A DISCUSSION DOCUMENT *

Global Ecological Integrity and 'Sustainable Development': Cornerstones of Public Health

by

Colin L. Soskolne *and* **Roberto Bertollini**

based on an

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*** This discussion document is 74 pages in length, comprising a cover page, a 1-page Preface, a 1-page Executive Summary, a 2-page Reader's Guide, 4 pages including a Table of Contents, Acknowledgements, Keywords, and a List of Acronyms, a 1-page Foreword, a 22-page Workshop report, a 6-page Reading List, a 3-page list of Workshop participants, and 20-pages of Annexes containing a synthesis of each report presented at the Workshop together with a summary of the discussion that followed each presentation. Also, four *post hoc* contributions (on 12 pages) are included, together with a 1-page Directory of Resources.**

Preface

The discussion document "Global Ecological Integrity and 'Sustainable Development': Cornerstones of Public Health" stems from a Workshop arranged by the World Health Organization's European Centre for Environment and Health, Rome Division, December 3-4, 1998. It was written by Colin Soskolne and myself and presents a summary of the Workshop discussion and subsequent exchanges of opinions of experts world wide. We believe that global change has become an issue warranting public health involvement. The public health community needs to face the challenges presented by global change and equip itself with the necessary scientific and technical means to anticipate and, where possible, prevent human health consequences arising from degrading life-support systems. This document is neither intended to be conclusive nor to reflect a WHO position on these matters. Rather, it is a contribution to the discussion on the human health consequences of global change. It is provided for the scientific community at large as a basis for future thinking and planning in this area. Comments, suggestions and criticisms are encouraged. Inputs will be expanded upon at a larger Workshop in the near future. For communication purposes, please see page 22.

Roberto Bertollini
Director, Rome Division
World Health Organization
European Centre for Environment and Health

Executive Summary

Humans, like other forms of life on Earth, are dependent upon the capability both of local ecosystems and of the global ecosphere for maintaining health. However, in relatively recent times, humans, particularly in industrialised countries, have developed an erroneous perception of being separate from nature's processes.

Many different measurement techniques show that current global patterns of human activity -- over-consumption, population growth and inappropriate use of technology -- are unsustainable and are likely to have profound consequences for human health. Major changes in policies that govern society are to be sought if emerging trends in ecosystem degradation resulting from human activities are to be arrested. Rational changes in policy will require the availability of scientific information appropriate to measuring global changes.

Mainstream economics continues to assume that consumption-based economic growth is the essence of development, persistently disregarding questions of fairness and equity, and displaying an uncritical technological optimism. The "technological fix" ideology reaffirms the unfortunate belief that "human survival is independent of nature". Human population health under such a model of development is placed at increasing risk as resources (i.e., natural capital) decline and ecological systems fail.

Potential solutions lie in models that focus more on social, informational and service-based "development" than on "growth". The challenges for science and society are unprecedented. Vigorous public discourse, engaging all regions of the world and all sectors of society, is urgently needed. With public support, policy-makers would be enabled to acknowledge the problem and to implement corrective policies.

Knowledge that transcends the boundaries of traditional scientific disciplines is necessary for achieving inter-disciplinary scientific understanding and consensus, and for reaching agreements among a plurality of societal interests and viewpoints in order to promote appropriate policy changes. Indeed, trans-disciplinary and multi-stakeholder consensus are prerequisites for new forms of monitoring, surveillance and assessment of ecological changes as well as their impacts on population health.

Because of WHO's strengthening commitment to healthy environments, social equity and sustainable development -- essential ingredients for the improvement and maintenance of population health -- it would be appropriate for the Organization to consider integrating the issue of failing life-support systems onto its agenda. Tools to monitor and evaluate changes in the quality of life-support systems, their subsequent health effects and the effects of interventions will have to be developed. Engagement with this topic would require public health sciences to become proactive; their more typical reactive role of documenting the adverse health consequences of recent-past circumstances is no longer adequate under global change.

The concerns raised in this discussion document are of great potential consequence. They are also of an unfamiliar type and scale. The challenge lies in communicating the message contained in this document in a credible way to the various constituencies by which it is intended to be taken seriously.

