-usual attitudes, sector-based solutions and short-term remedies. Globalisation enables perpetuation of the disconnect between individuals/communities and the local ecosystems of which they are an integral part. Looking at current international policy efforts and commitments, improving health worldwide is an important part of the United Nations Millennium Declaration (UN 2000), and the associated Millennium Development Goals (MDGs) to be reached by 2015. Four of these MDGs are directly targeting health issues. The last MDG, “a global partnership for development” addresses the processes of globalisation and is supposed to provide guidance for the achievement of the other MDGs. However, the recent MDG Report 2007 (UN 2007) states that there has been clear progress towards implementing the MDGs, but overall success is still far from assured. It is argued that rapid and large-scale progress is still feasible, but this will depend mostly on whether developed countries keep their aid commitments to developing countries (SOSKOLNE ET AL. 2007).

In the Millennium Declaration (UN 2000), governments agreed that globalisation should become a positive force for all. Instead, the trends are towards ever-widening disparities, nationally and internationally. However, there is also a need to consider the diverse negative health effects of the globalisation process. Hence, anticipating both the risks and opportunities provided by the globalisation process should be a vital part of the international effort to achieve the MDGs.

Other examples of global initiatives that need to account for the health effects of globalisation are Health for All (a global strategy for health development advocated by the WHO) and Agenda 21 (the United Nations programme of action on sustainable development). The recent ‘Global Health and Foreign Policy Initiative’ explicitly addresses the health impacts of globalisation. Under this initiative, Brazil, France, Indonesia, Norway, Senegal, South Africa, and Thailand issued the Oslo Ministerial Declaration in March 2007. In this statement they acknowledge that health as a foreign policy issue needs a stronger strategic focus on the international agenda (ANON 2007).

Another approach that can be used to stress the importance of ‘globalisation and health’ might be through the international human rights framework (HUYNEN & MARRANTS 2007). Under international human rights law, states have the legal obligation to respect, protect and fulfil human rights for all citizens. They have to ensure that their own policies do not impact negatively on the enjoyment of human rights in other countries, and that the activities of the international organisations of which they are a member are human rights-compliant (SMALLER 2005).

Our conceptual framework illustrates that achieving global health concerns not only the right to health, but also requires the fulfilment of other important human rights upon which human health and well-being depend. Several important human rights issues mediate the pathways from globalisation to health, such as the right to health care, food, water, and a healthy environment. In addition, the international community must stress the human rights obligations and responsibilities of both state and non-state actors (e.g. the WTO and transnational corporations). Hence, the current debate about the pros and cons of globalisation must recognise that the forces of globalisation should be subject to moral and ethical considerations and should respect international legal standards and principles. A rights-based approach integrates the
Increasingly stronger. What this exact-ly means, however, remains unclear. Especially in the phase of issue or problem framing, the development of a conceptual model improves the integrated understanding of all key components and processes involved. As such, our framework (Figure 1) can provide a useful contribution to ongoing discussions on the health effects of globalisation, 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 and good health for the (future) world population. As Soskolne et al. (2007) state, we “must embrace greater complexity” because “the traditionally used, reductionist, linear approaches are inferior for understanding the interactive webs that are critical for sustainable development and for the health and well-being of future genera-tions”. With an escalating number of ecosystem changes taking effect across the planet, attention to developing and evaluating epidemiological methods that will generate data to inform policy that might help to change the present course is critical. Indeed, Soskolne (2003) has drawn attention to the even greater need for precaution under global change. And, primordial pre-vention (Beaglehole et al. 2002) is the level at which precaution must be exercised.

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References


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Environmental change and health

human dimensions, ethics and global governance

L. Elliott

Introduction

The impact of environmental change on human health is increasingly well documented. As the Science Plan for the Earth System Science Partnership Joint Project on Global Environmental Change and Human Health (ESSP GEcHH) observes, “it is widely understood that human societies and the well-being and health of their populations depend on the flow of materials, services and cultural enrichment from the natural world” (GEcHH 2007, p. 1). We know also that these are not occasional or minor problems. The United Nations Environment Programme (UNEP) suggests that “poor environmental quality is directly responsible for some 25 percent of all preventable ill health worldwide” (2002, p.306). The World Health Organization (WHO) reports that every year “about 1.2 million people die from causes attributable to urban air pollution, 2.2 million from diarrhoea largely resulting from lack of access to clean water supply and sanitation, and from poor hygiene, 3.5 million from malnutrition, and approximately 60,000 in natural disasters” (2009, p. 2).

From a human dimensions and global governance perspective, this gives us cause to ponder a number of questions. What defines ‘global’ in this exploration of global environmental change and human health? What global patterns of risk and vulnerability characterise the human health impacts of environmental change? What current governance arrangements – rules, norms and institutions – address these concerns at a global level and, where gaps exist (as they almost certainly do), what can we say about the best way forward?

The human health dimensions of global environmental change

The negative impact of environmental change on human health – illness, disease, injury and a general loss of well-being – occurs through a number of overlapping and generally complex pathways. Some of these involve direct environmental hazards, such as air and water pollution, and the waste by-products of industrial and agricultural production. Others involve the loss of environmental services, such as clean water, biodiversity and arable land or the impact of environmental change on the genetics of pathogens and patterns of disease exposure. Other pathways are associated with structural changes, such as urbanization and the industrialisation of agriculture. Still others arise from the impact of natural disasters, such as drought, flooding and extreme weather events.

It is commonplace to note that we know a lot about the health burden associated with environmental change at the broad scale, but much less at the fine-scale of discrete and often differentiated local impacts. Taken together, however, the impact on human health – on people’s lives, in effect – is substantial: injury, an increase in cancers and infectious diseases, birth defects and neurological illnesses, eye cataracts, respiratory illness, hunger and malnutrition, suppression of immune systems, reduced ability to fight off other illness and disease (MA 2005). Much of the recent public attention to environmental change and health has focused on (even come to be dominated by) climate change. The Intergovernmental Panel on Climate Change (IPCC) confirms, with fairly high degrees of confidence, that climate change is implicated in a growing burden of disease and premature deaths. Those adverse impacts, which far outweigh likely positive impacts on human health, include an increase in cardiovascular and respiratory disease; a growing disease risk resulting from floods, droughts and contaminated water; hunger and malnutrition associated with reductions in agricultural yield; and a likely increase in other infectious diseases, particularly those that are transmitted by water and insects.
Defining the ‘global’

The global reach of the adverse health impacts of problems such as climate change and ozone depletion is clear. These are global commons issues, with health burdens that are dislocated from their causes. Other environmental problems which impact adversely on human health, such as the dumping of hazardous and toxic wastes, or the short- and long-range dispersal of other forms of pollutants are also fairly easily understood as challenges for the global agenda. They generate transboundary externalities, including health impacts that are so widespread, even if uneven in impact, as to be matters of shared concern that governments cannot address alone.

As a matter of scale, the ‘global’ in environmental change and human health is not confined to problems associated only with the global commons or with the displacement or dispersal of pollutants and wastes across borders. Many examples of environmental change that seem to have only local causes and consequences are tied up in the practices of a globalised political economy. Economic globalisation – the freeing up of trade, capital, labour and technology – has changed patterns of production, consumption and investment and, as a consequence, the patterns of supply, use and disposal of resources and environmental services. This has enabled major centres of economic and productive power to draw on the ecological capital of other (usually developing) countries or poorer communities. In such a complex world, even local economic decisions can be the result of demands and choices made by consumers or by corporate actors elsewhere. The diversion of land from subsistence farming to intensified agriculture or the diversion of water from agriculture to industry, with the possible loss of food security and biodiversity and increase in malnutrition and pollution related illnesses for example, can be read as a function of the global spread of corporate agribusiness and manufacturing investment, or western consumer demand for anything from flowers to soybeans, or industrial demand for processed raw materials to service global manufacturing.

The human health impacts of environmental change are also global in scale because of their links to the development agenda. The pursuit of development through economic growth, especially in the absence of effective or effectively implemented environmental management standards, can constitute a source of threats to human health. A growing health burden and weak health sector undermines development efforts and poverty alleviation. Developed countries are not immune to the kinds of adverse health impacts described above. But it is developing countries for whom these constitute the most serious challenges for economic and social policy. The IPCC is clear that the adverse health impacts of climate change will be greatest for those countries and peoples who have contributed least to global greenhouse gas emissions and concentrations (flows and stocks) – low income countries and, within those countries, the urban poor, the elderly, children, traditional societies, subsistence farmers, and coastal populations (Parry et al. 2007, p. 393). Poorer countries are less able to manage the output and disposal of hazardous and toxic wastes and pollutants, including those that are ‘dumped’, often illegally, from elsewhere in the world. As a result, local communities face greater waste and pollutant-related health risks than those in developed countries. At the same time, health infrastructure in lower-income countries is often under-funded, and access to what health services do exist is frequently restricted for those who
already live in poverty and are most vulnerable to environmentally-generated illness and disease.

**Thinking ethically**

These inequities in vulnerability, impact, resilience and ability to respond help to define the global dimensions of environmental change and human health in ethical terms. They call for equity, fairness and dignity to be understood as a global condition in which those who are already the most disadvantaged, especially through conditions not of their own making, are not further disadvantaged. As a result, ‘we have obligations to help the poor overcome the effects of inequalities’ – in this case the unequal impact of environmental change on human health – ‘even if we have had no part in creating them’ (Linklater 1999, p.476). In ethical terms, this is often argued to constitute a global obligation on the part of the rich (countries and people) that derives from an ability to pay – the Good Samaritan argument. That ability is measured not only in terms of financial resources, but also in terms of the technological resources and expertise in both environmental management and healthcare possessed by developed countries.

There is a further and often contentious step in this ethical apparatus of defining the ‘global’. Dobson argues that these are ‘relationships of actual harm’ (2003, p.31; emphasis added). Not all harm is intentional and deliberate. It can arise through unintended consequences and negligence or ‘the failure to take reasonable precautions to prevent the risk of harm to others’ (2002, p.330; emphasis added). It is difficult to argue that the suffering of illness, disease and injury arising from environmental change not of one’s own making is not a form of harm. And, to return to the unequal pattern of risk and vulnerability described above, it is difficult to refute the argument that at least some of this harm, even if unintended, arises through negligence and failure on the part of the rich to address the causes of environmental change that have both transnational and global health impacts.

**Global governance responses: practices, principles and rules**

As environmental, developmental and ethical challenges, these are matters of global concern that both require and demand global cooperative responses. Global governance can be defined as ‘efforts to bring more orderly and reliable responses to social and political issues that go beyond the capacities of states to address individually’ (Gordenker & Weiss 1996, p.17). It involves not just institutions in the organisational sense, but also the principles and practices that inform rule-systems and international agreements and the ways that governments, intergovernmental organisations and other actors cooperate on those orderly and reliable responses.  

The link between environmental change and human health is not entirely new to the international agenda and even a brief canvass of existing multilateral agreements and cooperative arrangements yields a wide-ranging set of rule-systems and governance arrangements. The 1947/1994 General Agreement on Tariffs and Trade (GATT) lists public health concerns as one of the few environment-related justifications for restrictions on international trade. Regional agreements such as the 1979 Convention on Long-Range Transboundary Air Pollution have been motivated in part at least by worries about the deleterious effects of pollutants on human health. These kinds of concerns are now scattered throughout key multilateral environmental agreements. Not surprisingly, some deal specifically with pollution and waste. Both the 1985 Vienna Convention and the 1987 Montreal Protocol on ozone depletion include as key concerns the adverse impact on human health of ‘modification of the ozone layer’ and the concomitant need to protect human health. In the 1989 Basel Convention on the Transboundary Movement of Hazardous Waste, Parties indicate that they are both ‘aware of’ and ‘mindful of’ the risk of damage to human health caused by hazardous and other wastes. The 1998 Rotterdam Convention on Prior Informed Consent also pays attention to the ‘harmful impacts on human health… from certain hazardous chemicals and pesticides in international trade’. Health concerns resulting from exposure to persistent organic pollutants (POPs), ‘especially in developing countries’, underpin the 2001 Stockholm POPs Convention.

These expressions of concern are not confined to pollution agreements. The long preamble to the 1992 UN Convention on Biological Diversity (CBD) notes that the ‘conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population’. Public health is central to the 2000 Cartagena Protocol on Biosafety adopted under the CBD. Biosafety is specifically understood to encompass ‘the need to protect human health and the environment … from the possible adverse effects of the products of modern biotechnology’ (CBD 2000, p.1). Article 1 of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) recognises that the adverse effects of climate change – those which the Convention is intended to avoid or minimise – includes those that could
have ‘significant deleterious effects’ on human health and welfare. The preamble of the 1994 UN Convention to Combat Desertification is ‘mindful’ that desertification and drought are linked to ‘important social problems’ including ‘poor health and nutrition and lack of food security’.

Global governance involves more than declaratory statements in treaty preambles and in plans of action. International agreements and arrangements and dialogues also establish the principles that should guide governments in addressing environmental change and human health.

This relationship between environmental degradation, human health and development has also featured in key action plans adopted and endorsed by the international community. Chapter 6 of Agenda 21, the programme for action for sustainable development adopted at UNCED in 1992, was devoted to protecting and promoting health care in the context of sustainable development. It recommended a range of programmes to ‘achieve health for all by the year 2000’ (UN 1992: Para 6.4) costed, for the period 1993 to 2003, at approximately $US51 billion. The abject failure of that objective is evident in the Millennium Development Goals (MDGs) in which health features prominently. This includes halving, by 2015, the proportion of people suffering from hunger and the proportion of the population without sustainable access to safe drinking water and basic sanitation. Health issues – including ‘clean water, sanitation … food security, chronic hunger, malnutrition … and endemic, communicable and chronic diseases’ – were one of five priority sectors in the so-called WEHAB agenda at the 2002 Johannesburg World Summit on Sustainable Development (UN 2002, paras 18 and 19).1 We can add to Agenda 21, the MDGs, and the Johannesburg Plan of Further Implementation, multilateral efforts such as the Conferences on Health and Biodiversity (COHAB), the Environment and Health Ministerial Conferences convened by the European Environment and Health Committee, and the European Union’s Environment and Health Strategy and Action Plan on Environment and Health.

Global governance involves more than declaratory statements in treaty preambles and in plans of action. International agreements and arrangements and dialogues also establish the principles that should guide governments in addressing environmental change and human health. Some of this has involved efforts to link human health to human rights. The 1972 Stockholm Declaration declares that people have the ‘fundamental right to … adequate conditions of life in an environment of quality that permits a life of dignity and well-being’. Principle 1 of the 1992 Rio Declaration states that human beings are ‘entitled to a healthy and productive life in harmony with nature’ although it is not clear from the Declaration whether entitlements differ from rights. The 1994 Draft Principles on Human Rights and the Environment establish that ‘all persons have the right to a secure, healthy and ecologically sound environment’ and elaborated more specific rights to ‘freedom from pollution, environmental degradation and activities that threaten life, health… [and] well-being’ (UN ECOSOC 1994, p. 75). However the Draft Principles have never been adopted by the UN General Assembly and claims about a human right to a clean environment have an uncertain status in international law.

Several other principles embedded in MEAs and other agreements and arrangements address the human health impacts of global environmental change. The most prominent are the precautionary principle, the principles of solidarity and equity, and the principle of shared responsibility, the latter entrenched in the Rotterdam Convention. The precautionary principle (which many governments still prefer to call an ‘approach’) requires that the lack of full scientific certainty, in this case about the impact on human health of pollutants or degradation of environmental services, should not be used as an excuse to defer action. The principles of equity and solidarity appear in various guises in regional agreements such as the 1994 Helsinki Declaration on Action for Environment and Health in Europe and the 1999 European Protocol on Water and Health but also in many of the global MAs described above which pay particular attention to the needs of developing countries. Underpinning all of this is a declaratory commitment to ‘determined’ action, to ‘speedy action’ and, from the preamble to the Basel Convention, to the principle that ‘States are responsible for the fulfilment of their international obligations concerning the protection of human health.’

The specifics of those obligations are established in the guidelines, procedures and rules adopted in the international agreements described above. Governments are required to reduce to a minimum the generation of pollutants and wastes that affect human health. They are supposed to minimise the adverse effects of environmental change on human health.

1 The other WEHAB sectors were water, energy, agriculture and biodiversity.
Governments are not fulfilling their obligations.

As an area of policy and research, global environmental change and human health is characterised by significant knowledge gaps. As the ESSP GECHH Science Plan observes, ‘there is still much to be learnt about the basic relationships between environmental changes and human health risks’ (GECHH 2007, p.14). The discussion above shows that we have a broad understanding of the contours of global governance arrangements for GECHH. But we require much more systematic research on exactly what international initiatives are being undertaken, the extent of financial and technical support, how international efforts integrate prevention and adaptation at multiple scales, and how they address the ethics of inequities in risk, vulnerability and resilience, taking people and their communities (not just countries) into account. Private, and public-private, governance arrangements involving nongovernmental organisations, civil society groups, and the corporate sector, are increasingly prominent in both environment and health sectors but we know little about how these function to address the human health impacts of global environmental change. Building these global governance questions into current research will help to broaden and deepen ESSP and IHDP research commitment to understanding the human dimensions of global environmental change and human health.

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through adopting various control mechanisms and regulatory actions. They are expected to establish implementation plans of various kinds, take human health impacts into account in developing social and environmental policies (or, at least, ‘carefully consider’ those impacts), to harmonise their efforts in doing so (where appropriate) and ensure that they consult stakeholders, including vulnerable groups, in the processes of developing policy.

Governance gaps: where to now?

Governments are not fulfilling their obligations. As well as raising questions of accountability (another theme in the IHDP Earth System Governance project), this identifies a ‘pressing need for international initiatives to fill the gaps between the environmental sector and the health and development communities’ (COHAB 2005, p. 4). Existing MAS focus on preventing pollutants, waste and other environmental impacts that can have deleterious impacts on human health but say little on how to manage those adverse impacts when they do occur. Global strategies for prevention need to be supplemented with adaptive interventions to deal with the adverse impacts of global environmental change. There is growing recognition that this requires effective surveillance and early-warning – and better methodologies – for monitoring health vulnerability, risks and impacts. It requires effective partnerships between health and environment sectors, international support (including financial and technical support) for public health systems especially in developing countries, equitable access to those systems for people most at risk, and inclusive and site-specific strategies for building social resilience in the most vulnerable and disadvantaged groups and communities.
Can syndromic surveillance be a valuable tool for enhancing the responsiveness of public health to global change?

The verdict on the usefulness of syndromic surveillance is pending. Opinions range between stressing its potentials for a low-cost warning of (unknown) public health threats, such as newly emerging infectious or environmental diseases earlier than by traditional surveillance systems and its limitations due to a lower specificity and a higher number of false alerts compared to disease-specific surveillance. While being an established supplement to traditional disease surveillance methods in the USA and the UK for some years, continental Europe, the European Union, and many other countries around the world continue to discuss whether there is an added value of this approach.

During the 2nd European Public Health Conference held in November 2009 in Lodz, Poland a session posed the question: “Syndromic surveillance in Europe – Needed or Needless?” The answers gathered by a half-standardised survey mirrored somehow the inconclusiveness, with at least 15% of public health research and practice representatives attending the session answering “not sure”. The respondents also provided clear insights into the reasons why syndromic surveillance is not applied at their services or in their studies. It is not so much the perceived or actual high number of false alerts but rather a lack of experience with or knowledge about syndromic surveillance and the missing link to the part of the health sector that could provide syndromic data (cf. figure 1).

What is the discussion around syndromic surveillance?

While being a well-established concept for routine surveillance in some developing countries, the concept of syndromic surveillance attracted new interest in the developed world after the 2001 terrorist attacks. Since then, the approach has been applied and researched mainly in Anglo-American countries for the purpose of early detection of bioterrorist events. In Europe, facing new health threats from heat waves and emerging infectious diseases, syndromic surveillance systems are now gaining new interest.

Syndromic surveillance does not replace but supports existing public health surveillance structures. Pre-diagnostic, routinely and electronically collected data, often gathered for a different purpose can be automatically analysed. Examples of the types of data that can be used are over-the-counter drug sales, calls to health advice hotlines, emergency department chief complaints, work or school absenteeism information, or internet search behaviour. Syndromic surveillance systems can detect respiratory and gastrointestinal diseases, influenza-like illness and environmental threats such as heat-related illness. Success seems to be highly dependent on the syndrome that was chosen as proxy for the health threat and on the respective data source. Over the years, different temporal and spatial statistical algorithms have been developed to improve the timeliness of early detection of public health events.

Parallel to the improved performance, the discussions about the general usefulness of syndromic surveillance continue: “if syndromic surveillance is the answer – what is the question?” (REINGOLD 2003).

Two general limitations are often mentioned in the literature on...
syndromic surveillance: a high number of false alerts and a low rate of specificity or undefined representativeness of the population under surveillance. On the other hand, there are several potentials that may outweigh these limitations and provide a rationale for the use of syndromic surveillance: timeliness, sensitivity, flexibility, simplicity, and cost-effectiveness. What is the evidence?

**Strength no. 1: timeliness**

Early or earlier detection of a health threat compared to traditional surveillance is supposed to be the main asset of syndromic surveillance (figure 2). BURKOM ET AL. (2004) for example estimated for different syndromic surveillance data sources an average of approximately one week earlier detection of respiratory and gastrointestinal illness in the USA (time between onset and identification). Despite the many studies describing or evaluating syndromic surveillance systems, the indicator of timeliness in terms of the point in time an event is identified by syndromic surveillance systems compared to traditional surveillance systems, is often not quantified. One underlying problem is the difficulty to assess the time from the onset of a health-related event until the availability of information to the public health agency that is in charge of controlling that event. Another problem is that syndromic surveillance data is available in near real-time (e.g. at least daily), while reference surveillance data often have a time lag of a couple of days or even weeks. This makes detailed comparisons more difficult and most assessments report “a similar onset” (RITZWOLLER ET AL. 2005; GREENKO ET AL. 2003; BORK ET AL. 2006). Delays in reporting/transferring data for analysis to a public health institution are easier to capture. Mainly, this is due to manual data collection which also results in lower data quality and validity (CARRICO & GOSS 2005; DAS ET AL. 2003; JEFFERSON ET AL. 2008; TRAVERS ET AL. 2006). Furthermore, the acceptance of surveillance systems among those collecting the data (e.g. clinical staff) is low. Therefore, in order to fulfill the task of “buying time”, syndromic surveillance systems have to function automatically.

**Strength no. 2: flexibility**

Flexibility is another major asset of syndromic surveillance systems as compared to traditional surveillance systems. Syndromic surveillance can easily be adjusted to various communicable or non-communicable health threats. Originally motivated by threats of bioterrorism, many applications were developed for syndromic surveillance. Seasonal influenza monitoring based on emergency department data is already called a “common extension” of syndromic surveillance (BUHLER ET AL. 2009, P. 174). VALENCIANO ET AL. (2004) describe the use of syndromic surveillance for zero-surveillance of rare diseases in Serbia. Health care professionals collaborating in syndromic surveillance systems (as data provider) make use of syndromic surveillance results for their health service’s resource planning (BUHLER ET AL. 2009). Syndromic surveillance systems are successfully applied as an ad hoc analysis tool after disasters, as they are rapidly deployable, can be maintained in difficult circumstances, and results can be achieved quickly without complex or intensive analysis methods. Sometimes, this kind of surveillance system is the only one available (e.g. as described by VALENCIANO ET AL. (2003) in the context of post-war Iraq). Many studies address the utility of syndromic surveillance during special events and mass gatherings (e.g. MEYER ET AL. (2008) on the 2005 G8 summit in Scotland).

**Strength no. 3: cost-effectiveness**

In general, costs are rated low for syndromic surveillance systems (KIRKWOOD ET AL. 2007; HEFFERNAN ET AL. 2004; SMITH ET AL. 2006). The costs vary also between manual (higher costs) and automatic systems (lower costs), as the costs for technical equipment are much lower compared to staff costs. Cost-effectiveness is also one reason why syndromic surveillance is applied in resource limited settings, such as developing countries, as the only form of disease surveillance (e.g. in rural areas (LA RUCHE ET AL. 2000) or in the context of disasters and wars. Counteracting the cost-effectiveness of a syndromic surveillance system are high staff costs for responding to alerts. This is mainly due to the tendency of syndromic surveillance to produce a higher number of false alerts, as the specificity and validity are lower compared to laboratory-based surveillance. As a consequence, there is a risk of losing the advantage of

![Figure 1A: Syndromic surveillance in Europe: Needed or Needless?](https://example.com/image1)

© 2009 SIDARTha project. Source: Half-standardised survey among 20 participants of the session “Syndromic Surveillance in Europe: Needed or Needless?” at the 2nd European Public Health Conference in Lodz/Poland (27 November 2009; respondents are working in public health practice and research; survey accomplished by SIDARTha consortium.)
timeliness due to scarce public health resources for investigation (e.g. BALTER ET AL. 2005). Therefore, any syndromic surveillance system should be adjusted to the local/regional circumstances to find its best performance level between validity and sensitivity for a certain syndrome, a certain time span and a certain area/population size. AS LEWIS ET AL. (2002, p. 185) warn: “any [syndromic surveillance] system is a tool and not the answer in or of itself”.

How can syndromic surveillance be useful in response to global changes?

Syndromic surveillance has been tested and assessed for various health threats that may occur suddenly or seasonally. The experiences also show its usefulness in the context of health threats related to global change, especially for extreme weather events and emerging infectious diseases.

Post-disaster situational awareness

Europe has faced an increasing number of extreme weather events, such as severe winter storms, floods, and heat waves over the last few years (COMMISSION OF THE EUROPEAN COMMUNITIES 2009). As projected by the Intergovernmental Panel on Climate Change, the highest climate change-induced health risks in Europe are going to originate from an increasing frequency and severity of extreme weather events (CONFALIONERI ET AL. 2007). After Hurricane Katrina in the USA in 2005, local and national public health authorities initiated syndromic surveillance of the people in evacuation centres one week after Katrina’s landfall. The system was evaluated as a timely reporting tool for potential outbreaks and for monitoring the development of existing chronic conditions. It was recommended to incorporate syndromic surveillance into response plans for future disasters (MIRHAI ET AL. 2006; MURRAY ET AL. 2009). Similarly, syndromic surveillance systems were successfully set up as situational awareness tools in the aftermath of the terrorist attacks in London in 2005 (SMITH ET AL. 2006) and New York in 2001 (Syndromic surveillance for bioterrorism following the attacks on the World Trade Center – New York City, 2001/2002) in order to assure that no public health event (e.g. infectious disease outbreak, further bioterrorist event) followed the original events. They were also used for general monitoring of the health impacts after the events. A recent example from Europe, though not related to global change, is the ad hoc surveillance in the aftermath of the Icelandic volcanic ash plume covering Europe in April 2010. Here, two different syndromic surveillance systems rapidly provided evidence that no health impact was identifiable in the UK (Elliott ET AL. 2010) and in three regions in continental Europe (ROSENKOETTER ET AL. 2010).

Early warning during heat-waves

The threat of heat-waves has attracted the attention of the public health sector in Europe following the aftermath of the 2003 extreme temperatures. Societal changes have increased the proportion of populations vulnerable to extreme heat, such as the elderly or the socially deprived. Syndromic surveillance is viewed as one aspect of enhancing the public health response to heat waves. LEONARDI ET AL. (2006) reported on a syndromic surveillance approach using the information coming from the NHS Direct telephone helpline on heat/sunstroke, especially for confirming any effect to public health. The NHS Direct system had an alert one day after the temperature increased in the 2006 heat wave (SMITH ET AL. 2006). MASTRANGELO ET AL. (2007) analysed hospitalisation rates in Italy during a heat-wave. The syndromic system in France provided earlier information compared to the traditional system based on mortality data and the overall number of emergency department visits (JOSSEAN ET AL. 2009). There is a clear indication that emergency data based syndromic surveillance systems detect heat-related illness in elderly populations (CERUTTI ET AL. 2006; MASTRANGELO ET AL. 2007). JOSSEAN ET AL. (2007) and KOVATS, HAJAT & WILKINSON (2004) also highlight the need to use specific diagnoses/chief complaints for syndromic analyses. JOSSEAN ET AL. (2007) identified significantly increasing numbers of elderly patients, especially with hyponatremia, dehydration, and hyperthermia and children with hyperthermia. KOVATS, HAJAT & WILKINSON (2004) found a higher number of respiratory diseases for the elderly and a higher number of renal and respiratory diseases for children. In the technical summary of the findings from the EUROHEAT project, MENNE & MATTHEIS (2009) recommend the expansion of existing
syndromic surveillance systems in Europe to heat-related syndromes where possible.

**Detection of emerging infectious diseases**

Against the background of newly emerging international public health threats the World Health Organization (WHO) revised their International Health Regulations in 2005 which entered into force in 2007. It provides further legal impetus for all WHO member states to develop and implement early outbreak detection systems for known, as well as unknown, causative agents (WHO 2005). During the SARS outbreak in 2003, the syndromic surveillance system implemented in New York City was used to assure that the city was not affected (Steiner-Sichel et al. 2004). The recent A/H1N1 influenza pandemic provides another case in point. Valdivia et al. (2010) compared Google Flu Trends with sentinel physician networks in 13 European countries and found a fair correlation with the number, highest for countries where the internet is frequently used for searches related to health. Different traditional and syndromic surveillance systems were used to assess the impact of the A/H1N1 influenza pandemic in New South Wales, Australia by the New South Wales Public Health Network (2009). While mortality surveillance did not support influenza surveillance because no rise in mortality was identified, health services, particularly emergency departments and intensive care units, were substantially affected by the epidemic, thus being able to provide valuable information based on morbidity. Additionally, by not using defined case definitions, but syndromes or just an increase in numbers, syndromic surveillance has the potential to detect unknown or undefined health threats and diseases (Buehler et al. 2004). When talking about emerging infectious diseases, the emerging and developing countries of the world play a crucial role. Syndromic surveillance, being a long known concept in many developing countries, might also support the early detection of later global epidemics.

**What should a European approach to syndromic surveillance look like?**

The International Health Regulations 2005 revision (WHO 2005), the Parma Declaration on Environment and Health (WHO Regional Office for Europe 2010), and the European Commission White Paper on Adaptation to Climate Change (Commission of the European Communities 2009) all call for improved monitoring and surveillance in Europe. Further, the European Centre for Disease Prevention and Control (ECDC) is focusing on preventive adaptation measures towards climate change impacts related to communicable diseases. Their recently established “Expert Group on Climate Change” identified “lack of awareness, lack of funding, and lack of data” as the main current problems to address or estimate the health impacts of climate change (ECDC 2009, p. 5).

Europe is mainly characterised by traditional surveillance, which also holds true for early warning systems providing room for improvement through a Europe-wide syndromic surveillance initiative. At the European level, the surveillance landscape is characterised by Dedicated Surveillance Networks (DSN) (ECDC 2005-2010a) of member states informing each other and the European Commission and ECDC about confirmed disease outbreaks or other public health threats in their countries. These networks will, in the near future, be incorporated in a standardised way into The European Surveillance System (ECDC 2005-2010b) operated by ECDC, which will form the main entry point for European public health surveillance in the future. The European Commission established surveillance, early warning/alerting and reporting systems for public crises – directly (Directorate General for Health and Consumers) and indirectly (other Directorates General, e.g., EURAMET monitoring radioactivity) related to health. Major examples are the Early Warning and Response System (EWRS) and Rapid Alert Systems (RAS); interactive virtual message exchange boards for member states and the European agencies on confirmed disease outbreaks and...
health threats, including biological, chemical and radio-nuclear threats. MedISys (Medical Intelligence System) is the only system that automatically and continuously scans postings on websites from serious sources dedicated to health to identify potential public health threats (European Communities 2007) (Figure 3).

There are also a variety of initiatives in Europe, active in syndromic surveillance (Box 1). Most are either locally/regionally confined and it is difficult to assess if the systems are running on a regular and continuous basis. In France and the UK, there are systems established at the national level. Two European initiatives (Euro-MOMO, EuroHEAT) only marginally touch syndromic surveillance having different foci. A new project of the EU Public Health Programme is seeking a review of all syndromic surveillance activities in Europe to define a harmonized approach for the future (Triple s-aGE, Grant Agreement No. 20091112).

**European syndromic surveillance system SIDARTHa**

Until now, the only “true” European approach (i.e. same system approach applied in several member countries) towards syndromic surveillance has been the European Commission co-funded project SIDARTHa (European Emergency Data-based System for Information on, Detection and Analysis of Risks and Threats to Health; Grant Agreement No. 2007208). The initiative of emergency medical care professionals aims at implementing and evaluating a real-time syndromic surveillance system at the local and regional level. The pilot syndromic surveillance system has been set up in four European regions: State of Tyrol/Austria, Capital Region/Denmark, County of Goeppingen/Germany, and Autonomous Region of Cantabria/Spain. SIDARTHa analyses pre-hospital emergency medical dispatch, emergency physician service, and in-hospital emergency department data by multiple temporal and spatial-temporal detection algorithms. The investigated syndromes are Influenza-like illness, respiratory diseases, gastro-intestinal diseases, heat-related illness, intoxications and unknown health threats (via aberrations in the overall volume of emergency cases).

A recent case study on the A/H1N1 pandemic in 2009 evaluated the performance of the SIDARTHa pilot syndromic surveillance system regarding timeliness, specificity, and sensitivity. The analysis of the performance of SIDARTHa was done in comparison to sentinel data from the respective regional public health authorities. Temporal detection algorithms such as c1, c2, c3 (cf. FRICKER, HEGLER & DUNFEE 2008) were applied on the daily number of Influenza-like illness cases in emergency departments in Leuven/Belgium and Cantabria/Spain. The epidemic curve significantly correlated with the respective reference data of traditional sentinel surveillance systems. Aberrations from expected values were identified earlier or at least at the same time as they were recognized by the public health authorities.

**Specific European syndromic surveillance characteristics**

A syndromic surveillance system in Europe must support the very well established national and European structures of surveillance and early warning. It must also take into account the diversity of health systems, data providers and risk groups for specific syndromes (e.g. the elderly population during heat waves). Such a flexible but still Europe-wide applicable approach
Syndromic surveillance can only be achieved when focussed on and adjusted to the local and regional level. This also can enormously reduce the common problem of data security (data analyses at the local/regional level). The system and its case/syndrome definitions have to be flexible and open enough to allow different institutions to participate and adjust a syndromic surveillance system to their circumstances. The link to the responsible national or European health authorities needs to follow the established reporting ways via the local/regional health authorities.

Syndromic surveillance improves the ability of the European states to meet the requirements of the International Health Regulations 2005. Low costs in implementing and maintaining the system and high flexibility undisputedly argue for the use of a syndromic surveillance approach. These potentials will foster acceptability across Europe. Improved generic preparedness and crisis management of public health and health care institutions during health crises can further be achieved when implementing syndromic surveillance systems based on collaboration between parties involved.

In the future, syndromic surveillance can be used not only during acute events but also for long-term health monitoring of the main causes of morbidity and mortality across Europe (i.e. infectious, cardiovascular, cerebrovascular, chronic pulmonary diseases, and injuries).

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References
Towards a sustainable health policy in the anthropocene

U. Oswald Spring

This essay links analyses on environmental deterioration and health efforts in a wider socio-economic and cultural context. It reviews effects of the neoliberal economic model (based on wasteful fossil energy, social inequality, consumerism, fashion, and growth concentrated in small elites) on the environment and on human well-being. If ‘business as usual strategies’ prevail (Oswald & Brauch 2011) the planet and world society may face, during this century, the societal impacts of ‘dangerous climate change’ (Schellnhuber et al. 2006). While this model has benefited a minority of the global population, it has and will affect regions, cultures, and social classes differently with negative impacts on international security (UN-SG 2009), thus posing new equity issues. Southern countries have usually been the main victims, suffering most from climate-induced physical (temperature and sea-level rise, precipitation change, increase in the number and intensity of natural hazards such as drought, heat waves, storms and floods) and societal impacts (famine, food protests, migration). Further, the coexistence of both traditional ill-
nences and modern ones, related to the pollution of water, air and soil (intoxication, respiratory, kidney and skin problems) and the transformation of diet (diabetes, cardiovascular illnesses), have exacerbated their vulnerability.

At the conceptual level, this paper explores the complex interaction between anthropogenic drivers, the impacts of and the policy responses to climate change, their interrelationship with the dominant productive system of globalisation and the effects on human health. It also investigates a preventive concept of sustainable health at affordable costs, based on the restoration of environmental services and the integration of traditional and modern knowledge. In future scenarios with severe climate change impacts, humankind, international society and the business community, as well as the community of states and international organisations will have to face many challenges to their well-being and survival, which may be more severe than any security threat that states have experienced in the past (Brauch et al. 2009, 2011).

These new and non-military security dangers in the Anthropocene have already resulted in a new ‘soft’ security agenda that fundamentally differs from the hard security policies of the past century. To deal with these new security risks and threats, a new policy of global health should complement the prevailing ‘state-centred’ approach to health security based on a widened understanding of security that is ‘people-centred’ (Annan 2005).

Such a human security approach to health (Chen et al. 2003, 2003a, 2003b, 2003c) may focus on all four pillars of a widened security concept understood as ‘freedom from fear’ (Human Security Report 2005); ‘freedom from want’ (Ogata & Sen 2003; Brauch 2005); freedom to live with dignity, justice and equity (Annan 2005; Sen 1995); and ‘freedom from hazard impacts’ (Bogardi & Brauch 2005; Brauch 2005a; Oswald 2008). Health security is therefore intimately related to a sustainable management of the environment (Bookchin 1988). Thus, as a holistic policy concept it combines four other key concepts: sustainability, development, security and health. Such an integrated strategy can offer both a conceptual framework and guidelines for translating anticipatory learning into proactive policies and measures—a strategy of sustainable development combined with a vision of sustainable health. In synthesis, this represents the vision or policy perspective of a combined human, gender and environmental security concept or of a huge2 policy approach to security.

The paper first explores the evolution of the term ‘health security’ by asking which strategies, policies, and measures of sustainable development and preventive health behaviour can contribute to a healthy society and environment. Then it poses the question how the environment is related to health and how environmental strategies, policies, and measures can influence values, change behaviour, and pave new avenues for an integrated health prevention and sustainable environment. This proposal implies a negotiated model of development that decreases pollution, environmental threats and social inequality and vulnerability. Later, it analyses the effects of climate change (CC) and its impact on different epidemiological patterns and the upcoming of new ones. Existing social vulnerability and vulnerability assessment are crucial to understand the often negative outcomes. Finally, it discusses both urban air pollution and water-borne and vector illnesses in Mexico. In the conclusions, the essay proposes an integral sustainable health approach to deal with the new threats and challenges posed by CC and social vulnerability. This may reduce social, cultural, and economic gaps without affecting the fragile equilibrium of the Earth and its threatened ecosystems.

Health security: a new concept with an integral understanding of health policy

Leaning (2009) has proposed a wider and people-centred understanding of health security, where underlying globalisation, demographic and environmental changes and particularly climate change effects, the growing disparity between rich and poor nations and people, as well as migration, are integrated. Leaning’s understanding of health security goes beyond the narrow approach of military security3 and links it to the fulfilment of the Millennium Development Goals (MDGs) and to the human security approach

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1 The term Anthropocene was coined by Crutzen (2002) and Crutzen & Stömer (2000) and describes the current period of Earth history since the Industrial Revolution when human activities have interfered with the Earth system.