Reader's Guide

Humans, like other forms of life on Earth, are dependent upon the capability both of local ecosystems and of the global ecosphere for maintaining individual and population health. Indeed, it is Earth's biophysical functions that maintain all life on the planet. However, in relatively recent times, humans, particularly in industrialised countries, have developed a perception of being separate from nature's processes. This perception has been enhanced by evidence of our species' ability to survive -- and even to thrive -- in "islands" of ecological impoverishment such as major cities, thus reinforcing a view that human survival is independent of nature. Both traditional knowledge and more recent scientific understanding indicate that this view is wrong.

While individuals and populations can thrive in local environments that have undergone ecological degradation, their health is maintained by subsidy from productive ecosystems elsewhere. Trade and technology thus serve to "distance" human health from its very life source. In reality, and increasingly so, local populations not only degrade the natural resources and ecosystems within their own political boundaries, but also those of the global commons (i.e., in countries or regions elsewhere on Earth). This relationship is unlikely to be sustainable in the long run under conditions of continued population and material growth.

The World Health Organization (WHO) Regional Office for Europe, Rome Division, has completed an initial exploration of this topic through a "pilot" Workshop. Available scientific evidence and philosophical considerations pertaining to the possible impacts of global ecological degradation on human health were reviewed. In part, the Workshop considered the scientific and philosophical bases for recommendations to effect paradigm shifts in social policy for a sustainable future. More directly, participants considered opportunities for and potential obligations of public health agencies, such as WHO, to help direct future research, identify and monitor relevant environmental, social and biological indicators, and contribute to the formulation of policy initiatives in the context of "sustainable development[#]".

The ideas contained in this document are intended to stimulate discussion on this complex topic. Policy formulation *per se* was not a goal of the Workshop. Given the breadth of disciplines needed for understanding the issues related to global ecological degradation, the document does not presume to convey the needed level of information from each area.

Some of the science and philosophy pertaining to global ecological degradation -- referred to more formally as loss of ecological integrity (EI) -- and its implications for human health are detailed in the Annexes to this document. Possible roles for public health agencies in addressing these emerging public health issues are suggested. The Annexes also present participants' concerns with respect to shortcomings in our understanding of this new field of study, the manner in which these scientific and value-based issues are addressed, and the future role of public health agencies *vis à vis* the inherent tendency for public health to treat human health separately from ecology.

The Workshop assessed that current world-wide patterns of over-consumption, population growth and the inappropriate uses of technology are unsustainable. Assessment methods included the ecological footprints of nations, the Index of Biological Integrity, the Measure of Mean Functional Integrity and the World Wide Fund for Nature (WWF) analyses. The use of each of these indices reveals that environmental degradation has the potential for severe negative human health impacts. Infrastructure is needed to establish and maintain data that are adequate for improved scientific assessments of resource depletion and health risks.

[#] "Sustainable development " is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission Report, 1987)

Consensus was reached that major paradigm shifts are needed in social and economic policies if current trends in ecosystem degradation resulting from human activities are to be arrested. To date, policies for a sustainable future have not been implemented. Because of WHO 's past successes and the respect that the Organization commands internationally, the Workshop recommended that WHO consider integrating the issue of global ecological integrity onto its agenda. WHO is now well-positioned to assume greater responsibility in catalysing and harmonising international efforts toward sustaining population health. After all, if public health and, indeed, human well-being are at stake, what agency is better suited to assume this mantle?

The global community needs sophisticated analyses of the linkages, both proximate and distant, for the relationship between levels of human health and EI, as well as for its converse, human disease and ecological disintegrity. WHO and other public health agencies need to seek tools to monitor and evaluate the changes in life-support systems, their subsequent health effects and the effects of interventions.

Several presentations indicated the need for major changes in the consumption patterns prevailing mainly in developed countries, and in the population growth rates prevailing mainly in developing countries. These proposed changes would need to proceed under an operating principle of local, regional, global and intergenerational equity if nature's services are to be maintained. While human rights must be respected in the anticipated process of change, there is a greater duty to acknowledge that human impacts on the ecosphere upon which humanity depends for its collective health and well-being must be recognised.

The challenges are great for science and society. Vigorous public discourse, engaging all regions of the world and all sectors of society, is urgently needed. In working democracies, policy-makers require public support to implement policies. Maintaining effective dialogue, facilitated through grass roots information exchanges that encourage support for substantive shifts in social and economic practices, presents a great challenge. In non-democracies, enlightened self-interest among policy-makers may be appealed to as the motivating force for needed policy shifts.