2 The huge concept (Oswald 2007, 2009) is based on a sustainable culture of peace, but goes a step further by including wider and deeper security concerns. This concept complements the formal policy approach on human security by UNDP (1994) by extending the traditional scope of security (horizontal widening) from political and military to economic, social and environmental security. In relation to the actors it includes a top-down and also a bottom-up self-reliant perspective. By vertical deepening the referent objects shift from ‘state’ to ‘human’ and ‘gender’ security as well as from ‘national’ to ‘regional’, ‘global’ but also ‘societal’ and ‘local’ security. Since the 1970s a sectoralisation of security with regard to energy, food, health, water and livelihood security was used by governments, international and societal organisations (Brauch et al. 2009).

3 After the Cold War the prevailing narrow concept of military and political security threats was widened and deepened (Buzan et al. 1998) to Wolfers (1962) classic realist definition of security. Due to an absence of objective threats and subjective fears, social constructivists have added an intersubjective understanding where security refers to ‘what actor’s make it’ by referring to their policy declarations or ‘speech acts’. These are central for Wæver’s theory of ‘securitisation’ (Wæver 1995, 2000, 2008) by moving an issue of ‘utmost importance’ from the political to the security realm, thus legitimising ‘extraordinary measures’. This process of securitization has only succeeded when the audience (population) has supported it. Thus, the recent securitization of the AH1N1 influenza by WHO and many governments has largely failed, as in many countries both physicians and the people remained unconvinced of the need for a massive vaccination.
Towards a sustainable health policy in the anthropocene

(UNDP 1994) that has been adapted to changing conditions posed by climate change, population growth, urbanization and environmental deterioration (Brauch et al. 2008, 2009).

On the other hand, the World Health Organization (WHO 2002a, 2003; WHO/FAO 2003a) has promoted a narrow and state-centred health security concept that was also influenced by the events of September 11, 2001 and by the potential threats of biological weapons and terrorism (Rodier & Kindhauser 2009). With SARS and the AH1N1 influenza, the outbreaks of pandemics were also integrated into its health security agenda and goals. The declaration by WHO of a global pandemic emergency has had severe effects on the economy and on jobs in some affected countries.4 This state-centred understanding of health security included recommendations to combat the pandemic with a global vaccination and severe hygienic practices to prevent a global spread of the pandemic, as well as developing specific drugs to combat the illness. Policymakers in industrialised countries emphasised the protection of their population against external threats, unknown epidemics and terrorism. This narrow understanding of health security was globally promoted by WHO (2003) at the request of and in close consultation with many industrialised countries. Poor countries were confronted with new political pressures to buy drugs and vaccines to fight against these epidemics, while other more urgent health issues could not be funded due to limited financial resources.

Therefore, in several developing countries the dominant state-centred understanding of health security by WHO, coupled with fears of hidden national security agendas of powerful countries, have contributed to a breakdown of mechanisms for global cooperation such as the International Health Regulations (William Aldis 2008). Nevertheless, globally shared epidemiological data have been interchanged, but several southern countries complied with this requirement often reluctantly.

WHO’s narrow definition and only partial elaboration of its health security concept (WHO 2002, 2002b) with regard to public health requirements of developing countries have been criticised (Chen et al. 2003, 2003c). In its understanding of health security, both community-based primary healthcare but also environmental factors have not been sufficiently integrated. Thus, health workers and policymakers in developing countries, threatened by traditional and modern illnesses and increasingly affected by climate change related health problems, have insisted on a broader approach to the health security concept. In a case study on health security in North Vietnam and Bangladesh, Fischer & Salehin (2009) proposed a wider understanding of human and health security that includes infectious diseases, impoverishment, economic crises, the megacity-slum development, post-conflict and public violence that have created syndromes of illness, injury, disability and death, where the unsafe environment and the lack of access to healthcare pose the crucial health security problems for most poor countries.

Health security and environmental services

Environmental services provide the basic provision for human wellbeing and livelihood, such as clean air,
freshwater, wood fuel, fibres, construction materials and food products. The environment further offers supporting services needed in the production chain, for survival and for all other ecosystem services, such as nutrient cycling (nitrogen, sulfur, oxygen, carbon cycles). In addition, ecosystems offer other benefits resulting from the regulation of both natural and anthropogenic processes. Crucial in this relation are proactive climate policies, natural water purification, protection from the stratospheric ozone, mitigation against hurricanes and surge waves (e.g. through mangroves), the control of landslides by forests cover, but also the separation of human waste and toxics and their integration into the natural cycle.

Finally, there are immaterial, cultural and belief processes related to environmental services and the cultural heritage. These processes have facilitated the development of cultural services (food culture, religious beliefs, joy, beauty, understanding, relaxation, etc.) as essential parts of the development of human civilizations. This complex interrelationship of providing, supporting, regulating and of cultural services from the environment has offered human beings the material and imminent minimum needed for their survival. The surplus contributed to the consolidation of urban areas and to the development of civilizations that increased the potential for freedom of choice, the consolidation of social relations and the division of labour. These processes support the new understanding of widened and deepened security concerns, where the values at risk (life quality, culture and identity) and the sources of threats (by other countries and non-state actors, such as terrorist or organised crime) have shifted from the protection of national sovereignty (of the territory, the people and the system of rule) to the fulfilment of basic human needs (water, food, health), the protection (often from their own government) and empowerment of the people by supporting local resilience-building.

Nevertheless, the human pressure on nature related to demographic growth, consumerist behaviour of global capitalism, urbanization and industrial revolution with intensive use of fossil fuel have altered traditional processes of providing, supporting, regulating and of culture. These processes were responsible for the emergence of new threats to security and to human health through different mechanisms.

Environmental security was threatened (Dalby et al. 2009; Oswald et al. 2009) by direct effects, such as forest clearance and land cover change due to urbanization and agricultural processes; loss of wetland related to drainage systems; destruction of biodiversity by overexploitation and pollution; stratospheric ozone depletion with CFC gases, and climate change due to intensive fossil energy use, all of which have created new and dangerous health impacts. New epidemics, intoxications, floods, heat waves, water shortage, increased ultraviolet radiation, exposure to pollutants, water-born and vector illnesses are some of the direct threats to human health security.

There also exist ecosystem-mediated health impacts with risks of altered infectious diseases. The reduction of yield productivity and food scarcity (malnutrition, stunting), the loss of traditional medicines, stress and the increase of patterns of mental illness, but also the destruction of aesthetics and cultural diversity in languages and behaviour are undermining health security. A third impact on health security due to climate change is of an indirect nature. It relates to people who have been displaced with livelihood losses, to people displaced by modernisation processes or due to climate change impacts (sea level rise, floods, air pollution, toxic accidents, etc.). The latter could also include the inhumane conditions of slum dwellers (‘freedom from want’); refugees fleeing conflicts and war and lack of public security (‘freedom from fear’); but also the inappropriate mitigation and adaptation mechanisms to climate change (‘freedom from hazard impact’), and the reiterative economic and financial crises affecting the prospects for survival of large sectors of the population, simultaneously producing a concentration of economic wealth controlled by a small elite. While global environmental change and globalisation processes have increased global life expectancy, both have created new threats and risks for health security, often related to the modernisation process and its negative outcomes for the environment and humankind.

Impacts of climate change and of the globalisation processes for health security in Mexico

Mexico is a threshold country seriously exposed to climate change and deeply transformed by urbanization and globalisation. In 2010, 72 per cent of its population is urban and since the 1950s, Mexico City has been one of the biggest third world megacities with large slums, a highly polarised society and limited economic growth during the past two decades. The country is not only threatened by urbanization and land use changes, but also by an inadequate management of toxics. The lack of integrated land planning has also affected the high level of cultural diversity, where 62 indigenous languages are still spoken.

The profound changes of the landscape have affected water security and air quality, both distressing human health and ecosystem services. Almost all 837 hydrographic basins and 42 main rivers are polluted and together with the overexploitation and contamination of 104 of the 653 existing aqui-
factors, the negative impacts that exist are water-born illnesses (e.g. cholera, salmonella, amoebas and diarrhoea), vector diseases (dengue, malaria) and declining soil productivity and falling agricultural outputs.

The overexploitation of aquifers has dissolved minerals in the groundwater and more than 400,000 people are now affected by arsenic pollution in their drinking water (GENERAL DIRECTION OF EPIDEMIOLOGY 2008). Small children in Aguascalientes, in the central high plateau of Mexico, have chronic kidney problems and require kidney transplantations and expensive dialysis treatment (ARREOLA ET AL. 2011). Diarrhoea is a common health problem, and although treatment plants and safe water have improved the health conditions of urban dwellers, they have, mostly, not yet reached the rural population. The incidence of gastro-intestinal deaths of children under five years dropped from 212.3/100,000 in 1984 to 60.4/100,000 in 2003. Nevertheless, the ongoing climate change threats related to more frequent and stronger hurricanes have increased the threats of malaria that nearly tripled between 2000 and 2005 from 2.77 to 7.27 cases per 100,000 people/year. It is estimated that 30 per cent of the Mexican population is at risk. Finally, dengue fever increased from 2004 to 2008 in Mexico by 800 per cent, with 80 per cent of these cases occurring in the South-Southeast (GENERAL DIRECTION OF EPIDEMIOLOGY 1984-2008).

Urbanization and industrialisation has increased air pollution and people living in the megacities, especially children near highways, are threatened by chronic bronchitis and asthma. The yearly costs for hospitalisation and the death toll in Mexico City due to air pollution were estimated at about 11.1 billion dollars. Further, hospitalisation due to air-born and cardio-vascular illnesses have cost several hundred million dollars. These figures do not include the loss of workdays and the impact on the economy of families who have to pay for the healthcare of affected family members. The chronic infection of lungs and pulmonary atrophy in children in the slum regions of Netzahualcoyotl, Chalco and Iztapalapa are not reflected in these data sets. Particularly at risk are bus drivers working in the public transportation system, where according to an epidemiological study in the state of Morelos, all of them showed alterations in their upper respiration tract.

These epidemiological data indicate that not only in Mexico, but worldwide manifold vulnerabilities result from globalisation and climate change. These environment related and specific human security threats must be addressed through appropriate coping strategies according to the sensitivity of the level of exposure. WATSON ET AL. (1998, 1998A) defined vulnerability as a function of sensitivity, adaptability and exposure. Recent studies from developing countries (VILLA GRAN 2011; ARIYABANDU & FONSEKA 2009; OSWALD 2008A; FLORES & WAGNER 2011) suggest a bottom-up approach with resilience-building processes to better cope in a preventative way with the health threats that are related to climate change and are projected to spread during this century.

Some concluding ideas

A widened understanding of health security could contribute to efforts to cope with the negative health effects of global environmental change by putting on its policy agenda (in cooperation with UNEP, UNDP and IFIS) the needs to avoid the destruction and to restore crucial environmental services. This requires a widened health security concept than the state-centred focus adopted by the member states of the WHO. It requires an intersectorial collaboration among different ministries (financial, environmental, social, urban, agricultural and health) to develop an integral and sustainable health strategy. This includes the need for a global health information system.

<table>
<thead>
<tr>
<th>Developing countries high mortality (%)</th>
<th>Developing countries low mortality (%)</th>
<th>Developed countries (%)</th>
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</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>Alcohol</td>
<td>Tobacco</td>
</tr>
<tr>
<td>14.9</td>
<td>6.2</td>
<td>12.2</td>
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<tr>
<td>Unsafe sex</td>
<td>Blood pressure</td>
<td>Blood pressure</td>
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<tr>
<td>10.2</td>
<td>5.0</td>
<td>10.9</td>
</tr>
<tr>
<td>Unsafe water, sanitation &amp; hygiene</td>
<td>Tobacco</td>
<td>Alcohol</td>
</tr>
<tr>
<td>5.5</td>
<td>4.0</td>
<td>9.2</td>
</tr>
<tr>
<td>Indoor smoke from solid fuel</td>
<td>Underweight</td>
<td>Cholesterol</td>
</tr>
<tr>
<td>3.6</td>
<td>3.1</td>
<td>7.6</td>
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<tr>
<td>Zinc deficiency</td>
<td>Overweight</td>
<td>Overweight</td>
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<tr>
<td>3.2</td>
<td>2.4</td>
<td>7.4</td>
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<tr>
<td>Iron deficiency</td>
<td>Cholesterol</td>
<td>Low fruit and vegetable intake</td>
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<tr>
<td>3.1</td>
<td>2.1</td>
<td>3.9</td>
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<tr>
<td>Vitamin A deficiency</td>
<td>Low fruit and vegetable intake</td>
<td>Physical activity</td>
</tr>
<tr>
<td>3.0</td>
<td>1.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Indoor smoke from solid fuel</td>
<td>Illicit drugs</td>
</tr>
<tr>
<td>2.5</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Iron deficiency</td>
<td>Unsafe sex</td>
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<tr>
<td>2.0</td>
<td>1.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Unsafe water, sanitation &amp; hygiene</td>
<td>Iron deficiency</td>
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<tr>
<td>1.9</td>
<td>1.8</td>
<td>0.7</td>
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TABLE 1: Risk factors to health security related to different socioeconomic conditions of countries.
Source: WHO (2002)
with integrated databases on development, industrial and environmental hazards and the spread of pandemics. Thus, the member states of the WHO should reconsider their narrow and state-centred health security concept and shift to a human-centred focus, where the prevalence of basic preventive and curative health care is included. It must also include the delivery of basic health services at the local level. The combination of traditional and modern medical and environmental knowledge, and the training of local people, may support such an integral health strategy and both together could strengthen the well-being of the people and the restoration of their ecosystems.

A particular challenge is efficient land planning that establishes equilibrium among environmental services and development processes, taking population growth, environmental fragility, urbanization and sustainable management of resources fully into account. Governmental capacity and efficiency plays a crucial role for improving health security. In poor countries with multiple health threats solely, participative governance will be able to create resilience of the population to deal with the old, new and often unknown health challenges. Governmental promoted mitigation and adaptation processes against climate change are complementary to bottom-up efforts, and together, they may efficiently combat both existing and emerging health security risks.

A crucial item for complementing these processes is access to affordable and available medications and health services for the world’s poorer nations and social groups. To deal with this challenge, human resources may be trained at the local level for supporting health professionals, but drugs and treatments at available prices must also be offered to these countries. Further, special health support and education facilities must be made available for women as they are crucial in the development process. Their education not only increases the survival of their children (Álvarez & Oswald 1993), improves their health and that of their families, but it may also reduce population growth. Improved global maternal and child health programs also require actions such as full vaccination schemes to improve their immunological system, food aid for pregnant and breastfeeding mothers and for undernourished children to avoid long-term brain damages due to chronic malnutrition.

As a result of the impacts of climate change, the WHO and national governments need to systematically monitor the threats and challenges to the health of all affected people. This may also reduce the probability of an outbreak of new epidemics and could avoid the resurgence of eradicated or controlled illnesses (such as tuberculosis). Table 1 indicates that there are different health challenges facing countries with different socio-economic development. Therefore, the conceptualisation of health security should reflect these differences. While traditional disease patterns dominate in poorer countries (related to indoor and water pollution), modern and traditional epidemiological patterns coexist in threshold countries but at the same time, water-born and modern illnesses (related to, for example, overweight, cardiovascular, tobacco, alcohol, etc.) must also be countered. The latter processes also exist in OECD countries.

The Millennium Development Goals (MDGs), as well as human and health security concerns, are complementary tools and approaches for a combined management of human well-being and the environment. A poverty-related lack of education increases health problems due to malnutrition and therefore, reduces human security and environmental services. The recognition that health, development, environment and security are interlinked would allow for the alleviation of poverty levels; conservation and restoration of the environment; increase of human security and therefore in a preventive way, enhancement of human health. Thus, a wider human health security concept may be able to integrate these processes and to promote the fulfilment of the MDGs.

References
Infectious diseases account for 29 of the 96 major causes of human morbidity and mortality listed by the World Health Organization, representing 24% of the global burden of disease (WHO 2004). Infectious agents, vectors, hosts, and reservoirs are markedly affected by climate- and climatic changes (Reeves et al. 1994; Gubler et al. 2001; Peru 2008a). The following factors are of great importance, when considering the vectors: (i) vector survival and reproduction, (ii) biting rates, and (iii) incubation rate of pathogenic microorganisms inside the vector. Vectors, pathogenic microorganisms, and hosts, survive within an optimum interval of climatic conditions: temperature and rainfall are the main determinants, but altitude, winds, and length of daylight are also important (Peru 2008a). The geographic distribution of disease transmission may increase or decrease when vectors take advantage of changed climatic conditions to move into new areas, or changing conditions decrease the ability of vectors to reproduce and survive long enough for disease transmission to occur. Even small increases in the range of a vector can result in the exposure of new populations; and, because new populations often lack acquired immunity, more severe clinical diseases can occur (Aggarwal et al. 2007).

(Re)emergence of infectious diseases

Infectious diseases are caused by viruses, bacteria and other types of microbes or parasites. Only a few infectious agents cause actual disease in plants, animals, and humans; usually these are constrained geographically and seasonally by ecosystems and ecological relationships in nature. Patterns of microbe entry into the human species (sometimes as new mutants) are sensitive to climatic and micro-environmental conditions. These factors may affect the spread of microbes between humans; their more distant dissemination, and the activity of vector organisms (e.g. sand flies, mosquitoes) involved in their transmission. Human induced changes in ecosystems and in physical environmental conditions often alter these natural influences on infectious agent range and activity (WHO 2005). The pattern and extent of change in incidence of a particular infectious disease depends on the particular ecosystems affected, type of land-use/cover change, disease-specific transmission dynamics, sociocultural changes, and the susceptibility of human populations. Infectious diseases are particularly affected by:

- Destruction of, or encroachment into, wildlife habitat (particularly through logging and road building);
- Changes in the distribution/availability of surface waters, e.g. through dam/ hydroway construction, and irrigation/stream diversion;
- Agricultural land-use changes, including proliferation of both livestock and crops;
- Climate variability and change;
• Migration and international travel and trade.

Recently, there has been an upturn in the rate of emergence or re-emergence of infectious diseases. Factors contributing substantially to this trend include, among others:

• Intensified human encroachment on natural environments;

• Reductions in biodiversity (including natural predators of vector organisms).

Further contributors include:

• Habitat alterations that lead to changes in the number of vector breeding sites or in reservoir host distribution;

• Niche invasions or interspecies host transfers;

• Human-induced genetic changes of disease vectors or pathogens (such as mosquito resistance to pesticides or emergence of antibiotic-resistant bacteria).

According to CasH & NarasimHan (2000), globalisation has increased the attention paid to the international movement of people and goods. On top of expanding trade and travel, such movement accelerates the scale and speed of the transmission of infectious diseases. Most of these diseases are those once considered to be under control and more than 30 have emerged over the past decade, many with a potential for rapid spread across borders. Communicable diseases present enormous trans-national challenges that are beyond the governance capabilities of individual nations and require multi-lateral approaches (Aginam 2002).

SolTanI & osborne (1997) see environmental degradation as a common result of “business-as-usual” infrastructure mega-investments, and UNEP (2003) states that environmental deterioration may reduce up to 11 years of life expectancy, if forest conversion, biodiversity loss, soil and water degradation, air pollution, and the high level of existing vulnerability continue to impact on people’s health, in Latin America. Vaux & Goldman (1991) reviewing the impacts of dams, include as their direct impacts, the displacement of human populations, the loss of wildlife habitat and extinction of species, and the decrease in the number of fish caught downstream from the dam (leading to malnutrition among local communities). They also highlight as important indirect impacts the increase in migration and the integration of once isolated regions into the national and the so-called ‘globalized’ economies, with changes in local market structures and in income distribution, as well as an increase in conflicts between local population and migrants. According to Carvalho ET al. (2001), if the historical relationship between roads and forest loss continues, then the planned road paving will cause additional deforestation, and further biodiversity losses through logging and forest fires over the next two or three decades. Schneider (1995) recognizes that “the most direct way to reduce the rate of forest conversion is to control the rate of expansion of the road network in the Amazon”. Kaimowitz & Angelsen (1998) consider that “roads are the single and most robust predictor of frontier expansion and accompanying deforestation in tropical forest regions”, complemented by the studies of Nepstad ET al. (2001) and Alves (2002), stating that the great majority of deforestation in the Brazilian Amazon region takes place within 50 kilometres of recently paved roads.