Trans-disciplinary and multi-stakeholder consensus is needed if necessary monitoring, surveillance and assessment programmes are to be implemented. Successful implementation would provide a basis for formulating rational policy toward maintaining an environment capable of supporting a sustainable future. Degradation of ecosystems will have to end if global resources are to recover and be permitted to maintain themselves. Only then will we have a sufficiently healthy ecosphere to continue supporting human life. Hence, global ecological integrity, including the health of ecosystems and climate change, is identified as a paramount determinant of public health. Thus, WHO should consider contributing as a major player to the maintenance of EI.

The thought-provoking discussion at the Workshop stimulated two creative documents: a poem by Waltner-Toews and an essay by Hess, both very different in their approach. Also, two external reviewers of this document (Vineis and Richter) contributed an essay. These are included as Annexes to this document, complementing and challenging its themes. These *post hoc* contributions demonstrate the constructive nature of multidisciplinary interactions and exemplify the blend of science and art needed in discussions about possible paradigm shifts.

Finally, engagement with this topic represents an attempt by public health sciences to become proactive -- in relation to unprecedented large-scale anticipated changes -- as opposed to continuing with the more typical reactive role of documenting the adverse health consequences of recent-past circumstances. The concerns raised in this discussion document are dramatic, even shocking. The challenge will be to communicate its message credibly to the constituencies by whom it ought to be taken seriously.

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The Workshop was organised by Colin Soskolne, chaired by Roberto Bertollini, with Morgan Scott acting as Rapporteur. The organisers gratefully acknowledge all of the Workshop participants who contributed either by presenting information, participating in discussions, and/or by providing follow-up written submissions. The list of participants can be found on pages 29-31.

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The draft document was reviewed by 11 experts (who did not participate in the Workshop) to ensure external input to the WHO Workshop process. Some of these external reviewers provided valuable substantive suggestions that have been integrated into the document. The 11 external reviewers, whose efforts are greatly appreciated, were: Solomon Benatar, Eric Chivian, Paul Epstein, Silvio Funtowicz, Kenneth Jubber, Tord Kjellström, Anthony McMichael, Elihu Richter, Carlos Santos-Burgoa, Benedetto Terracini, and Paolo Vineis. It has been both a pleasure and privilege to work with these experts in preparing this document.

Efforts to include known contrarian perspectives through external reviews were unsuccessful.

This discussion document was conceived, compiled, co-ordinated and edited by Colin Soskolne based on the initial draft Workshop report prepared by the Workshop Rapporteur, Morgan Scott, and the subsequent and successive feedback from the reviewers. Roberto Bertollini's direction and input throughout the entire process are noted with gratitude. Francesca Giampieri served as the project librarian. Enrico Nasi provided computer and internet expertise. Editorial assistance was provided by Philip Gorman.

Individual authors bear responsibility for the content of their own presentations contained in Annexes I and II. Responsibility for the Workshop report component rests with its authors, Colin Soskolne and Roberto Bertollini.

Keywords

Ascetic Ethic
Adaptation
Advocacy
Agroecosystem Health
Anthropocentrism
Antibiotic Resistance
Behavioural Psychology
Biological Integrity
Biosphere
Biotechnology
Children
Climate Change
Community
Consumer Movements
Consumption
Democracy
Determinants
Development
Ecocide
Ecological Capital
Ecological Degradation
Ecological Disintegrity
Ecological Health
Ecological Integrity
Ecological Economics
Ecological Footprint
Ecology
Economics
Ecosphere
Ecosystem Health
Ecosystem Impoverishment
Education
Environmental Degradation
Environmental Health
Environmental Integrity
Environmental Sustainability
Epidemiology
Ethics of Integrity
Equity
Family Planning
Functional Integrity
Future Generations
Genocide
Global Change
Global Ecological Integrity
Globalisation
Grass Roots
Human Health
Human Rights
Index of Biotic Integrity
Index of Biological Integrity
Inequalities and Health
Information Dissemination
Interdisciplinary
International Organisations
International Perspectives
Law
Life-Support Systems
Mass Media
Measure of Functional Integrity
Mitigation Measures
Molecular Mechanisms
Multinationals
Natural Capital
Non-Governmental Organisations
Ocean Enrichment
Paradigm Shifts
Partnerships
Philosophy
Policy
Population Growth
Poverty
Precautionary Principle
Predictive Modelling
Principle of Integrity
Public Health
Research
Restoration
Scientific Uncertainty
Socio-Economic Development
Sociology
Stakeholders
Structural Integrity
Sustainable Development
Systemic Integrity
Technology
Theologians
Thermodynamics
Trade Unions
Trans-disciplinary
Upstream determinants
Vested Interests
Water Quality
Women

List of Acronyms

AIDS	Acquired Immuno-deficiency Syndrome
BCSD	Business Council for Sustainable Development
BSE	Bovine Spongiform Encephalopathy
DNA	Deoxyribonucleic acid
DPOR	Directory of Personnel and/or Organisational Resources
EI	Ecological Integrity
ECEH	European Centre for Environment and Health
GDP	Gross Domestic Product
GMO	Genetically Modified Organisms
IBI	Index of biological (or, biotic) integrity
ILO	International Labour Organisation
ISDE	International Society of Doctors for the Environment
IUCN	International Union for the Conservation of Nature
MFI	Measure of functional integrity
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PI	Principle of Integrity
SOP	Second Order Principle
SO_2	Sulphur Dioxide
SSHRCC	Social Sciences and Humanities Research Council of Canada
TV	Television
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
US	United States
USA	United States of America
UV	Ultraviolet
VRE	Vancomycin resistant enterococci
WHO	World Health Organization
WRI	Word Resources Institute
WWF	World Wide Fund for Nature

FOREWORD

In this *discussion document* we have attempted to synthesise current state-of-the-art scientific and philosophical knowledge covering the broad areas of global ecological integrity in relation to public health and with a view to "sustainable development". We hope to extend the thinking embodied in previous reports cautioning about the implications for both human and other forms of life on earth should life-support systems be degraded. Life-support systems of concern include fresh and ocean waters, fisheries, forests, climate, soils, air, as well as biodiversity. Current indications suggest that not only are certain life-support systems malfunctioning, but some are even collapsing.

Concerns have been addressed about the ecological sustainability of life-support systems and its implications for human health. Particular examples of note include the Stockholm Declaration of 1972, and the Club of Rome reports (see DPOR, Annex III) since the early 1970s. Several others include the Brundtland Commission Report in 1987, and, more recently within the World Health Organization itself, the publication of "Our Planet, Our Health" in 1992. Thus, almost all of the topics raised in this document have been addressed to some extent before. Indeed, since biblical times (referring here to the Four Horsemen of the Apocalypse: famine, pestilence, war and conquest), philosophers, scientists, thinkers and futurists have voiced concerns about the human health consequences of ecological degradation. Some cultures and religious groups continue to this day (e.g., North American Indians and Buddhists) to believe in living in harmony with the environment.

It is from the work of all those who have contributed to this discussion in the past that this document derives much of its basis and richness. From the more recent period, which served as the major stimulus for the Workshop, the WHO publication "Our Planet, Our Health" broached many of these issues. Of particular note is Anthony J. McMichael's subsequent book, "Planetary Overload: Global Environmental Change and the Health of the Human Species". A few years later, in 1997, WHO's report "Health and Environment in Sustainable Development: Five Years after the Earth Summit" was published. More recently, McMichael and co-workers published their paper entitled "Globalisation and the sustainability of human health", which bridges the broad issue of ecological integrity (EI) with environmental epidemiology and public health. The concerns raised continue to attract increasing attention.

Where this document differs from its predecessors is in its framing of the issue and in its timing. The information upon which concerns are now based draws upon more systematic data and reflects longer-term trends. Hence, the concerns are more compelling. Furthermore, the political climate now may have become more receptive to new priorities, packaged differently, in order to have access to options that are conducive to a sustainable future. The combination of these circumstances means that the message contained in this document could actually trigger global actions where previous efforts, whether in the form of conference reports, books, agency reports or movies, did not.

This *discussion document* also differs from all prior reports in that it calls upon WHO to recognise the issue of global ecological integrity as one of its foci for future activities. It calls upon WHO to consider placing the issue squarely onto its agenda for health in the new millennium, working jointly with related UN agencies playing their respective full and integrated roles.

The serious nature of the message stemming from the December 3-4, 1998, pilot Workshop suggests the need for a full-scale Workshop which would base its agenda on this *discussion document*. The challenge for a future event will be to present its message in ways that will lead to determined and targeted research and policy actions.