The Commission on Development and Environment for Amazonia - CDEA (1992) confirmed this:

Highway construction in the Amazon region has had a heavy impact on the environment because of migratory movements, destruction of forests all along the roadways, and pressure on resources. The most neglected aspects have been land management, preparing the local population for change, and upgrading local government in the newly opened zones. Much of the highway infrastructure is expensive to maintain and has been abandoned or is in very poor condition, making it a burden rather than an advantage to settlers. Another factor warranting serious consideration is the high percentage of land connected to highways that have been abandoned or yields very little. It would be irresponsible to think of building more highways that would simply replicate the same problems already experienced elsewhere.

A phenomenon that raises great concern is the probable increase in migration, a relatively uncommon practice in the Andean-Amazon region that appears to be rising, and that subject border migration newcomers to precarious – and in some cases, illegal – living and work conditions that hamper their complete economic and social integration (UN International Organization for Migration 2000). Ribeiro (1992) highlights that “roads and other infrastructure work, financed by the state and implemented by powerful companies under government contracts, absorb large labour contingents, but on a temporary basis - no conditions are usually created for the permanent settlement of workers”. They are more likely to trigger a dynamic process of disrupting biological processes by clearing, forest fragmentation and conversion, and forest fires (Chomitz & Thomas 2000). Their other option is to migrate again to the nearby cities, increasing unemployment and contributing to the worsening of urban violence. Ribeiro (1992) also suggests that historically, from the 1970s, the jobs offered to migrants were, and still are, deforestation, wood extraction, cattle ranching, agriculture, and road and dam building. Another factor to be aware of is the failure of
migrants to adapt; their difficulty in living off the resources of the region is compounded by their lack of familiarity with the new environment. Certain types of malnutrition, for example, are due to the change in eating habits. “The peripheral zones – especially the Andean – are also plagued by poverty (at times, extreme poverty) and migrants come into the Amazon unprepared to cope with the new life that awaits them and unable to better their condition”, states the Commission on Development and Environment for Amazonia – CDEA (1992).

The case of Southwestern Amazonia

The Amazon Basin spans over seven million square kilometres throughout nine countries; contains the largest river system on the planet with one-fifth of its freshwater, and is host to nearly one third of the Earth’s biodiversity (Soltani & Osborne 1997). Its Brazilian part covers some 5.2 million square kilometres, represents 61% of the country’s land area, and is where some 20 million Brazilians live (12% of the Brazilian population). The pristine region known as Southwestern Amazonia represents a microcosm for the resources and challenges of the whole Amazon region. It is one of the largest contiguous blocks of tropical rain forest in the world and is the Amazonian “hot-spot” for biodiversity, with its influence area reaching from Andean ecosystems to marshes and savannas, mainly over the higher parts of the Amazon watershed.

The region includes the whole States of Acre and Rondonia (Brazil), as well as the Departments of Pando (Bolivia), and Madre de Dios (Peru) and encompasses more than one million inhabitants, including more than two dozen different indigenous groups, with their own languages and lifestyles, some of them without any contact with industrialised society. Its influence reaches some 30 million regional inhabitants living in a 500 mile radius of the Acre State.

It had been an isolated area until the end of the 20th century - a dead-end for the precarious and unconnected roads within the three neighbouring countries.

Southwestern Amazonia’s isolation and wealth, in terms of biological and cultural diversities, are threatened (Chavez et al. 2005) by the ongoing implementation of mega-infrastructure projects:

The three hydroelectric dams along the Madeira River basin, a US$ 10 billion investment to produce 10,000 MW energy (CAF-IIRS 2005) resulting in additional 2,500 miles of hydroways, will have a dramatic impact on sediment dynamics, with a serious risk of bringing to the surface the mercury from gold mining that lies on the bottom of the rivers. Considering that the Madeira River is the largest tributary to the Amazon basin in terms of sediments, this may become a health problem of even greater consequences. There are also two protected areas, indigenous archaeological sites, and parts of the legendary Madeira-Mamore Railway that are under the influence area of the dams;

Another US$ 1.5 billion investment for three major all-weather high-speed roads (Assis Brasil-Cusco; Cobija-Extrema-Iberia, and Guayaramerín-Yacumo) to link this historically isolated tri-national region to the Pacific coast, allowing increased regional commerce and transportation, especially of Soya-bean production from central Brazil to the Pacific ports (CAF-IIRS 2005). Two bridges over the River Acre, which forms the tri-national border, were inaugurated in 2004 (Brasílieá, Brazil-Cobija, Bolivia) and on 21 January 2006 (Assis Brasil, Brazil-Iñapari, Peru). The so-called ‘Pacific Highway’ is already under way (Chavez et al. 2005). The 240 kilometres of the BR-317 road, between Rio Branco and Assis Brasil (respectively, Acre’s capital city of some 260,000 inhabitants and the last Brazilian village before the Peruvian border) were paved in 2002. The 235 kilometres of dirt road between Iñapari and Puerto Maldonado are scheduled to be paved by 2009. From Puerto Maldonado to Cusco, another 365 kilometres will be paved by 2011. Half of the total costs involved in the paving of the roads have already been made
available from the Brazilian Bank for Economic and Social Development.

Preliminary investigations (CESARIO & CESARIO 2005; CESARIO & CESARIO 2006; CESARIO 2007; CESARIO & ANDRADE-MORRAYE 2008) suggest that the most striking examples of the impacts of the Global Climate Change phenomenon on human health in Southwestern Amazonia are, so far, the emerging diseases transmitted by phlebotomine sand flies: Bartonellosis (Carrión Diseases) and Cutaneous Leishmaniasis. The first is a neglected disease of growing importance in Peru, both in terms of prevalence and geographical spreading. The latter has a pan-tropical distribution and, according to the Health Synthesis of the Millennium Ecosystem Assessment (WHO 2005), its emergence mechanism is linked, approximately, to host transfer and habitat alteration and, ultimately, to deforestation and agricultural development, being included among the diseases with the highest sensitivity to ecological change. A preliminary analysis of the flebotomine (Diptera: Psychodidae) fauna in Assis Brasil, Acre, has already been produced and presented for scientific scrutiny (RAMOS ET AL. 2009).

Bartonellosis (Carrión Disease)

“Bartonella bacilliformis has caused debilitating illness since pre-Incan times, but relatively little is known about its epidemiology” according to CHAMBERLAIN ET AL. (2002). HIler (1996) pictures Bartonella bacilliformis as a “dangerous pathogen slowly emerging from deep background” and argued “it was perhaps the most lethal human pathogen in the pre-antibiotic era”. The Bartonella Genus includes at least 11 species of bacteria; four causing human diseases, including the ‘Cat Scratch Disease’ and ‘Bacillary Angiomatosis’. Nevertheless, the term ‘Bartonellosis’ refers exclusively to ‘Carrión Disease’, caused by the bacteria Bartonella bacilliformis, isolated by Alberto Barton in 1909, but not identified as the etiologic agent of Bartonellosis until 1940 (PERU 2001).

Bartonellosis (Carrión Disease) is a vector-born infectious disease caused by the bacteria Bartonella bacilliformis, transmitted by phlebotomine (Diptera: Psychodidae) Lutzomyia sp., and its occurrence has been historically related to the high-altitude Andean valleys of Colombia, Ecuador, and mainly Peru. Silvatic and/or domestic reservoirs are yet to be described.

Presently, up to three clinical forms of the disease (PERU 2001) are considered:

1. An insidious acute form (quick start, rapid evolution, high lethality), know as Oroya Fever;
2. A chronic one (gradual start, long duration, important impairment), known since pre-Incan times (through mummies and Wari pottery from the VIIth and VIIIth Centuries) as Peruvian Wart; and
3. The asymptomatic host (9-29%) of the Cusco-region inhabitants are asymptomatic hosts, according to ELLIS ET. AL. (1999).

In 1885, a Young Peruvian medical student, Daniel Carrión, inoculat-
ed himself with blood from a ‘Peruvian Wart’ and developed the fatal ‘Oroya Fever’, demonstrating that both clinical forms belonged to the same nosological entity, which ever since has been known as ‘Carrión Disease’ in honour of his fatidic experiment.

The acute form of the disease took its name from an epidemic that happened in 1871 during the building of the ‘Lima-La Oroya Railway’, when more than 7,000 workers imported from non-endemic areas died when they encountered the bacteria. This form is characterized by fever, general indisposition, headache, muscular and joint pains, evolving to haemolytic anaemia. Some 11% of the patients with fever and without apparent infection present paleness and light to moderate anaemia, and may evolve to severe sepsis with organ/system failure, organic multi-systemic failure and death, if antibiotic treatment is not administered and adequate vital functions support is not guaranteed.

From the patients without treatment, the ones who do not die normally evolve, in two to eight weeks, to the chronic form. Nevertheless, some people may develop the skin lesions without presenting the acute form (asymptomatic), or may even present eruptive skin lesions concomitantly with the severe anaemia (mixed form). The chronic form is characterized by one or more reddish eruptive skin lesions (looking like blood bubbles or nodules), with well-defined limits, that are painful or not, and that may bleed if touched. Specific training is necessary for the differential diagnosis of the dermatologic lesions, which if not treated may last for months or even years.

Bartonellosis was, since pre-Colombian times, a disease confined to the Colombian, Ecuadorian, and Peruvian high-altitude Andean valleys. In Colombia, it is no longer a public health problem, since only two cases were observed during the last 60 years, while in Ecuador, cases have been re-
ported from the coastal zone, only 150 metres above sea level. Laboratorial evidence was found in native Amazonian communities at just 150 metres above sea level. In Peru, an alarming spread of the disease during the last decade has been seen, with the number of Departments infected mounting from 4 in 1995 to 14 in 2004 (Figure 2).

The incidence of Carrión Disease, in Peru, soared from some 4 to almost 40 cases per 100,000 inhabitants between 1997 and 2005 (Figure 3).

The growing importance of the Department of Cusco (which is expected to be linked to the Southwestern Amazon tri-national frontier by a paved road by 2011) for the transmission of the disease has been a focus of attention of the Peruvian Epidemiological Surveillance personnel. The number of cases reported from this region has been steadily high over the past years, although they are still under-estimated. The last outbreak of Bartonellosis in Peru occurred in the months of August, September, and October 2008, and was geographically located in Cusco (PERU 2008B).

ELLIS ET AL. (1999) corroborate the literature evidence of 9-29% of asymptomatic individuals in this region, while CHAMBERLAIN ET AL. (2002) found only 0.5% among the 690 participants monitored with asymptomatic baceraemia at their study initiation. Quispe (PERUVIAN REGIONAL EPIDEMIOLOGY OFFICE 2004: personal communication) showed 18% of lethality in the Department of Cusco, during the year 2004. The first reported case of Bartonellosis from outside the Andean region was diagnosed by an Italian tourist, who spent time in the Peruvian Andes region, two months before presenting the symptoms back in Europe (MATTEELLI ET AL. 1994). In 2004, for the first time, 175 suspected cases (by clinical-epidemiological criteria) were reported in the Department of Madre de Dios, bordering Bolivia and Brazil. The risk of Bartonellosis transmission is reaching the disease-free Peru-Bolivia-Brazil tri-national borders. In the following years (2005-2009) other cases were reported from the Peruvian side of the tri-national frontier. CESA-RIO & CESARIO (2005) first presented the alert to the risk of expansion of Bartonellosis from Peru to Bolivia and Brazil – countries where health professionals are not trained to diagnose or to treat the disease.

HUARCAYA ET AL. (2004) suggested that ENSO (El Niño Southern Oscillation) influenced the epidemiology of Bartonellosis in the departments of Ancash y Cusco between 1996 and 1999, pointing to a close relation between the re-emergence of this disease and Climatic Variability / Climate Change. The PERUVIAN REGIONAL EPIDEMIOLOGY OFFICE (2005: unpublished data), on the other hand, relates the spreading of Bartonellosis in Peru with increased "temporary migration" and "LUCC due to agriculture pressures". Since LUCC is a major driver of Global Climate Change, it seems that the re-emergence of Bartonellosis (including its geographical spreading) may be attributed to Global Climate Change in different ways, further reinforcing the need for future studies.

Cutaneous Leishmaniasis

As early as 1764, Cosme Bueno already implicated the phlebotomines in the transmission of both the ‘Peruvian Wart’ and Leishmaniasis (HERRER & CHRISTENSEN 1975). According to WHO’s Macroeconomics and Health Comission, Leishmaniasis are vector-borne neglected anthrozoones, with high public health importance in the world (WHO 2001). Leishmaniasis is a worldwide disease, affecting 88 countries, of which 72 are developing countries and 13 are among the least developed; 90% of Cutaneous Leishmaniasis occurs in 7 countries (WHO 2002). Among them are Brazil and Peru, where environmental changes (new settlements, intrusion into primary forest, deforestation, human migration, dams building) increase the exposure to sandfly vectors and are leading to a clear and disturbing increase in the number of cases (PAHO 1998).

The type of clinical manifestation (cutaneous or visceral) depends on the interactions vector-protozoa, therefore it is fundamental to know each of the species involved in the cause/transmission of the disease for each geographical area; this is also important for the definition of control strategies and treatment. Although Visceral Leishmaniasis is not yet found in Southwestern Amazonia, Cutaneous Leishmaniasis is hyper-endemic in the region (BRASIL 2007). The known reservoirs are both silvatic and domestic: marsupials, rodents, sloths, anteaters, dogs, equines and mules. The interaction parasite-reservoir is a complex system and deserves further investigation efforts to better define the role of reservoirs in the disease cycles. It is widely accepted that each transmission site has its biological singularities and must be investigated as such (BRASIL 2007). The main clinical manifestation of Cutaneous Leishmaniasis is a skin ulcer, which when cured will evolve into a scar that usually leads to strong social stigmatization. Many complications can be associated, avoiding or delaying the cure process, which in turn increases the diseases’ social stigma.

The Brazilian Health Ministry relates the changing epidemiology of Cutaneous Leishmaniasis to both mining, extractive activities and agriculture - it was historically a zoonosis of wild animals that occasionally reached people in contact with forests, and then has been reported from deforested rural- and peri-urban zones (BRASIL 2004A). Presently, there are three epidemiological patterns of the disease in Brazil: (1) silvatic – when the
transmission occurs in areas of primary vegetation, the disease is, fundamentally, a zoonoses of silvatic animals; (2) occupational leisure – when the transmission is associated with uncontrolled forest exploitation (forest logging for timber extraction; deforestation for road and dam building, and for the expansion of agricultural activities); and (3) rural peri-urban – in settlement areas, associated with migratory and unplanned urbanization processes (Brasil 2007).

From 1985 to 1994 the incidence of Cutaneous Leishmaniasis increased from 13 to 40 cases per 100,000 inhabitants in Peru. The number of reported ACL cases at the Peruvian Department of Madre de Dios, on the South-west Amazonian tri-national frontier, increased from 432 in 1996 to 589 in 2003 (Peruvian Regional Epidemiology Office 2004: unpublished data). Bolivia considers the Department of Pando, especially the areas along the Brazilian frontier, as a Hyperendemic Zone, with the Detection Coefficient of the six municipalities along the tri-national borders varying between 198 and 1,622 (cases per 100,000 inhabitants) in 2004.

In Brazil, from 1985 to 2005, the incidence of Cutaneous Leishmaniasis varied from 10 to 23 cases per 100,000 inhabitants in Brazil. Of the reported approximately 35,000 cases of ACL annually, 35 - 40% are from the Northern Region (Basano & Camargo 2004). In Acre, the annual number of reported cases increased from 41 in 1980 to 1,589 in 2003 (Brasil 2004b). While the Brazil’s Detection Coefficient average is about 18 cases per 100,000 inhabitants in the last 20 years, in the Northern region it was around 93 cases per 100,000 inhabitants, and in the Acre State 126 cases per 100,000 inhabitants - the highest coefficient among the 27 states of the country (Brasil 2007). Within Acre State, the highest Detection Coefficient is found in the municipality of Assis Brasil, located at the tri-national frontier of Southwestern Amazonia, with an average Detection Coefficient (2000 to 2007) of 1,232 cases per 100,000 inhabitants (Raquel R. Cesar-Rio: data not yet published). These are, undoubtedly, the reported cases. The Pan-American Health Organization (PAHO 1994) estimates five unreported cases for each reported case in the Americas. It is also important to emphasize that the Brazilian Ministry of Health states, “A Detection Coefficient above 71 cases per 100,000 inhabitants represents an area under a very high risk of transmission” (Brasil 2007).

**Final remarks**

The tri-national frontier at Southwestern Amazonia developed a bottom-up phenomenon called MAP (standing for Madre de Dios-Peru, Acre-Brazil and Pando-Bolivia), which is an initiative by individuals and institutions that seek to develop tri-national
The development of adaptation tools for the negative impacts of socio-environmental changes on the health determinants of human communities living in Southwestern Amazonia is urgent. These tools must include the development of an early warning system for emerging infectious diseases in Southwestern Amazonia, embedding at least two components: (1) the monitoring of the changes in the eco-epidemiology of Cutaneous Leishmaniasis and Bartonellosis (Carrión Disease), in the local/regional climate (temperature, rainfall, air humidity, wind, altitude) and in land use and cover, and (2) the identification of the sand fly vectors (Diptera: Psychodidae: Phlebotominae) involved with the transmission of both diseases in the tri-national region.

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Migration and health in China
challenges and responses

J. Holdaway, T. Krafft and W. Wuyi

Introduction

Labour migration has played a crucial role in the rapid economic growth and urbanization process that China, India, Brazil and other emerging countries have experienced over the last decades, contributing to poverty reduction in rural areas through remittances, and supplying labour for manufacturing and service industries. While the short-term financial benefits of migration for many individuals, families, and communities are clear, large-scale population movements present new challenges for health systems and public health in terms of disease monitoring, prevention and treatment. Focusing on China, this article provides an overview on some of the health risks migrants have to face, the evolution of research and policy responses, and the challenges that remain.

Internal migration in China

Large-scale labour migration has been a crucial component of the sweeping changes that have taken place in China over the last three decades and is inextricably linked with processes of industrialization, urbanization, and the shift from a centrally planned to a largely market-based and globally-connected economy. Currently, about 140 million people or over a tenth of China’s population is mobile depending on the definition used (NBS 2010; Chan 2008).

The most recent round of large-scale rural-urban migration in China began as a consequence of economic reforms starting in the late 1970s. The break-up of the People’s Communes and the introduction of the Household Responsibility System stimulated agricultural productivity and released workers from agricultural employment. The creation of local Township and Village Enterprises (TVES) initially provided opportunities for non-agricultural employment in rural areas, but as China opened to foreign investment and embarked on a development strategy of export-driven growth in the 1980s, manufacturing industries began to generate a demand for labour and drew workers from the interior to the coastal regions. The expansion of construction and service industries in cities also attracted migrant workers, and the development of a private rental market and the emergence of free markets for many foods made it
However, still gave residence only to those who could make substantial investments or held professional qualifications (Chan & Buckingham 2008). As rural people living in the city, migrants were a population whose health status was not effectively monitored by either the rural or urban systems – their access to professional health care services particularly remained limited. This was the result of the institutional separation between rural and urban health care systems, coupled with changes in both systems that eroded coverage of low-income groups (Xiang 2004). Prior to reform, separate but fairly effective health care systems operated in urban and rural areas. Rural residents received quite extensive services through the Cooperative Medical System, which operated publicly-funded clinics and financed “barefoot” doctors to provide basic care. Urban residents received free health care through one of two state-run schemes (Duckett 2007; Bloom & Fang 2003). This bifurcated system rested on the assumption that people did not move between rural and urban areas, and consequently left rural migrants with no access to health care in the city. At the same time, the rural health care system that they were expected to fall back on was undermined with the dismantling of the communes and the introduction of the Household Responsibility System in the 1980s. Without a system for collective financing, individual families became increasingly responsible for paying for their own care, and illness quickly became a major cause of poverty in rural areas (Liu et al. 2003).