Introduction

A “pilot” Workshop was convened at the WHO/ECEH offices in Rome, Italy, December 3-4, 1998. The overall objective of the Workshop was to conduct an initial review of the available scientific evidence and philosophical considerations pertaining to possible impacts of global ecological disintegrity (or, ecosystem degradation) on human health while bearing the principle of “sustainable development” in mind. In part, the meeting was designed to convey the relevant information with respect to this emerging field of study. Most importantly, the participants were asked to consider the opportunities and potential obligations of public health agencies, such as WHO, in helping to direct future research, in identifying and monitoring relevant indicators, and in contributing to the formulation of policy initiatives in this area. As an initial foray into this complex area, the ideas contained in this document are intended to stimulate discussion on ecological integrity and human health as a multidisciplinary learning exercise; policy formulation *per se* was not a goal of the Workshop.

This discussion document is structured around a series of primary and secondary objectives (see the following section) from which the participants were directed to formulate their analyses and responses. The scope and purpose of the meeting are presented, along with the list of objectives for transparency purposes. The science and philosophy pertaining to global ecological integrity and its implications for human health are detailed in participants' presentations in Annex I.

The Workshop discussion summarised here explored scenarios for human health in the face of increasing ecosystem degradation and suggested possible roles for public health agencies in addressing this as an emerging public health issue. In addition, this document presents participants’ concerns with respect to shortcomings in our understanding of this new field of study, the manner in which these scientific and value-based issues are addressed, and the future role of public health agencies *vis à vis* the inherent tendency for public health to treat human health as being separate from ecology. Conclusions and recommendations are included.

The concept of "global ecological integrity" may be new to most readers of this discussion document. It is defined more completely in the Annex by Westra. The word "integrity" connotes neither propriety nor honour, but wholeness or integration of ecosystem structure and function. In essence, it is an umbrella concept that includes the following components: the ecosystem must retain the ability to deal with outside interference and, if necessary, regenerate itself following upon it; the systems’ integrity reaches a peak when the optimum capacity for the greatest number of possible ongoing development options, within its time/location, is reached; and, lastly, it should retain the ability to continue its ongoing change and development, unconstrained by human interruptions, past or present. (Westra 1994). Terms more familiar to most might include "ecological health", or "ecosystem health". Throughout this document, it is the term "ecological integrity" (EI) that is used frequently. It should be noted that the converse of these terms, namely, "ecological disintegrity", "ecosystem impoverishment" and/or "ecological degradation" are used to convey the opposite of a state of integrity and/or health. "Biological impoverishment" lies at the base of each of these latter terms.

There is a need to distinguish between those familiar "life-support systems" that are associated with medical care facilities, and those, much less appreciated, that are integral to the biophysical functions of the ecosphere and thus sustain life on Earth. In the medical context, life-support refers to generally controllable and artificial services in the main targeted at a single patient. In the ecological context, life-support refers to "nature's services", from which all living organisms and living systems derive their viability. It is in the latter context that the term "life-support" is used throughout this discussion document.

We explore the potential role of public health agencies such as the World Health Organization (WHO) in the General Discussion section of this document. These discussions were framed around the secondary objectives and centre on: 1) WHO's role in recognising the implications of ecological disintegrity for public health; 2) WHO's role in encouraging the scholarly research necessary to acquire high quality qualitative and quantitative data (including case studies), integrating data sources, developing appropriate analytical methods, and developing predictive scenario-based assessments (modelling); and 3) WHO's role in advocacy and policy development within the context of sustainable development, with regard to such contentious issues such as over-consumption, population growth, social inequalities, poverty, continued environmental degradation and their impact on health and well-being. This document is confined to a discussion of the topics that took place in accordance with the Workshop agenda.

This discussion document is intended to serve as a resource for future work in this area. A Directory of Personnel and/or Organisational Resources (DPOR) has been started and is available on page 64, with a view to facilitating follow-up work.

Scope and Purpose of the Workshop

Until recently, science has been preoccupied with reductionist, specialised approaches in pursuit of specific questions or goals relating to scientific sub-specialty interests. Masses of data have been produced in the ecological and human health realms at the local level. However, there has been relatively little attention to a global synthesis. With a multi-disciplinary approach to this disparate knowledge base, a more holistic picture of the global state of, and trends in, life-support systems is possible.