The New Cooperative Medical System introduced in 2002 has improved the situation somewhat, and has now been extended to cover nearly all rural counties, although problems remain in adjusting the program to local needs and providing adequate coverage for low income populations (Cook 2007). In 1999, reform of the work-unit-based system in urban areas led to the establishment of a system in which employees hold individual accounts to which both they and their employer contribute monthly, but which can be transferred if the employee changes jobs.
Migration and health risks

Over the last decade, it has become increasingly clear that migrants present new challenges for the health system in terms of disease monitoring, prevention, and treatment, facing a variety of health risks that stem from employment, living conditions and their mobile status (ZHENG & LIAN 2005; XIAO 2004; HANSEN 2001).

Although generally more educated than their peers who remain in the countryside, migrants are relatively low-skilled compared to urban workers. Consequently, and also because of barriers to entry into formal urban labour markets, they are concentrated in jobs that involve high risks of occupational injury and illness, including construction, mining, and certain types of manufacturing. They are also more likely to be employed in the informal sector or in Town and Village Enterprises and small private businesses where worker health and safety is inadequately regulated (LI 2008; XIAO 2004; HANSEN 2001). Like undocumented migrants in many countries, migrant workers in China are often afraid to complain for fear of losing their jobs, and many consciously or unconsciously risk their health in return for greater income in the short term (HU ET AL. 2008; WRIGHT 2004).

Data on occupational health and injury rates in China is unreliable. It is collected by many different agencies and reporting is patchy (LI 2008). This is particularly true for migrant workers, who often do not seek care in hospital. But a few statistics give some indication of the extent of the problem. A study by the Ministry of Health (MOH) and the Ministry of Agriculture (MOA) found at least one occupational hazard in 83% of the Town and Village Enterprises surveyed, and estimated that at least one third of workers were exposed to health risks. Of factories with hazardous conditions, less than half had any kind of ventilation equipment. Almost five percent of workers surveyed had identifiable occupational diseases and another 11% had health problems that appeared but were not proven to be related to their work (SU ET AL. 2000). In 2005, the State Administration of Work Safety estimated that there were 15,000 deaths from occupational injury annually, and 30,000 work-related incidents in the Pearl River Delta area alone (XINHUAET 2005; CHINA NEWS DAILY 2005). Seeking to assess the scale of the problem from another angle, research conducted in migrant-sending communities estimated that 1–2 percent of all male migrant workers had work-related injuries (XIAO 2004).

Among occupational illnesses, the lung disease pneumoconiosis, accounts for over 70% of the reported total, with over half a million cases recorded by 2001 (LIANG ET AL. 2003). Fourteen thousand new cases were reported in 2009 – more than 90% of them among coal miners and over half in small and medium-sized enterprises (MOH 2010). Benzene, toxic glues, and many other chemicals and pollutants are the cause of other illnesses to which migrant workers are disproportionately exposed. The MOH reported 272 cases of acute and 1912 cases of chronic occupational poisoning in 2009. (MOH 2010)

Migrants are vulnerable in less obvious ways as well. First, they routinely work longer hours than urban residents—up to 50% longer on average, according to one study conducted by researchers at Chinese Academy of Social Sciences (DU ET AL. 2006). Another study in Hangzhou found that 28% of migrants worked more than 12 hours a day and 81% worked six or seven days a week (HESKETH ET AL. 2008). Working long hours increases the risk of injury and repetitive-stress disorders. And, while they earn less than urban residents, migrants also save more, meaning that they often skimp on food, clothes, and other necessities. Although they are less likely to have insurance coverage, migrants also spend less than urban residents on out-of-pocket medical expenses (DU ET AL. 2006). This frugality benefits their families in the short term, but it takes a toll on their physical and mental health.

Migrants make up a large percentage of the population in China’s rapidly expanding cities, accounting for up to a third of the population of Beijing and Shanghai and an even greater proportion in Shenzhen and other new cities. The pace of urban expansion has strained infrastructure, and urban peripheries where migrants are concentrated tend to be underserved in terms of water and sanitation services, as well as the sites of small scale industry (WANG & KRAFFT 2008). Studies have found that migrants on average have half (11 square meters) the living space of urban residents, and that 63% of migrants live in housing without a bathroom, compared to 16% of long term urban residents (DU ET AL. 2006). Migrants working in factories often live in dormitories, which are typically over-crowded and do not have adequate protection against fire hazards. Because of crowding and inadequate sanitation, higher rates of malaria, hepatitis, and other infectious diseases have been found among migrants (ZHENG & LIAN 2005). In recent years, tuberculosis has been an increasing concern, with migrants showing higher rates of infection, delayed diagnosis and less access to care (JIA ET AL. 2008; YANG ET AL. 2008; WANG ET AL. 2008; SHEN ET AL. 2009).

As a result of these stressful work and living environments, and also because they are separated from their families and usual social constraints, migrants may be more likely to engage in risky behaviours that may expose them to disease, including unsafe sex (YANG 2008; LI ET AL. 2007). In fact, migrants’ circumstances vary
considerably in this respect. As ZHENG & LIAN (2005) point out, many migrant workers live in dormitories where the gates are locked at night and no visitors are allowed, making it hard for them to be sexually active. Other migrants live in enclaves together with others from their home village, where social constraints may be quite strong. At the same time, certain categories of migrants are clearly at high risk of HIV/AIDS and other sexually transmitted diseases, including those who work in China’s growing sex industry (XIANG 2004; LI AT AL. 2009; YANG ET AL. 2008; LAU AT AL 2009).

Recent policy affecting migrants’ health

Since 2000, a gradual but important shift has taken place in attitudes and policy toward migrants – a number of factors have contributed to this. Firstly, a broader change has taken place in social policy toward a greater emphasis on social justice and harmony (hexie shehui). Within this context migrants have increasingly come to be seen as a vulnerable population with particular needs; a perception supported by a considerable volume of research documenting the problems of occupational health and safety, access to services in urban destinations, and social discrimination. Media reporting of such issues, and of egregious cases of exploitation and unsafe working conditions has also raised both public and government awareness (XIANG & TAN 2005). With some delay, the health system was galvanized into action during the SARS epidemic in 2003, in which migrants were seen as primary carriers of disease. Growing attention to HIV/AIDS, tuberculosis, and other infectious and emerging diseases has also focused attention on migrants and while it used to be difficult to find information on migrants’ health status, it is now becoming routine for migrant status to be a variable in epidemiological studies.

As the government has actively promoted migration as a development strategy and recognized the contribution of migrants to the economy, steps have been taken to end discriminatory practices toward migrants and integrate them into urban social welfare schemes. From 2001, the central government began releasing a series of documents calling for attention to the working conditions and rights of migrant workers, further requiring local governments to make greater efforts to provide more services, better working conditions, and schools for children. During this period, the government repeatedly acknowledged migrants’ contribution to rural poverty alleviation, and in 2004 in a key document, also indicated that “rural migrant workers have become a crucial component of the industrial workforce, creating wealth for cities, and generating tax revenues” (CAI & WANG 2008).

With the change in the government’s approach to migrants have come a series of policies specifically targeted at reducing migrants’ exposure to health risks and improving their access to health care. The 2006 State Council document, “Several
Opinions on Resolving the Problem of Migrant Workers,” called for further efforts to improve migrants’ legal status and access to public services (State Council 2006). In response to the State Council’s initiative, the Ministry of Labour and Social Security (MOLSS) issued a document indicating its plans to expand migrant workers’ participation in health insurance (MOLSS 2006). The initiative focused on provincial capitals, large cities, and occupations in which migrant workers are concentrated, including manufacturing, construction, mining, and services. The stated goal was to have 20 million migrant labourers enrolled in insurance schemes by the end of 2006, and nearly all migrant workers working for urban employers enrolled by the end of 2008, with specific quotas for individual provinces and cities. Urban governments developed a variety of approaches including: giving migrants access to existing insurance schemes; setting up a separate scheme for migrants; and relying on rural insurance programs (HE & HUA 2006). Official statistics report that by 2009, over 43 million were enrolled in insurance programs (NBS 2010), although this appears to vary widely across cities. One study in Hangzhou reported enrolment rates of 19% (Hesketh et al. 2008) compared with 45% in Shenzhen (MOU et al. 2009). Migrants who are employed primarily in TVEs, or who migrate seasonally, may choose to participate in rural insurance programs which have improved considerably in recent years (HE & HUA 2006).

There is also greater attention to the occupational health problems faced by migrant workers with the monitoring and prevention of occupational health risks included as a goal of the broader reform of the health system. The MOH conducted a survey of migrants’ occupational health and in 2006 launched a program to provide Basic Occupational Health Services in pilot sites in 20 counties of 10 provinces. It was expanded to 46 counties in 19 provinces in 2010, with further measures planned for the 2009-15 period. Efforts have focused on particular industries, including coal mining and construction and appear to have had some effect. Official statistics reported an 8.8% decrease in the number of reported deaths in workplace accidents in 2009, to 83,196, or 2.4 people for every 100,000 working in mining industry, commerce, and trade respectively. The number of miners who died for every million tons of coal produced was 0.89, a drop of 24.5% over the previous year (NBS 2010). In addition to the government, a number of NGOs are now involved in providing training on occupational health and safety.

Continuing challenges for research and policy

Despite greater awareness, many difficulties remain in addressing the health needs of migrants. Although the new insurance schemes are expanding, for a variety of reasons, the majority of migrants are still not covered. Some are defined out of eligibility (e.g., the Shanghai program does not include people working in agriculture or as housekeepers – two large groups that are rarely covered by employers). In other cities, such as Shenzhen, comprehensive schemes face problems of employer compliance, especially among smaller firms (MOU et al. 2009). Even where it is available, co-payments, upfront payment for services and ceilings on coverage often deter migrants from buying insurance and from seeking care. Awareness of the need for treatment and trust in health providers are also an issue (Barnighausen et al. 2007). Overall, insurance enrolment and use of services show demographic patterns common to other countries that lack universal coverage (MOU et al. 2009; Hesketh et al. 2008).

To date, the focus of most policy has been on improving migrants’ access to healthcare in urban areas. However, many migrants who are injured or become severely ill return to the countryside, where they present a serious challenge to the rural health care system and an economic and social burden on rural communities. The serious health risks that migrants face have led one group of researchers to characterise migration as a process of “youth mining” in which the human resources of rural young people are being consciously expended in pursuit of financial gain, as China’s countryside exports healthy workers and re-imports the sick and injured (Hu et al. 2008). This remains an area in which research is still limited and explicit provisions for disabled workers have yet to be introduced, although some programs have begun to address the needs for rehabilitation among returning migrants (Loa et al. 2008). In fact, many migrants do not return to their villages but to small towns and cities in the same province, which lack the resources of large cities but do not receive the subsidies available to rural areas. Building health service capacity in county towns and small cities would therefore seem to be a priority (Science Times 2010).

In terms of prevention, there is now a strong commitment on the part of the central government to improve occupational health and safety in industries in which migrants are concentrated. But even with this political will, progress will not be easy. The monitoring and enforcement system faces serious problems of capacity. For example, according to the Provincial Administration of Worker Safety, in 2006, Jiangsu had over 230,000 industrial enterprises employing nearly twelve million people, as well as 34 coal mines and 3,000 other mines. Another 3.8 million people were working in the construction sector. But the province had only 563 professional safety in-
spects and 256 occupational health inspectors (xia 2006). In poor areas, it is hard to recruit and retain trained personnel, who generally leave to find work elsewhere, and enforcement is further hampered by the difficulty of regularly inspecting facilities in remote locations. As with the enforcement of environmental regulations, corruption and local protectionism are also serious problems, especially in poor areas with few alternative sources of revenue.

In most cases, migrants find themselves at risk as the result of a complex interaction between structural factors and choices made by individuals and their households. Migrants often risk their health as the result of a lack of information, a lack of alternatives, or in some cases, a deliberate decision in return for other perceived benefits. A much better understanding of how migrant households and individuals perceive and respond to various health risks, how they access and use information, and how they value and weigh considerations of health and increasing income is needed.

Given the diversity of the migrant workforce, and the range of different health risks to which they are exposed as the result of their specific occupations and place of residence, these issues need to be explored through in-depth research on particular sub-populations and employment sectors. There is also a need for longitudinal research that can capture the effects of cumulative exposure of migrants to occupational and environmental health risks and the long-term costs of lost capacity to work and in treatment and care for the sick. All these tasks are complicated by the pace of urbanization and by ongoing changes in the structure and location of industries in which migrants are concentrated, including the trend towards relocating many industries away from major cities and into the hinterland.

Nearly all work on migrant’s health focuses on their physical condition, but migration also causes considerable psychological stress that can have serious consequences. The recent spate of suicides at the Apple contractor Foxconn in Shenzhen is a dramatic manifestation of stress-related health issues. More often, stress has an insidious effect, exacerbating physical health problems and making it difficult for individuals to live productive and fulfilled lives. Sources of stress include discrimination, but also isolation and separation from family. Studies indicate that migrants stay away from home on average for four to seven years (murphy 2002; ngai 2005). Some researchers are beginning to explore these issues but the findings are as yet somewhat inconclusive (wong et al. 2008; li et al. 2007). The implications of migration for the physical and mental health of migrants’ children represent another problem that is only beginning to be explored but is now beginning to receive attention in professional journals (li et al. 2009; chen et al. 2009; lu et al. 2008; wong et al. 2008; ye & pan 2008).

Policy toward rural-urban migration in China has undergone a significant shift in the last decade, and improving the working and living conditions and access to health care of migrant workers in cities is now clearly on the agenda of national and local governments. Nonetheless, migrants’ mobility and their concentration in hazardous industries continue to make it difficult to reduce their exposure to environmental and occupational health risks and to ensure their access to affordable care. As it grapples with these challenges, China is experimenting with a number of approaches to addressing migrant health issues that will be informative not only in the domestic context but also for other countries undergoing significant internal migration.
MOHSS (Ministry of Labour and Social Security) 2006a. Guan Yu Shi Shi Jie Shi Jue Nong Min Gong Wen Ti De Zhi Yi (Regarding the Implementation of the State Council’s Opinions on Solving the Problems of Migrant Workers). MOHSS Document No. 15.
MOHS (Ministry of Labour and Social Security) 2006b. Jie Jue Nong Min Gong Can Jia Yi Liao Bao Xian Wen Ti (Solving the Problem of Health Insurance for Migrant Workers). MOHSS Document No. 11.


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Urban health in megacities extending the framework for developing countries

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Introduction

Global climate change and megacity urban health is of vital relevance at a time when the majority of the world’s population is living in urban areas. It is especially in the megacities of developing countries that higher urban growth rates can be found (UN-HABITAT 2008). Further, WHO estimates suggest that around 150,000 deaths now occur in low-income countries each year due to climate change (MCMICHAEL 2000; WHO 1990, 2009). Hazards range from the increased risks of extreme weather events, to effects on infectious disease dynamics and sea level rise leading to salinisation of land and water sources. These factors further push villagers to move to the cities to find alternative income sources.

Urban environments influence almost every aspect of human health and wellbeing. Generally, cities are associated with both positive and negative effects on public health. On the one hand, they offer various public health innovations, provide improved health care and services, and offer better information and health education. On the other hand, cities are commonly areas of deteriorated physical and social environments. Especially in rapidly urbanizing megacities of developing countries, the growing number of people living in slums and unhealthy environments is of rising concern. High levels of environmental pollution, high building densities, and the loss of social connections often have negative impacts on the health of urban residents (HARPHAM 2009; STEPHENS ET AL. 2008).

During the past decade there have been various frameworks proposed that consider the interrelationships among social and environmental influences and population health (DEHOLLANDER 2003; GALEA ET AL. 2005; and GEE PAYNE-STURGES ET AL., 2005). Nevertheless, most of these frameworks have been developed in the context of cities in industrialised...
countries. As living conditions, urban structures, social and cultural aspects differ greatly among countries and particularly between industrialised and developing countries, most existing frameworks cannot be applied to developing megacities but have the potential to be adapted to the particular circumstances which exist in the megacities of developing countries. One of these conceptual frameworks proposed by Galea et al. (2005) has been widely accepted in the research community. Since it was developed in the context of North American cities, the goal of this study is to apply and extend this framework to megacities in developing countries. We focus on Dhaka, the capital of Bangladesh, since it is one of the fastest growing megacities in the world with currently 13 million inhabitants and more than one third of the population living in slums (Burkart et al. 2008).

The framework for urban health and the environment

The conceptual framework of Galea et al. (2005) is based on the hypothesis that multiple levels of influence shape population health. The core concept underlying the framework is that the social and physical environments that define the urban context are shaped by municipal factors, such as government and civil society, and that national and global trends set the context in which local factors operate. The framework assumes that the urban environment in its broadest sense (physical, social, economic, and political) affects all strata of residents, either directly or indirectly. In order to consider all these factors and the ways in which they affect the health of urban populations this conceptual framework proposes mechanisms through which these variables may influence the conditions that are the primary social and economic determinants of the health of urban populations (Figure 1). This leads to the conclusion that in order to understand urban health it is important to shift the focus of inquiry away from disease outcomes towards urban exposures, namely, the characteristics of the urban context that influence health and wellbeing in cities. Furthermore, research on urban health must acknowledge the reality of complexity. This complexity can itself cause or exacerbate problems, where a response to one part of a problem can precipitate an accident or other disastrous unintended consequences (Perrrow 1999). Approaches that recognise the importance of studying interactions at multiple levels are thus a useful tool for the study of urban health (Dez-Roux 2000; Galea et al. 2005; Vlahov & Galea 2003).

Applying the framework to megacities of developing countries: evidence from Dhaka, Bangladesh

Adapting the above framework to megacities in the developing world, we propose that the urban context is defined by both the bio-geo-physical and the human-social systems, which determine urban health at different scale levels (Table 1). We also assume that while the urban environment affects all strata of residents, either directly or indirectly, the urban population carries different exposures to health risks depending on factors to be measured at the various relevant scales.

Enduring structures and conditions

In their concept Galea et al. (2005: 1021) highlight the role of enduring social structures and conditions, which is reflected in the prevailing political and economic system underlying all aspects of living in particular countries. While economic and governmental systems, religion, or

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**FIGURE 1:** Conceptual framework for urban health. Modified from Galea et al. (2005)
culture might be viewed as enduring social structures and conditions, we argue that the geography of a country or region - such as the climatic zone or the geology - determines the physical condition in which local variations apply. These enduring social and physical structures and conditions are likely to play a role in shaping the other key elements in the framework.

For example, Bangladesh has a constitutional democracy which cannot yet be considered as consolidated. Corruption, weak institutions and mismanagement have contributed to a fundamental distrust of the political class. Further, with a liberal but weak economic system with a GDP per capita of 560US$ (IMF, 2009), Bangladesh provides hardly any state driven social insurance and no health insurance system for its citizens (Islam 2005). Geographically, Bangladesh is determined by a tropical climate with heavy downpours in the monsoon season (June to September). Large parts of the country are inundated almost every year with, at times, devastating consequences for public life and human health (Burkart et al. 2008).

Global and national trends and dynamics

As outlined in Galea et al. (2005: 1021), global and national economic, social, and political trends shape cities in both the long and the short-term (Figure 1). One prominent example of an economic trend in Dhaka is the flourishing export-oriented garment industry. More than 800,000 of Dhaka’s inhabitants are employed in this sector producing labour intensive goods under poor working conditions (Kaberi & Mahmud 2004). Social trends are, for example, constituted by migration and immigration. In Dhaka, 300,000 new migrants arrive every year (World Bank 2007) and initially concentrate in marginal settlements due to poverty (CUS 2006; Islam 2005). National trends in the role of the government affect the financial and political support that municipal governments can mobilise to confront new threats to health (Galea et al. 2005: 1022). Rapidly growing slums in Bangladesh’s major cities create enormous pressure on public services and utilities. Government agencies are trying to address these challenges by focusing on slum development, low-cost housing, and relocation. Many NGO activities coincided with the government’s poverty-alleviation initiatives, with programmes starting in the late 1980s focusing particularly on health, education, water, sanitation, and credit (Habib 2009).

Galea et al. (2005: 1022) further propose sub-urbanisation as a global and national trend. While sub-urbanisation is mostly happening in cities of industrialised countries, urbanisation is taking place in many cities of developing countries (Satterthwaite 2002). However, both processes are structural changes in land use most often connected with the loss of ecosystem services (Ma 2005). In the mega-urban region of Dhaka for example, Griffiths et al. (2010) found that urban land use increased nearly threefold during a 16-year period from approximately 162 km² in 1990 to nearly 440 km² in 2006. Three main urban growth related processes characterised land system change around Dhaka during that time. First, prime agricultural lands and ecologically valuable areas were increasingly being converted into settlement areas or land in-filling. Second, there was extensive industrial sprawl in Dhaka’s peri-urban hinterlands. Third, the fast growth of satellite and model towns was a dominating element of urban expansion.

While the concept of Galea et al. (2005: 1021) reflects developments only on a social level, we introduce the importance of physical dynamics, such as global climate change and seasonal effects, since physical dynamics also determine urban health, both in the long and the short-term (Table 1). Global climate change is one of the priority ecological challenges of our time. The IPCC has assessed and published a comprehensive scientific basis of the physical and climatological forces and directions of climate change, as well as of its possible and likely implications. Besides various ecological and economic implications, human health will be profoundly affected by a changing climate. The effect of climate, weather and atmospheric conditions on human health is well recognised within the scientific community. Numerous studies have investigated the association between temperature and mortality; most of them were focused on industrialised countries in the mid-latitudes (Basu & Samet 2002; Eurowinter Group 1997; Rau 2006). However, the effect of meteorological conditions depends on the geographical region, the aligned macro- and mesoclimatic conditions, and the prevailing burden of disease, as well as socio-cultural and socio-economic aspects (Burkart & Endlicher 2009; Curriero et al. 2002; Jendritzky 1992; McMichael et al. 2008). All of these determinants are subject to spatial and temporal fluctuations and dynamics. Due to a lack of both resources and available data, little is known about the atmosphere-health relationship in tropical developing countries. In particular, the complexity of the matter requires a detailed and differentiated analysis and – during times of climate change – knowledge about interdependencies between season, climate and health is gaining in importance (Confalonieri et al. 2007; Kalkstein 1993; Who 2009).

In Bangladesh, seasonal effects like tropical or monsoonal rain showers and related river erosion and flooding appear regularly every year, albeit with changing intensity and varying effects on human health. Ahmed &
Falk (2008) for example, showed the effects of global climate change for Bangladesh. Salinisation of agricultural fields is increasing in pace in the south of the country due to the rise in frequency of cyclones. Burkart & Endlicher (2009) further showed that urban population health in Dhaka varies with different seasons and is determined by atmospheric variables such as temperature and humidity. For instance, they found that all-cause mortality levels are generally higher during the cold season. Likewise, a winter peak was observed for cardiovascular and respiratory mortality.

### Municipal level determinants

Municipal level determinants of health are those determinants which can be applied to the whole urban area or to large areas of the city. We propose grouping them into urban sociological and urban ecological determinants. The perspective of urban sociology includes the municipal government, the civil society and markets.

Municipal government and other government agencies such as Dhaka City Corporation (DCC) and the Local Government Engineering Department (LGED) have the authority to improve the health of the urban population by improving the overall environment (e.g. slum settlements). For instance, the UNICEF-funded Slum Improvement Project (SIP) in collaboration with LGED attempts to ameliorate the slum environment through infrastructure development, cleaning footpaths, drains and latrines, primary health care, credit provision, community participation, increasing awareness, and women empowerment (Habib 2009).

Many civil societies and voluntary organisations including media and press such as the Centre for Policy Dialogue (CPD), Poribesh Rokkha Shapoth (POROSH), Doctors for Health and Environment (DHE), Bangladesh Environmental Lawyers’ Association (BELA), The Daily Star and The Prothom Alo are actively working for the prevention of environmental degradation (Islam 1999; Sobhan & Rahmatullah 2003) by knowledge generation, awareness raising, policy influencing and capacity building (Sobhan & Rahmatullah 2003).

Galea et al. (2005: 1024) stress the central role of markets in determining the health of urban populations, as markets allocate crucial elements of the citizen’s life, such as housing, food, employment opportunities, medical care, and transportation. In contrast to cities in high-income countries, the economy of the rapidly growing urban areas of developing countries is characterised by the dominance of the informal economy. This sector offers a flexible labour market, absorbs most of the workforce and provides income-generating opportunities and services for a large number of unskilled and manual labours (Upadhyay 2007). Kulke & Staffeld (2009) found that informal activities in Dhaka are the survival means for a substantial section of the workforce. Most of the migrants who come to Dhaka are engaged in the informal sector as the formal economy fails to absorb them. According to their study, more than 80% of adult slum dwellers are engaged in informal activities. Although the informal sector substantially contributes to the national and urban economy (Heinonen 2008; Nwaka 2005), informal sectors are often associated with unfavourable
conditions with regard to, among others, working and living conditions, pollutants, discrimination, exploitation, income, occupational safety, and legal and social security. All these factors substantially increase the risks of ill-health among people engaged in the informal sector.

Using the perspective of urban ecology, we propose to include ecosystem services (ESS) and urban fabric. For example, urban expansion facilitates the loss of regulating ESS (e.g., water retention during the monsoon season) and provisioning ESS (e.g., local food production). The study of Griffiths et al. (2010) makes it obvious that the widespread practice of earth in-filling in low lying, (i.e. temporarily inundated) areas, for building ground construction is increasing in pace in Dhaka. The loss in provisioning and regulating ESS fosters deteriorating living conditions and increases environmental risks, particularly the risk of flooding (Caldwell 2004; Griffiths et al. 2010). Due to poverty, such negative effects are most prominent in the marginal settlements (Burkart et al. 2008). Furthermore, Dhaka’s expansion has been constrained by the surrounding tributary rivers of the Ganges-Brahmaputra Basin resulting in extreme densification of urban areas. Dense urban areas can be identified through their impervious urban fabric; this has manifold consequences for the urban ecosystem, including increased surface runoff or urban heat island effect (Alberti 2009), thus indirectly affecting urban health.

We further propose including meso- and microclimate issues, such as the urban heat island effect, which is directly connected to the urban fabric. Burkart & Endlicher (2009) for example, found that cardiovascular mortality in urban areas of Bangladesh showed a secondary maximum during the hot season. This underscores the relevance of the urban heat island, as well as the increased vulnerability of
urban populations toward heat. These findings can be helpful for identifying target groups and target regions. Moreover, certain times and seasons were identified for which increased care can mitigate excess mortality.

**Neighbourhood level determinants**

When considering the different scales which constitute urban living conditions, it seems logical to additionally introduce the neighbourhood level, as it directly determines urban public health. For example, health responses may differ depending on people’s social environments (i.e. social networks, social capital, segregation, social support, population density and security); availability and affordability of health and social services; and socio-economic status. The main health care providers for the poor and disadvantaged in Dhaka come from the private sector (USAID 2004) or the informal sector, and provide mostly non-qualified practitioners (Ahmed et al. 2009). Khan et al. (2009) found a higher burden of communicable diseases and underweight/malnutrition among poor population groups in urban slums than among the inhabitants of urban affluent areas. In contrast, urban affluent residents suffer more from non-communicable diseases and overweight/obesity than slum and rural inhabitants. Intra-urban health differences are sometimes even larger than rural-urban differences. Such health inequalities may be attributed to, for instance, differences of socio-economic status and varying lifestyles of inhabitants (Khan et al. 2009).

Socio-economic status defines, among other things, the frame of action within which a household can respond to a health threat. In this context, resilience can be considered as the intrinsic ability of a household, a person, or a community to resist or cope with the impact of a physical or social event (Villagráñ De León 2006).

**Conceptualising urban health not only requires analysis of current health determinants, but should include consideration of the dynamic nature of the cause-consequence chain which underlies the strong effects of, for instance, global climate change.**

Furthermore, health responses may also differ depending on variations in the quality of the physical environment (i.e. ecosystem services) and in the artificial built environment that influence exposure to relevant effects. For example, health responses may differ depending on people’s exposure or resilience to poor health. Exposure can be determined by the geographical distance to a health threat (e.g. source of air pollution or noise). It is also crucial to consider the period over which a person is exposed to a health threat. In contrast, short geographical distances to health promoting sites (e.g. parkland), may contribute to good health and resilience. However, there is also a second more qualitative element to exposure to the physical environment. Khan et al. (2009), for example, found that housing and infrastructure were part of the explanation for health inequalities between urban poor and affluent populations. Also the type of water connection or the type of sanitary facility either increases or decreases exposure towards poor public health (UN-HABITAT 2003).

**TABLE 1: Extended Framework for Urban Health: Multi-level Effects of Mega-urban Environments Related to Human Health**

<table>
<thead>
<tr>
<th>Local context / Scale level</th>
<th>Bio-Geo-Physical System</th>
<th>Human Social System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enduring structures and conditions</td>
<td>Climatic zone</td>
<td>Economic systems</td>
</tr>
<tr>
<td></td>
<td>Geology/Geomorphology</td>
<td>Religion</td>
</tr>
<tr>
<td>Global &amp; national trends and dynamics</td>
<td>Global climate change</td>
<td>Culture</td>
</tr>
<tr>
<td></td>
<td>Climatic seasons</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td>Land use and land cover change</td>
<td>Globalisation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Changing role of government</td>
</tr>
<tr>
<td>Municipal level determinants</td>
<td>Urban ecological determinants</td>
<td>Urban sociological determinants</td>
</tr>
<tr>
<td></td>
<td>Provisioning and regulating ecosystem services</td>
<td>Civil society</td>
</tr>
<tr>
<td></td>
<td>Meso- and microclimate</td>
<td>Markets (including informal sector)</td>
</tr>
<tr>
<td>Neighborhood and household level determinants</td>
<td>Natural Environment</td>
<td>Municipal government</td>
</tr>
<tr>
<td></td>
<td>Urban green/park/land</td>
<td></td>
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<tr>
<td></td>
<td>Air</td>
<td></td>
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<tr>
<td></td>
<td>Artificial built environment</td>
<td></td>
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<td></td>
<td>Type of water supply</td>
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<td></td>
<td>Type of sanitation</td>
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<td></td>
<td>Type of housing</td>
<td></td>
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<tr>
<td></td>
<td>Noise</td>
<td></td>
</tr>
<tr>
<td>Individual level effects</td>
<td>Age, gender, education, health knowledge, marital status, place of birth, attitudes, behaviour, etc.</td>
<td></td>
</tr>
</tbody>
</table>
Individual effects

Although the health of a population is determined by a large number of factors (Table 1), we place more emphasis on individual level determinants such as age, education, marital status, behaviours and health competencies. The effects of individual factors are stronger than other level determinants. KHAN & KRÄMER (2010) found that cigarette smoking and smoking inside the home were significantly lower among people with better health knowledge and education. Slum dwellers with better health knowledge also reported better environmental management (e.g. garbage was collected regularly in their areas) and better living conditions (e.g. living in a house getting sufficient light and air) than slum dwellers with poor health knowledge.

Public health interventions and research

One of the fundamental purposes of public health intervention is to promote living environment conditions and healthy lifestyles through environmentally friendly behaviour, health education and improved personal hygiene. Such interventions are particularly necessary for slum dwellers because such people experience a higher burden of diseases, mainly attributable to poor socio-economic and environmental conditions, poor governance, and limited basic and health care resources. Community-based public health interventions thus need to be at the centre of our interest. Several studies have reported on the effectiveness of interventions in developing countries including Dhaka (LUBY 2001; RANA ET AL. 2009; SHAHID ET AL. 1996). For instance, after one study, the incidence of diarrhoea was 62% lower in the intervention community (who twice a week received half a bar of soap and a pitcher to facilitate hand washing) than in the non-intervention community. Through this intervention study, participants were encouraged to wash their hands with soap before eating or handling food and after urination or defecation (SHAHID ET AL. 1996).

Conclusions

Conceptualising urban health not only requires analysis of current health determinants, but should include consideration of the dynamic nature of the cause-consequence chain which underlies the strong effects of, for instance, global climate change. Conceptual frameworks for urban health need to be further extended to consider informal processes and environmental exposures of poor population groups in the megacities of developing countries. Multiple determinants and interacting factors at different scale levels need to be addressed when megacity urban health is investigated. We described urban exposures and the reality of complexity within an extended framework for urban health in megacities of developing countries, in order to support intervention strategies for slum improvement in Dhaka and other megacities in comparable settings worldwide.

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Health governance and the impact of climate change on Pacific small island developing states

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Pacific SIDS are particularly vulnerable to the health impacts of climate change. Interviews with experts examine health sector responses to climate change and key actors setting the agenda.

Introduction

The future implications of climate change have been widely recited, not least within this publication. Yet, to be writing this article from Suva (Fiji), while waiting for a category four tropical cyclone to pass, is a stark reminder of the impact global environmental change is already believed to be having on the most vulnerable parts of the world.

Extending from the Federated States of Micronesia in the East to French Polynesia in the West, Pacific small island developing states (SIDS) are spread over thirty-six percent of the world’s surface and consist predominantly of small, dispersed populations. Pacific SIDS are low-lying developing countries that have been vocal advocates for action on climate change, as they comprise an environmentally fragile region. Pacific SIDS are of particular interest for climate change research due to the high level of environmental change presently being experienced and may provide a barometer for the ability of vulnerable countries to adapt to the health impacts of climate change (Patz & Kovats 2002).

Research into the health implications of global environmental change is an emerging science that has been dominated by efforts to model the future health impacts of processes such as heat waves and other extreme weather events, patterns of infectious disease, and food yields (see for example, Kovats et al. 2005; McMichael et al. 2006; McMichael et al. 2008). Food security and access to fresh drinking water are already recognised as primary threats to the public health of many Pacific nations as saline intrusion into ground water tables is brought about by rising sea levels and increases in extreme weather events (Comrie 2007). The very viability of some islands may be compromised if predictions by the IPCC (2007:2) of further sea levels rise and warming of 0.2 degrees Celsius per decade are realised. While international agreements on emission reductions have sought to conceptualise the impacts of climate change in terms of global temperature shifts, Kovats et al. (2005) remind us that, as far as public health is concerned, other thresholds are also important. These may be the local temperature shifts that see mosquito breeding grounds expand, or the

regular intrusion of salt water into the fresh water lens of an atoll.

Many of the anticipated health effects of climate change in Pacific SIDS are anticipated to be indirect, connected to the increased stress and declining well-being that comes with property damage, loss of economic livelihood, and threatened communities (Lancet & University College London Institute for Global Health Commission 2009). Vulnerability is a concept of particular resonance to Pacific SIDS as colonial legacies, aid dependency, growing remittance levels, and little diversification of exports tie the well-being of Pacific SIDS to the success of overseas economies (Brown & Mineshima 2007; Kaly et al. 2002). The potential for climate change to undermine economic development, and in turn worsen poverty and its antecedents, is a very real concern for Pacific governments and for the health of their populations (Kovats et al. 2005; McMicheal et al. 2008; Morrell et al. 2009). From a governance perspective, this landscape of vulnerability makes the agendas of aid agencies, NGOs and national governments integral to promoting health sector resilience to the effects of climate change.

Governance and the health effects of climate change

Supported by a rapidly growing body of evidence the health implications of climate change are widely cited at international meetings as a reason to demand action on climate change (Kovats et al. 2005:1409-10; McMicheal et al. 2006; McMicheal et al. 2008). Efforts to mitigate the effects of climate change are, however, anticipated to largely take place outside the domain of the health sector, thereby limiting health sector response to adaptation initiatives. Adaptation for climate change is equated by Frumkin et al. (2008) with the well established concept of public health preparedness and necessitates that traditional public health initiatives, such as vaccination programmes, disease surveillance and monitoring, be integrated with weather warning systems, climate forecasts and disaster preparedness. Health system strengthening must be
coupled with local adaptation initiatives that, Pacific countries argue, should be community-driven with both short and long-term outcomes to engage communities (Morrell 2009). Presently, Pacific SIDS are working to reconcile traditional concepts of health and well-being with the Western disease-centred model of health care and the role of donors in facilitating or hindering this approach is explored in this paper (Ueda 1996:220; YANUCA Islands Declaration 2005). In 2009, the Pacific Island Forum Secretariat leaders reiterated a call for overseas assistance to help strained sectors, including health, to adapt to challenges associated with “extreme climatic events, such as tropical cyclones, flooding and droughts, while simultaneously delivering on sustainable development goals” (Pacific Island Forum Secretariat 2009: 4). While attention has been focused on emission reductions in developed and emerging economies, the funding for adaptation initiatives in the world’s most economically and geographically vulnerable regions remains unresolved. For example, international funds established in the late 1990s under the United Nations Framework Convention on Climate Change (UNFCCC), prioritised mitigation of the effects of climate change, with funding for adaptation only becoming available in 2005 and with limited accessibility (MacE 2005; MacEllan 2009).

Inadequate health care infrastructure increases vulnerability to the effects of climate change and reduces the adaptive capacity of nations (Patz & Kovats, 2002). Finau (1994:154) describes the unique geography of Pacific countries as creating “small captive populations” with whom health workers have personal relationships. While this may be the case, the strain on public health is evident with more than 20% of deaths in the region1 attributed to unsafe water, sanitation and hygiene inadequacies (SOPAC 2008). The remote geography of Pacific SIDS also creates numerous challenges for their health systems; amongst these is the retention and training of medical staff, the collection of health system data and the provision of infrastructure (Finau 1994).

Methods

Interviews with academic, government, and non-governmental experts are currently being undertaken to gain insight into the nature of health sector action on climate change. Approximately thirty participants are being sought to participate in interviews from a range of regional and national organisations. The selection of key informants recognises that health policy responses to climate change transcend scale, as local adaptation initiatives are connected to such factors as national capability, regional policies, and global support.

This paper draws on the existing literature and the preliminary results of in-depth interviews with six key informants undertaken in March of 2010. Interviews were between 34 minutes and 1hr 23 minutes in duration and incorporated experts from a range of non-governmental organisations and universities working at national and regional levels. The data was analysed thematically and, due to the ongoing nature of the research, draws considerably from existing studies of health and development in the Pacific.

Results

Health researchers have highlighted the many threats that the populations of Pacific SIDS face due to climate change. While participants in this research did not doubt the presence of climate change several did note that other climatic processes including El Nino weather systems may be the dominant cause of environmental

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1 Data refers to the Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.
change. These participants highlighted the challenge scientists face in isolating the effects of climate change in Pacific SIDS, particularly at the local level, where longitudinal data is sparse. Regardless of the cause of environmental change, experts agreed that action and financial investment is needed to prepare health systems. Community stress as food and fresh water stocks have been eroded by drought and increasingly frequent storm surges were frequently cited. The increased vulnerability of the smallest nations, such as Kiribati, was a concern of most participants who questioned their future in the face of environmental change. The results section examines how health sectors may best respond to the effects of climate change and explores who is driving the health and climate change agenda in Pacific SIDS.

**Health sector action on climate change**

Interviews with key informants sought to identify the health system needs most urgent to reducing the implications of climate change. Participant narratives consistently stressed the need for improved surveillance and emergency preparedness, coupled with concern over the accessibility of health services, and workforce issues, particularly for those residing in more remote areas. These needs are consistent with recommendations for general health sector development identified by KUARTEI (2005) and FINAU (1994) and indicates that investments in climate change should pursue broad goals of health system strengthening, as one participant explained: “We are not in a situation where everything is in place and everything is doing fine and health systems are great and now there is a threat coming through climate change. We’re in a situation where there are a lot of unfinished agendas, so we still need better systems in place and more resources and more developed procedures independent from climate change” (Regional NGO).

Difficulty in the training and retention of medical staff in Pacific SIDS is a problem emerging out of the remote geography that sees healthcare workers spread across hundreds of islands with only one medical school in the region. Meaning, as one participant explained, that health professionals frequently gain their qualifications in developed Pacific Rim countries, and may experience culture shock as they return to their relatively isolated homes that lack many of the resources and technology available in the countries where they received their medical education. The resulting out-migration of health care professionals to Pacific Rim countries including New Zealand, Australia, and the USA is a drain for many Pacific countries (BROWN & CONNELL 2004).