This Workshop was a first attempt to reflect on the global condition from a public health perspective. A distillation and synthesis has been made of selective knowledge at hand, and a determination reached about the extent to which current science is sufficiently certain to draw conclusions about the state of global life-support systems. Where the knowledge-base is not sufficiently certain, discussion took place concerning what improvements would be required in the indicators of EI, environmental health, as well as human health, before sufficient confidence could be associated with them to rationally argue for changes in social and economic policy. Where knowledge is ill-developed, the information needed must be identified and the necessary infrastructure set in place to ensure that the essential data are gleaned for the purpose.

Up to now, scientists have not systematically linked life-support systems with human health concerns on a global level. In this Workshop, an attempt has been made to combine numerous disciplines (see section on Composition of the Workshop) to examine the current state of life-support systems.

By way of background, the Workshop participants were told the following: "Traditionally, public health risk assessment has been based on empirical exposure data around which substantial uncertainty has existed. We now are proposing **scenario-based risk assessment** as the method to address questions of global ecological disintegrity and human health. We suggest as a method conducive for identifying and establishing the most appropriate indicators as measures of declines in life-support systems, and for measuring the impacts of such declines on the health of humans. However, this method introduces yet another level of uncertainty in that not only are the exposures uncertain, but the scenarios themselves (i.e., the potential outcomes) are speculative. Despite the above-noted uncertainties and in light of the social relevance of the question, we propose that understandings must be sought to provide us with tools, both sufficiently sensitive and specific, to evaluate changes in both life-support systems and any associated negative human health impacts, as these occur. With appropriate indicators, close monitoring of changes in any of them should serve as an early warning signal

to indicate society's movement toward any of the possible scenarios under a model of declining life-support systems".

"In this way, through appropriate shifts in social policy, it would be possible to monitor the impacts on life-support systems, an essential component for determining whether changes in social policy are adequate to protect us from the impacts of possible declines on health. Any method that we can develop to measure changes that may help society to avoid harm to its health, is our goal. A greater alliance between science and policy is a likely result".

Two days were devoted to a scientific and philosophical discussion of the multidisciplinary methods and findings from research into global ecological integrity and its relationship to the health and well-being of both human and non-human life forms. The Workshop was regarded as a "*Pilot Workshop*" because it was organised on a smaller scale and hence had a lower level of representation of expertise and world views than would have been expected for a standard WHO Workshop.

Objectives

Primary Workshop Objective

To provide an understanding of both the science and philosophy underlying the concepts of "global ecological integrity" and of "sustainable development". The relationship between these two concepts was to be used as the basis for assessing the science that is driving concerns about the potential consequences for human health of global ecological disintegrity. Implications that this may have for public health policy were to be considered.

In order to prevent negative scenario-based assessments, necessary remedial shifts in existing policies and paradigms related to public health (including both social and economic policies and paradigms) were explored. The findings, concerns and remedial actions needed were discussed among the scientists, philosophers, and others present over the two-day session.

Secondary Workshop Objectives

1. To explore whether "environmental sustainability" is actually attainable, or whether humanity has impacted the environment beyond its self-perpetuating maintenance needs and even beyond its potential to be restored. Indeed, is sustainable development completely harmless to human life and/or to those life-support systems upon which human life itself depends? What is public health's role in these discussions?

2. To recognise what the public health consequences might be of a non-sustainable environment over the short-, medium- and longer-terms. What adaptations are feasible in the face of progressive declines?

3. To explore those interdisciplinary options to build partnerships for achieving perceived necessary mitigative approaches (including potential restorative approaches) toward an environment capable of sustaining life. Should this be a major mission of public health in the 21st century?

4. To make public health recommendations for adaptations in anticipation of health effects associated with a non-sustainable environment. This will be scenario-based, addressing both progressive declines as well as precipitous declines in ecological capital.

5. To determine whether there is any role for national and international public health and related agencies to play in this arena, and what this/these role(s) might be[#].

6. To identify the kinds of data to be collected if public health sciences (including epidemiology and ecology) are to play a more useful role in evaluating the effects of progressive global ecological disintegrity on public health, and for predictive purposes.

7. To explore needed shifts and even new paradigms for social and economic policies that might better ensure a sustainable environment for public health. The role of any NGOs in the Workshop would help to identify consumer movement roles for influencing social change at the grass roots level.

8. To identify those shifts and new paradigms in social and economic policy that will be needed if corrective environmental restorative measures are to be accomplished in the projected time frame for the public's health.