Pacific small island developing states incorporate 20 countries, just five of which have populations greater than 250,000. The administrative load on health systems can be very high as governments seek to undertake many of the same functions as much larger countries, including the collection of health information, but with few resources. Regionalism has become a very important tool to the functioning of health systems in the Pacific, as evidenced by the status of organisations such as the South Pacific Commission and the South Pacific Applied Geoscience Commission that seek to provide monitoring and supporting infrastructure development across the region. Participants highlighted the vulnerability of Pacific SIDS to extreme weather events and stressed the need for strong monitoring to ensure health systems are well prepared in times of disaster. In this respect, regionalism acts as a kind of insurance policy guaranteeing support: “With disaster response a regional approach is very important, I think, because you will always have some countries who are heavily affected and others countries that are unaffected from such a disaster and then it is really important that there is a mechanism in place that unaffected countries can give help to strongly affected ones” (Regional NGO). In this way, resources are pooled.

**Governance and support for action on climate change**

“Here in our division in a week usually we will receive two to three emails or faxes from outside the Pacific Islands where organisations in the US, Europe, Australia look for partners to do work here. Often funding structures for climate change projects requires a partner from a region that is most likely affected by climate change... so many institutions, organisations from all over the world are trying to get us as partners and that’s much more than five years ago, that’s much more than two years ago” (University).

While the topic of aid and its effectiveness is much too large for this paper to address, FINAU (1994) notes that the activities of Pacific health sectors are shaped in part by donor priorities. Climate change, key informants indicated, is currently in favour with funders, replacing previous emphases such as pandemic preparedness. While the focus of funders was seen to fluctuate, key informants identified health system strengthening as the underlying need of Pacific SIDS. Interestingly, interviews with those active in Pacific health sectors described bending their agendas in pursuit of funding including climate change: “When we do research regarding the impact of climate change it has the purpose to strengthen surveillance systems in countries in a general manner” (Regional NGO).

For other organisations, climate change agendas have meant greater collaboration, particularly with or-
organisations involved in the science of climate change, in part, as a means of ensuring their work fits funding criteria. “I think if we’re able to collaborate more with our partner NGOs... they have the scientific data and if we’re able to get this scientific data and see how it fits in with our communities then maybe, you know, the resources are there but it’s a matter of getting us to work together” (National NGO).

While climate change funding for research and surveillance was described by participants as plentiful, investment in grassroots adaptation processes was much more scarce, a concern articulated in recent meetings of Pacific SIDS (MacLellan 2009). Participants working in development organisations to support communities described continued difficulty in securing the resources for basic initiatives such as building sea walls. Considerable frustration was expressed by these individuals that the increasing funds being allocated to climate change prioritise science and monitoring at the expense of population adaptation. Participants were clear that further investment was needed in research and monitoring but saw the need for greater balance in the focus of funders. Current recommendations are for public health professionals to enhance their monitoring of the health impacts of environmental change, to ensure the most vulnerable populations are prioritised and to identify and advocate for adaptation initiatives locally – but is this being matched by funding investments (Frumkin et al. 2008; McMichael et al. 2008)?

Discussion

Calls for action to address climate change frequently identify research modelling the future health impacts of climate change but little empirical work has been undertaken to examine health sector responses to the issue. This article drew on preliminary findings from interviews undertaken with experts in the South Pacific, one of the most vulnerable regions to the effects of climate change, to examine health sector action.

While donor commitment to action on climate change is evidenced in the amount of resources and time being invested in international lobbying, the changing nature of aid priorities highlights the need for governments and NGOs to be adaptable in their pursuit of funding. Participants in this research argued for investment in health system strengthening to adapt to the health impacts of climate change, however, the specific climate change agenda has meant that many of these individuals have manipulated project focuses to gain continued funding as other sources have dried up. These findings are consistent with Barrett’s (2008) research in Niue, a country which has signed nearly thirty environmental agreements at the regional and international level and, in turn, has received generous funding: “Not surprisingly, then, adaptation to climate change is seen as necessary to avoid climate impacts, but also as a source of revenue to augment departmental operating costs and salaries (Barrett 2008:43).” Even more significant for participants in this research was the impact of the global recession on aid levels making funding scarcer,
regardless of any new funding emerging from the climate change agenda.”

This research raises many questions over the nature of health system aid and the effectiveness of climate change funding in assisting adaptation in Pacific SIDS. Human health in the Pacific is being shaped by processes of global environmental change that extend beyond climate change. Debate over the extent to which environmental change in the Pacific can be attributed to climate change remains and may be influencing the availability of international aid. Importantly, we must ask whether the current funding focus on surveillance is intended to distinguish between the effects of human induced climate change from other sources of environmental change in order to determine international obligations.

The results presented here are preliminary, further interviews are currently being undertaken and participants, as with all qualitative data, seek to describe and contextualise the experience of climate change in Pacific SIDS, they cannot be generalised.

Conclusion

Consistent with key informant criticisms of the distribution of aid, the majority of health research on climate change has sought to model the future implications for health. That government and NGO funding is also favouring research and surveillance, raises concerns over how communities already experiencing the effects of global environmental change are likely to secure adequate funds for adaptation initiatives. Non-governmental organisations are already experiencing declining funding due to the global recession and recognise the need to pursue targeted funding, such as that for climate change, to secure future revenue. Interviews with key informants highlight the need for generic health system strengthening, in order for Pacific SIDS to adequately address the implications of climate change. Interviews with key informants indicate that amongst governments and NGOs, the priorities of health system strengthening associated with climate change – pandemic preparedness, disaster response mechanisms, and improved health care accessibility – are already priorities regardless of the climate change agenda that appears to be driven by aid donors. Targeting specific issues may serve to erode the overall strength of the health system.

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References


Abstract

We propose a study that combines population-based malaria transmission data (parasitological and entomological), generated by health and demographic surveillance systems (HDSS), with climate variability data, to develop an early warning system that will be used to predict changes in malaria transmission in Africa and Asia. This will help in defining well-targeted and cost effective prevention programmes. This will help in preventing the transmission of malaria and malaria-related deaths, particularly in children under five in Africa and Asia. The HDSS member centres of the INDEPTH Network (www.indepth-network.org) generate high quality, population-based, health and demographic data on a longitudinal basis, and constitute a critical alternative to the dearth of valid, population-based information in much of the developing world.

Introduction

Malaria remains a major burden and killer disease in the many parts of the developing world, with 90% of the mortality occurring in Africa. An estimated average of 400 million cases of malaria are reported each year, causing more than two million deaths. Children under five years of age and pregnant women are at highest risk of malaria morbidity and mortality (WHO/UNICEF 2003).

Environmental factors affect malaria transmission and, as a WHO report (WHO 2004) points out, may be essential to include in an early warning system for detection of malaria epidemics. The current knowledge about climate change suggests that it is essential to integrate environmental factors in the fight against infectious diseases, including malaria, as we face global environmental changes (WHO 2003). The evidences of climate change are now well established (IPCC 2001) with the expected consequences of temperature increase, change in the hydrological cycle, and increased frequency of extreme events such as droughts, floods, and storms. Such changes are likely to affect malaria transmission patterns by affecting mosquito population dynamics, availability of breeding places, and parasite survival. Several studies have shown that there is a linkage between climate and malaria risk (Craig et al 1999; Ye et al 2007; Ye et al 2007; Tonnang et al 2010). There is a need to incorporate environmental factors into the quest to better understand the causes for changes in malaria transmission.

It is well established that effective malaria transmission is dependent both upon mosquito life cycle and the ability of the parasite to mature within the mosquito. Environmental parameters such as temperature, precipitation, humidity, and vegetation cover have been shown to affect malaria transmission. Temperature was shown to affect the malarial cycle in several ways; mosquito larval development is accelerated with higher temperature, adult survival and parasite maturation within the mosquito (Ye et al 2008). The association between temperature and malaria varies. For example, higher minimum temperature in Uganda led to an increase in vector density in the highlands (Lindblade et al. 2000), while higher temperatures in Kenya were linked with reduced biting rates (Patz et al. 1998).

Studies have shown that humidity affects the life span of the adult mosquito with possible consequences for the effectiveness of malaria transmission (EIR levels). However a study in the highlands of Uganda (Lind-
BLADE ET AL. 2000) noted that humidity level was not a relevant factor.

Land use and land cover play an important role in malaria risk. Proximity to breeding sites such as rice paddies or stagnant water increases the relative risk of malaria (KLEIN-SDSCHMIDT ET AL. 2000). Vegetation cover also influences mosquito survival and longevity and should be considered in a malaria risk assessment.

Some objectives

1. Examine associations between climate variability and changes in e.g. malaria transmission in the study areas.
2. Monitor e.g. malaria incidence in children under five in the study areas.
3. Monitor the effects of land-use and land cover on mosquito-population dynamics and on malaria risk.
4. Measure the mosquito characteristics (e.g. species, age, sex, breeding sites, feeding and resting behaviours and infectivity).
5. Develop and validate models for predicting malaria transmission using the generated data and establish an early warning system.

Gaps that the project is intended to fill

There is a lack of coincidental data permitting a clear understanding of the influence of climatic variations upon malaria transmission. A study using HDSS data can bring light to the relationship between climate variability and malaria transmission by collecting, simultaneously, epidemiological, entomological and environmental data in a concerted manner from several sites in Africa and Asia. The HDSS platform will allow a population-based study and provide the opportunity to follow individuals within households over the entire study period. This approach, which is not commonly employed because of a lack of structural and comprehensive access, allows micro-scale epidemiological studies by measuring trends and changes at a detailed level within populations and has a clear advantage over cross-sectional studies. Furthermore, the coordinated approach among HDSSs with standard methods of data collection will allow covering different ecological settings. Finally, the fact that epidemiological, entomological and environmental data will be collected at the same time for the specific purpose of the study will allow a direct assessment of malaria risk in function of environmental conditions at a micro-scale. Such data have been unavailable at a detailed-enough level and are cruelly needed. In addition, it will be possible to tap into other resources provided by HDSS centres that will have the capacity to capture non-climatic but relevant events affecting malarial outcome, such as change in level of drug resistance, public health interventions (were they to take place), or human migration. This setting represents a unique opportunity of scientific investigation.

Proposed research design and methods

The study will combine retrospective and prospective data (Figure 1). Prospectively, a cohort of sampled individuals in each HDSS will be followed up over three years. They will be visited at defined regular intervals. Their health status will be assessed and all malaria outcomes will be recorded and pathologically confirmed. At the same time, climate parameters (temperature, rainfall, humidity and evaporation) will be monitored using the National Meteorological Service (NMS), own measurement units (digital weather stations) and remote sensing data.

Retrospective data of 30 years climate parameters will be obtained from NMS. This long period data will be used to assess climate variability and change over this period in order to better predict for the coming years. Retrospective (five years) data on disease will be obtained from health care centre records (Figure 2). We will only be interested in the number of malaria cases per month. This data will then be correlated with the climate data.

To examine possible associations between climate variability and changes in malaria transmission

Two different disease risk models will be developed, one based on retrospective data and other based on prospective data. These models will then be combined to develop a validated prediction model for disease risk (Figure 2). This approach allows cross validation between the models. The retrospective models will be used to predict the expected cases of malaria for the three-year follow up. This result will then be compared with the observed cases.

Satellite data on temperature, rainfall and humidity

Weather conditions data will be assessed through remote sensing. MODIS data at 250m spatial resolution and 10 days temporal resolution will be acquired and processed to obtain surrogates or proxies for weather data.

Land based data on temperature, rainfall and humidity

Weather data will be collected using Digital Dataloggers installed in each of the four sites within the health and demographic surveillance area (HDSA), which automatically measure ambient temperature, rainfall and relative humidity every ten minutes. Daily average temperature, relative humidity...
and total rainfall will then be calculated.

To monitor malaria incidence in children under five in the study areas over a period of at least five years.

Figure 3 presents the conceptual framework for field data collection. Malaria infection data among under-five children will be collected by active case detection in each of the HDSS centres during three years. Within site, areas will be selected to represent the different ecological settings. Children will be randomly selected from the HDSS database and identified physically in the field. Sample size will be estimated based on the each HDSS centre malaria prevalence. Methods of collection (field procedures and laboratory analysis) will be harmonised. Clinical malaria outcome will be defined as fever (body temperature ≥37.5°C) and parasite ratio of 5000/µl or greater for highly endemic sites (African sites).

**Sampling Process**

Human parasitological studies require that clinicians treat patients tested positive for malaria parasite, even if such parasitaemias would not normally proceed to clinical infection. It is thus impossible to follow the whole population continuously to discover the time course of natural infections. To overcome this problem a selected cohort of children will be followed up over time and infected children will be dropped from the cohort after initiation of treatment. They can join again after the washout period of the drug.

**Parasites Detection Process**

**Field work** - Malaria infection data will be collected by active case detection over three years. Children will be visited at home weekly by trained interviewers and their body temperature measured using auricular thermometer. All children with fever (body temperature >37.5°C) will be finger-pricked and a fine film prepared. The blood slides will be transported to the laboratory to be stained with Giemsa and read for malaria parasite count. Parasite ratio will be estimated by counting 100 fields and equating it to 0.25µl of blood (Muller et al. 2001). Additional data on malaria treatment (anti-malarial), prevention (use of mosquito net), behaviour and household characteristics will be collected.

**Data analysis** - Incidence will be calculated as the number of confirmed malaria cases within a specific period. Parasite species will be reported and compared using chi-squared or Fisher’s exact test. Parasite density will be summarised using the geometric mean density with 95% confidence intervals. All three indicators will be summarised according to the risk factors: age, sex, site, district, housing conditions and bed net use.

**Monitor the effects of land use and land cover on mosquito-population dynamics and assess the entomological inoculation rate (EIR)**

Mosquitoes will be collected from breeding sites and feeding sites. Ten main breeding sites will be sampled across the study area. Collection methods will include Light Trap Capture (LTC), Human Land Captures (HLC), and Pyrethrum Spray Capture (PSC). Satellite imagery will be used in combination with field surveys to examine land cover and land use.

**Mosquito Larval Habitat and Microclimate Monitoring**

Mosquitoes (anopheles) larvae habitats within one km radius from
human settlements will be identified and a selected sample will be monitored every two weeks. For each habitat, data on pH, temperature, humidity, distance to the nearest house, habitat type, presence and density of mosquito predators and anophelines larval density will be collected. Each sampled larval habitat will be geo-referenced with a GPS unit and integrated into the GIS database for mapping purposes. Mosquito larvae samples will be collected to identify subfamilies within the *Anopheles gambiae* species.

**MOSQUITO ADULT POPULATION DYNAMICS MONITORING**

*Light Trap Capture (LTC)*

LTC method is a standard method for indoor adult mosquitoes sampling used to measure anophelines biting rate (Marrama et al. 2004). Four households (preferably participant households) in each ecological setting will be randomly selected every month for indoor and outdoor mosquito capture. Trained entomological field workers will set up the light traps fitted with incandescent bulbs close to a human volunteer(s) sleeping under an untreated mosquito net in a selected household.

The number of people sleeping under the index mosquito net, other people in the room will be recorded as well as the use of personal protection against mosquitoes for each house (e.g. treated or untreated nets, treated curtains indoor residual spraying or other traditional methods burning of plant etc).

The Light traps will operate from 18.00 to 06.00 hours for two consecutive nights in each house and they will be emptied every morning by the entomological field worker, who will also record the status (off/on) of the light. To avoid sampling bias, different households will be selected every month.

*Human Land Captures (HLC)*

HLC will be used for calibration purposes. The capture will take place every two months in four different households in each site. Mosquito capture for calibration (HLC and LTC) will be performed at the same time in different houses.

The house used for HLC will have one man sitting indoors and another outdoors, collecting mosquitoes that land on their exposed legs using torchlight and test tubes. Two pairs of collectors will be in charge of the HLC. The first pair will interchange their positions every hour and will be replaced by a second pair of collectors after the sixth hour (18.00 to 24.00 hours). There will be no other occupants in these houses used for HLC. Collections will take place from 18.00 to 06.00 hours with the mosquitoes caught during each hour labelled and stored separately. The entomological field worker will be in charge of recruiting the collectors, getting their informed consent and making sure that the collection procedures are respected.

*Pyrethrum Spray Capture (PSC)*

This method will be used to estimate the transmission coefficient from vertebrate to vector. It will be performed for two consecutive nights only during the high transmission period from June to October. In each site, four households (different from HLC & LTC houses) will be randomly selected.

At 06:00 hours, entomological fieldworkers will use white cloth sheets to cover every floor area inside the selected houses. The doors and windows of the houses will be closed, and the inside sprayed with pyrethrum. After ten minutes the unconscious mosquitoes on the white cloth sheets will be collected. These mosquitoes will be used to determine which of the malaria parasites in human hosts are detectable within the mosquitoes.

**Mosquito processing**

Mosquitoes will be brought from the field to the laboratory in a cold-box. Specimens will be counted and sorted by species, and stored in tubes with a small quantity of silica gel in the bottom, separated from mosquitoes with
a small amount of tissue paper or cotton wool. Samples will be labelled according to collection method, position (indoor or outdoor), and the site, ID of the person who was under the mosquito net, the mosquito species and the number. Samples will be stored in a freezer and checked regularly.

Temporal/spatial analysis of mosquito population

Mosquito distribution maps will be generated with the ArcView Geographical Information Systems (GIS). Seasonal variation in mosquito abundance will be examined using classic inference and cross-correlation methods to determine spatio-temporal variation of mosquitoes.

Factors determining the difference in mosquito density among ecological settings, will be assessed using statistical methods, including, multivariate regression analysis, and spatial statistical techniques. Independent variables will include, rainfall, temperature, vegetation types around houses, distance to aquatic habitats, distance to forest or cropland and other environmental variables.

To measure the mosquito characteristics (e.g species, age, sex, breeding sites, feeding and resting behaviours and infectivity)

Mosquitoes collected will be tested for sporozoite infection by ELISA with Plasmodium falciparum sporozoite antigen. Malaria transmission intensity will be measured by the entomological inoculation rate (EIR), which is the product of the human-biting rate, the human blood index and the sporozoite rate.

The human-biting rate will be estimated by dividing the number of freshly-fed indoor resting female anopheles by the number of house occupants. This will directly test whether malaria transmission intensity varies among ecological sites.

Examination of land cover and seasonal variations

Satellite images will be used in combination with field surveys to assess the seasonal variation and different types of land covers during the seasons. LandSat data will be used (visible, near and mid-infrared bands) to map vegetation type/coverage variation, aquatic habitats, settlement patterns and infrastructure. We will conduct a ground survey to assess the accuracy of the land cover classification derived from the LandSat TM. We will then develop land cover classification maps in the different seasons.

The field survey will be conducted by interviewers trained on how to use Global Positioning System (GPS) and to identify the type of land cover and aquatic habitat. They will use Pocket PC-GPS, to allow direct data entry in the field. Surveys will be conducted, in each season, preferably in the middle of the seasons.

Data analysis

A database will be created to include, household GPS coordinates, anopheles mosquito densities, the density of infectious mosquitoes. The geographic coordinates for each household will be overlaid with data on the mosquitoes, humans, malaria parasites and availability of aquatic habitats, using the ArcView and IDRISI GIS systems. Through this process, we will generate dynamic maps of human, mosquito and malaria distribution in the HDSA. These maps will be overlaid on the land cover map generated from the Landsat-7 satellite images. The spatial distribution pattern of mosquitoes and malaria will be determined.

To develop and validate models for predicting malaria transmission using the generated data and establish an early warning system.

Data analysis will involve regression analysis, process based modelling and risk mapping. Regression will be used to estimate some of our model parameters which are not directly measured in the field.

The model will be comprised of non-spatial and spatial components. The non-spatial models will address three epidemiological questions: 1) will malaria cause an epidemic, 2) can malaria persist in a population, and 3) when will epidemics occur and reoccur? Spatio-temporal models will predict where malaria transmission occurs from heterogeneous environmental variables.

Classical epidemiological modelling methods will be used to predict the mosquito threshold density or number of infectious human hosts below which an epidemic cannot occur. Spatial models will then be used to
predict transmission based on climate and land cover use data.

**Conclusion**

Data on geographic differences in mortality or incidence of malaria as they can be provided by health demographic surveillance systems (HDSSs) tend to be related to other variables, which show a similar distribution pattern, for example climate data. But due to the multifactorial nature of the causation of most human health disorders, there is little published evidence due to the multifactorial nature of the causation of most human health disorders, there is little published evidence that changes in population health status actually have occurred as yet in response to observed trends in climate over recent decades. As a result of this situation, the occurrence of malaria and its changes are currently investigated in context with the impacts of climate change and variability on ecological and social systems. This investigation requires population-based data of malaria cases and climate data at the regional or local level, which can be provided by the INDEPTH Network’s centres in Africa and Asia.

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**References**


**FIGURE 3: Conceptual framework for field data collection**

![Conceptual framework for field data collection](image_url)
Health literacy driving change towards equity and sustainability

scenarios on trends, trade-offs and health attitudes

K. Sørensen

A scenario analysis of health literacy as driver for change for equity and sustainability influencing the health attitude of healthy people, people at risk and patients.

The Nairobi Call for action emphasizes the need to support empowerment by ensuring basic education for all citizens; by building on existing resources and networks to ensure sustainability and enhance community participation; by designing health literacy interventions based on community needs and priorities in their political, social and cultural context and by ensuring that communities are able to access and act on knowledge and overcome any barriers to health (WHO 2009). In health promotion, sustainable development is important in terms of building healthy public policy, and supportive environments for health in ways which improve living conditions, support healthy lifestyles, and achieve greater equity in health both now and in the future (WHO 1998). Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED 1987). Health literacy is a prerequisite for equity and sustainability. It encompasses the skills, knowledge and confidence to access, understand, appraise and apply health information in all forms in terms of cure and care, disease prevention and health promotion in order make decisions in everyday life throughout the life course (Sørensen et al. 2010). This implies that all people have an equal opportunity to develop and maintain their health, through fair and just access to resources for health. Despite global strategies, poor health literacy prevails, even in high-income countries, and is likely to contribute to health inequities between social groups (KicKbusch, Wait & Maag 2006).

By improving people’s access to health information, and their capacity to apply it effectively, health literacy is critical to empowerment (WHO 1998). Different levels of empowerment are achieved by the health profiles sketched by Ferguson (n.d) in “The Rise of the Medical Prosumer”, where he discusses self-care involvement and names three groups of patients: the passive patients, the concerned consumers and the health-active prosumers. The term “prosumer” was created by futurist Toffler (1976).
arguing that for most of the last two
centuries, our society has been di-
vided into two groups: the producers,
who make or deliver our goods and
services, and the consumers, who use
them. Toffler believes that in the new
information age, there is the rise of a
third group, prosumers, who produce
many of their own goods and services.
Ferguson claims that health-active
prosumers feel responsible for their
own health, and believe that they can
do more to keep themselves healthy,
and manage illness related problems
better than their doctors can. In
contrast, “passive” patients feel they
need not worry about their health.
When they fall ill, doctor’s magic will
make everything right. Health-active
prosumers no longer subscribe to
this model of medicine. They have
a much more realistic understand-
ing of what doctors can and cannot
do. They know that heart disease
risk increases with smoking, stress,
high blood pressure, lack of exercise,
and lack of social connections, and
they no longer harbor unrealistic
expectations of being “saved” from
self-induced illness. In turn passive
patients expect doctors to take care of
them. In exchange, they are willing to
be helpless and passive, giving physi-
cians the control. Is Ferguson right
that the health-active prosumers are
on the rise and they are committed to
influence their own health, being co-
producers of services and initiatives
and advancing their own health by
playing a sustainable role in managing
health resources?

Inspired by Ferguson’s argu-
ment, this paper discusses three
scenarios considering health literacy as
a driver for change. The paper employs
the “Trilemma Triangle” introduced in
Shell Global Scenarios to 2025 (SHELL
INTERNATIONAL, 2005). The aim of
the study is to explore the trends and
trade-offs with respect to health litera-
cy and health attitudes among healthy
people, people at risk and patients in
the future and how systems and societ-
ies facilitate these processes towards
achieving equity and sustainability.

The trilemma triangle

Shell’s Trilemma Triangle, is in-
tended to capture the full range of the
combinations of three forces chosen.
It can be applied globally, nationally
or on a market or, more generally, on
any community that is bound together
by elements of economic, social and
political organization. An analysis
based on the Trilemma Triangle yields
points representing a unique trade-off
between the three objectives chosen.
It is stressed, that one cannot achieve
the three objectives completely and
simultaneously, as each of the apexes
can be associated with “utopia”. Having
identified fundamental forces that can
shape strategies, what is in focus, is
the more plausible equilibrium states
that emerge, when interacting forces
achieve some kind of lasting balance
and coherence; as to search for more
realistic perspectives than the utopias
can offer. Thus, instead of focusing on
the apexes, the spotlight is directed to
the three zones on the triangle, which
can be called “two wins-one loss”
zones (Figure 1).

The trilemma of health sustainability

Health sustainability and health
literacy as drivers for change will
be explored through the trilemma
sketched by Ferguson. How these
health approaches are changing and
competing is the triggering point
of this study, where a relabeling has
been made of Ferguson’s profiles to be
‘Prosumer’, ‘Consumer’ and ‘Laissez-
faire’ to illustrate a scenario for the
general population and not patients
only (Figure 2).

A kaleidoscopic view through
the prism of the Trilemma Triangle
yields an insight of which trends,
trade-offs and healthy choices the
profiles are likely to influence, and
it can be discussed how this in turn
will impact equity and sustainability
in terms of health literacy driving the
change. The challenge is to locate the
trends, the trade-offs and the focus of
the win-win/one loss situation to make
a forecast on where the equilibrium
can form between the forces mov-
ing towards the utopias of Prosumer, Consumer or Laissez-faire approaches to health in the future.

**Trends**

**Health-active prosumer**

*Kickbusch (2007)* argues that a new society – the health society – is evolving, where a reorientation towards participation and user involvement will be one of the most important governance shifts. The 21st century health society is characterized by two social processes: the expansion of the territory of health and the reflexivity of health. The boundaries of what is called “the health system” are becoming increasingly fluid and health has become an integral part of everyday life. “Health is no longer a given, it is produced, maintained, enhanced (Kickbusch 2007, p. 342).” “Health care ‘should’ be designed like car insurance” according to managing director Mur from Accenture (Finnegan 2010). In the future, citizens have to understand that health care is expensive, that everyone has to have in mind that resources must be managed in a good way, and that they themselves are responsible in the end for the costs, even though it enters the questions of personal freedom. According to *Smith & Duman (2009)* changes in new technology fundamentally change the way information is accessed and will have a significant impact on how patients and the public communicate about health and how they feedback their opinions and needs into a more patient-centered health service. Health information is becoming part of policy and the public increasingly expect that information which meets their needs will be a “given” to provide the ground of becoming active partners in producing own health.

**Concerned consumer**

*Fitzgerald Bone et al. (2009)* identify a pragmatic drive towards the creation of health care systems, which maximize consumer health literacy. They identify areas of concern for both people and health care providers which can be improved and represent new values for change. Plain language as a basic tenet of health care communication is often ignored, and this is more attributed to the communicator than the consumer, though often creating concerns and difficulties. Plain language documents should be designed so that “people can find what they need, understand what they find and act appropriately on that understanding” according to the *USDHHS (2009).* In the future, health literacy will act as a driver of change to overcome misconceptions, where consumers are wasting their money if they have persistent inaccurate beliefs because of lack of knowledge or lack of having “updated” knowledge. When consumers are knowledgeable, they have a higher awareness of risks and the ability of learning will be advanced in the concerned consumer directed future society. The consumer knows the fact – smoking is unhealthy, and that regular exercise and/or dieting are needed to lose weight. The knowledge is there. The desire, for most, is also likely there to quit smoking or lose weight. Yet, the behavior – the long-term commitment – does not occur.

**Laissez-faire attitude**

Research reveals that not only do the situation and other social
factors impact decisions but also the context in which information is presented impacts how that information is perceived and used (Fitzgerald Bone 2009). In terms of information processing, a positive emotional state increases optimism, whereas the negative state increases pessimism (Walters 2008). Research in the area of risk communication demonstrates that heightened emotional states negatively impact one’s ability to process information (Finucane 2008).

The increased awareness and yet, not fully developed critical reflexivity and responsibility seen in the utopia of prosumers, can shape future generations where health care professionals are to play a significant role as advisors and knowledge brokers to meet the concerns of the citizens, the consumers.

Many consumers are operating under resource and ability constraints. About 45 million people in the United States do not have health insurance (US Census 2008), which may influence the consumer’s consideration of costs versus benefits of expensive preventive health care procedures; resulting in inactivity in terms of health status. Almost 20% of the US population performs at the lowest levels of health literacy with very limited skill and significant difficulty in performing simple tasks, such as determining how often a medication should be taken (Educational Testing Service 2004). Health care providers often face challenges when catering to the needs of the communities they serve. Murthy (2009) explains that there is a lack of compliance due to low levels of health care literacy worldwide and though there is a compelling need for effective communication, the process is extremely complicated and often poorly developed. Language, socio-political, economic and cultural barriers, as well as time constraints, pose future challenges to people and health care providers; superficial to be seen as laissez-faire attitudes, but likely to be a lack of compliance due to the structural barriers towards advancing health and health literacy.

Trade-off’s

The trade-offs give us reasons to believe that future developments will not reach the full stage of utopias but may find equilibrium in a stage of win-win/one loss, as there are also hindering factors making barriers to become health-active prosumers, concerned consumers, or having a laissez-faire attitude or showing lack of compliance.

The tendency shows a driving force away from laissez-faire, as to be a passive and compliant person, who follows the physician’s instructions, is no longer sufficient. A rapid transformation of research to news through the media about new cures, new methods of prevention, new confirmation of old behaviors or new changes in healthy behaviors has, as a consequence, health literacy playing a critical role. As more and new information becomes available, it becomes a difficult challenge for ordinary citizens, particularly if they are not well educated or even functionally illiterate. The expansion of health choices and the complexity of health systems drive a demand for an ever higher degree of sophistication and participation than seen before. Yet it appears that the emerging trend of becoming an active and critical consumer (so called prosumer) is too idealistic, and that only few members of the population can aspire to achieve this stage (Kickbusch 2007). Furthermore there are still some major obstacles to overcome, as quality information is not yet “a given” as assumed in the health society. Information provision is often inconsistent and often poorly resourced, new technologies and approaches to developing information, such as social marketing, are quickly changing the landscape for both users and providers and all sectors that produce information have to adapt to changing public demands (Fitzgerald Bone et al. 2009). According to Fitzgerald Bone et al. we must face the fact that consumers are human, they are prone to take the path of least resistance; they have limitations in abilities and resources; and sometimes, simply do not have the need or the motivation to actively engage in their own health; pulling the forces away from the apexes of being concerned consumers or becoming fully empowered, to the level of prosumerism.

Adkins & Corus (2009) offer a broader perspective of health literacy and sustainability than a problem to fix in terms of low functional health literacy scores. Focus should include the consumers’ ability to use other personal and social resources to improve their health. They propose that health care providers should optimize a match between low-literate consumers’ strategies for improving health and the health care provider’s options to give assistance to the consumers on the basis of power relationship, as defined by the consumers, between consumers and providers. Murthy (2009) describes driving forces such as recommendations to promote and improve health literacy among populations, which shift the direction away from the laissez-faire approach and lack of compliance due to health
Focus of equilibrium

The equilibrium focus for the healthy group of people may be a new type of health information user; those who are not yet patients but who can be helped to maintain good health, but who may also be at risk of becoming worried well (NHS Confederation 2008). The increased awareness and yet, not fully developed critical reflexivity and responsibility seen in the utopia of prosumers, can shape future generations where health care professionals are to play a significant role as advisors and knowledge brokers to meet the concerns of the citizens, the consumers. On the other hand, significant change in health care is likely to continue in the future with a greater emphasis on self-management for long-term health conditions and personal responsibility for maintaining good health. The individual is expected to play an active role in their health care; so whereas in the past the individual would have been asked to take medication to treat high blood pressure and visit the doctor for a check-up every few months, they are now and in the future expected to manage their condition and may be asked to follow a low salt diet, measure blood pressure at home and see their pharmacist for an annual medicine use review. (Smith & Duman 2009).

Health literacy is an essential requirement of achieving and maintaining good health because it enables the individual to make informed choices about their health, to self-care, to access services and to navigate their way through an increasingly complex healthcare system (Smith & Duman 2009). To meet such demands, all need to be health literate, and those with a low degree of health literacy skills will be marginalized, further creating a gap. The equilibrium focus is likely to be the win-win/one loss point, which could be labeled the ‘Concerned prosumer’ (Figure 3). If the scenario is realistic, we will see a group of concerned prosumers who are actively involved in their own health, yet not fully committed to all kind of changes towards healthy behaviors. Being humans after all, they will be worried about risks, though they will not take all actions towards overcoming these risks.

According to Kaisel (2007), in line with this forecast, an important shift is occurring away from a cause-and-effect view of health toward a more holistic, ecological language of health. One driver of a new form for health literacy relates to an ecological health model looking beyond single factors to the dynamic interplay of social, environmental, economic, and behavioral, as well as biological determinants of health. A second driver has been the unveiling of the detailed mechanisms behind health and disease through sequencing the human genome, which expands the understanding of genomic discoveries in an ecological perspective. A third driver is the growing understanding of social epidemiology and the understanding that health is determined by non-biological as much as biological factors. The fourth driver is the growing burden on individuals to manage their own health risks and expenses.

Conclusion

By using Shells’ approach of the Trilemma Triangle; future scenarios of health sustainability have been drawn and an equilibrium focus has been identified, which could be linked to the development of a new health attitude, labeled the concerned prosumer. Health is becoming ecological, and from a consumer perspective, the language of health has broken free of the doctor’s office and is becoming firmly entrenched in the landscape of commerce (Kaisel 2007). The forecast corresponds with a recent call that envisage the scope of health literacy to
be expanded to include the ability to access, understand, evaluate and communicate information on the social determinants of health. Improving health literacy is an important element of strategies to reduce health inequity. This requires good, reliable, accessible information tailored to the needs and circumstances of different social groups. It involves the ability of public and private sector actors to communicate health-related information in relevant and easy-to-understand ways in general, and requires improved awareness and knowledge of health literacy among health professionals in particular (CSDH 2008). Improved health literacy can drive change towards active participation and a high degree of knowledge and awareness, which is required in future health-care and self-care management. Health equity and sustainability is yet to be achieved, as long as a gap exists. To narrow this gap between those who have capabilities and those who do not, it is important to recognize that it is a fundamental goal for all to improve health literacy.

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Globalization is profoundly affecting the way we live on this planet in a multitude of ways that are diverse and beneficial, yet also intricately damaging. Hypermobility of information, people and goods usher in unprecedented business opportunities and fabulous wealth. Information technology enables us to live in a global village. The separation of physical space seems not to matter as ubiquitous audiovisual peripherals enable us to vicariously experience a competitive run of the real thing. Faster and larger vehicles ply our airspace and oceans to move us and our goods ever more rapidly. New ideas and value-laden visuals in full color also travel at lightning speed over broadband video technology to reach even the humblest living room.

However, in this context of a booming global economy, cultural convergence and human mobility, stark and serious issues loom large. Issues of social justice, distribution of resources, and ethnic identity and social exclusion cry out to be heard. Underlying concerns related to the financial crises of the past 20 years, hypermobile capital, unstable labor markets, transmission of disease, brain drain and complex emergencies involving local and international conflict dot the terrain of international concerns. Abject poverty continues to grip a third of humanity, whereas the world’s top 10% have 3000 times more wealth than the lowest 10% of humanity (Davies et al. 2006). Global markets have grown through trade liberalization and market integration, but the parallel development of economic and social instruments and laws have not kept pace. Consequently, the world, especially the poor, is faced with the unfairness of global rules and its cascading side-effects that manifest in tribulations such as job insecurity and gender inequality (WHO 2008). Such inequalities are projected to affect at least 80% of humanity in the next 20 years. And on top of this, the issue of climate change has emerged as perhaps the most pressing one of this century, and one that embodies the ills of all the above.

We come with the belief that in an era of economic growth and overriding veneration of materialism, production is the competitive force that separates winners from the losers. The prevailing wisdom noted the availability of unlimited supplies of fossil fuel on this one earth to power this growth. However, time catches up with our folly and makes it clear that such a way of life cannot continue unabated. But the momentum of the economic behemoth cannot be halted at will too. Perhaps the glitter of gold is too bright and blinds our vision from the impending precipice which global warming and climate change are inexorably leading us to.

Prescient warnings of scientists have fallen on deaf ears for several decades. More recently, the UNFCCC’s reports have repeated these warnings with embellished data. But there still are no takers as world leaders grapple with the tantalizing temptations of the global marketplace and the fear of losing out on market share. However, as blistering heat waves stupefy our minds and bodies with alarming regularity every year, devastating galeforce
winds of all-too-frequent cyclones demolish our homes, or flash floods and inundations from the unrelenting monsoon rains lay waste human settlements and labored farmland, and devastating droughts and irreversible desertification displace humans from native spaces, the enormity of human misery and loss of life that can be attributed to mega global greed is all too evident. Unfortunately, the convergence of global leaders at COP15 at Copenhagen did not provide us with a convergence over a solution but only yielded yet another year of wait for citizens of the earth and an equivalent slot of time for the machines of global growth to litter and pollute some more. No doubt, there will now be renewed hope on the Mexico Summit for a decisive decision that can save us. Perhaps the Gulf of Mexico oil spill being fresh on our minds will make our hidden guilt surface.

We need to bring the agendas of separate development programmes together for a converging synergy of solutions. But this can only happen if the sectors that manage socio-economic affairs talk to each other with a genuine willingness to see the woods from the trees. Perhaps, all this knowledge that appeals to the head must now be translated into the language of the heart to arouse the poignancy of feelings and sensibilities. This colossal agenda will require transcendental awareness and a herculean effort, with the underlying understanding that it involves the very survival of the human race. This understanding must also be embedded in the acceptance of our mother earth Gaia, as living and compassionately providing us humans perhaps the only home in this universe.

In a similar vein, to address many of the above concerns, the health sector advocacy must necessarily and unrepentantly venture out of the domain of medical and clinical services promotion. Addressing the geographically expansion of disease vector prevalence, the emergence of new diseases and study of the ecology of new infections, the stress and disease propensity of urban settings, internal migration and its attendant health concerns, just to name a few, are quite beyond the ability of many national health authorities. Incidentally, however, there are many entry points for immediate engagement. WHO’s primary health care programmes since the 1980s, its push for national environmental health action plans (NEHAP) – in progress in most countries now for the past 17 years since Rio –, its related actions on healthy cities and more recently its focus on social determinants of health (SDH), the GATS and TRIPS dialogues of the World Trade Organization, and National Climate Change Adaptation Plans of several countries all provide the openings for advancing partnerships with other sectors. All this requires enhanced will to work with others.

All our knowledge of these happenings has been the result of applying our analytical skills and models from economics and the physical and biological sciences. The prevailing rigor of scientific methods has helped us enumerate our global problems and map the terrain as never before. However, this knowledge must now be put to practice to demonstrate the benefits of reduced risk and vulnerability. The “whats” must now give way to “hows”, and much of what we do in mitigation or adaptation in the climate change agenda must require the understanding of human behavior in models that strive to reverse the tide. This implies the rigorous application of social sciences to understand how best to address behavior change and mitigate or adapt. Here too, a convergence of research and review will be needed to enable greater programme effectiveness through the lessons learned from each method of inquiry. For the health sector, the internal programmatic par-
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