9. To declare the extent to which public health researchers and/or practitioners should become involved in advocacy on these matters.

Composition of the Workshop

Before understanding the nature of the Workshop discussion, it is pertinent to know about the context within which the discussion took place. Context, of course, is established by virtue of the perspectives brought to the table by each of the participants. The disciplines included in the Workshop were the biological and ecological sciences, biostatistics, community and regional planning, ecological economics, emergency assistance, environmental ethics, environmental epidemiology, food sciences, forestry, health economics, human ecology, psychology, public health, water sciences, law, medicine, moral philosophy, sanitation, sociology, soils sciences, veterinary sciences, toxicology, and waste management engineering.

A complete participant list is provided toward the rear of this document. From this list, it will be seen that the Workshop participants were exclusively from developed European and North American countries. However, as a "Pilot Workshop" it was exploratory in nature. Broader participation had been sought, although timing and financial constraints made this unattainable. Hence, the discussion reflected in this document is intended to be neither comprehensive nor conclusive. In the context of public health, the pilot nature of the Workshop should rather be seen as making attempts -- for the first time -- to explore the broader public health consequences of global environmental degradation. Primary, and even primordial prevention options and their operationalisation were given due consideration.

Because some scientists hold that there is no reason to believe that life-support systems could collapse, significant efforts were made at selected levels and through various avenues to secure the input of such contrary viewpoints at the Workshop. Unfortunately, no success was attained, noting the same constraints as above under which invitations to these experts also had been made. However, in the interest of rich and comprehensive debate, an honest effort was made throughout the Workshop to raise and accurately convey contrasting opinions.

[#] During the external review, it was pointed out that this objective should rather have been "to consider the role that national and international public health and related agencies might play in this arena, and what this/these role(s) might be."

Global Ecological Integrity and Human Health: The scientific and philosophical context

Presentations began with empirical evidence from experts with skills in the fields of ecology, economics, planning, food safety, and molecular biology. One session was devoted to philosophy, environmental ethics and law. Another session included a presentation by an epidemiologist of an initial attempt to study the relationship between ecological disintegrity and human health indicators globally. An example of a successful grassroots effort, via a non-governmental agency (NGO), in proposing an agenda for physicians in addressing environmental concerns, also was presented. Syntheses of these presentations are included in the respective Annexes to this discussion document.

General Discussion

General discussion in the Workshop was structured around addressing the primary and secondary objectives of the meeting. Based on information gleaned from the first day-and-a-half of presentations by experts, the participants were able to formulate opinions and offer arguments toward each of the objectives. The General Discussion section of this document attempts to capture some of the major points made during those discussions. In cases where consensus could not be reached, alternative approaches are offered.

Throughout the text, the effects of escalating human actions are mentioned, including, for example, extinction, soil erosion, depletion of fresh waters and climate change. A systematic organization of these effects of concern will assist the reader. Thus, to appreciate both the breadth and depth of the explicitly ecological and biological challenges at the heart of the concerns noted throughout this document, the following structure is adapted from Karr and Chu (1995):

Ecological and Biotic Impoverishment, or Loss of Life-Support Systems

1. Alteration of Earth's Physical and Chemical Systems (Indirect depletion of living systems)
Soil depletion
Degradation of water
Chemical pollution
Climate change, globally
Alteration of global bio-geo-chemical cycles

2. Direct Depletion of Non-human Living Systems
Renewable resource depletion
Crop homogenisation
Habitat destruction and fragmentation
Extinction
Diseases, red tides, and pest outbreaks
Alien taxa (growth of foreign organisms)

3. Direct Depletion of Human Living Systems
Epidemics
Emerging and re-emerging diseases
Reduced quality of life
Reduced human cultural diversity
Economic deprivation
Environmental injustice

This kind of organisation permits several things. For example, it:1) illustrates the breadth of the challenge; 2) makes the human-environment connection explicit; 3) illustrates the common underpinning of ecological and human health challenges, as well as social concerns; and 4) provides opportunity for the exercise of ingenuity because it provides a broad context. The broad stroke defined by this organisation forces us to go beyond a series of narrowly-conceived problems that foster the equally narrow approaches to developing solutions. Those solutions frequently either treat the symptoms without eliminating the disease, or they stimulate other problems because the underlying problem has been inappropriately narrowly handled.

The reader is cautioned against simple linear inferences that may preclude questions of relative position in terms of, for example, quality of life, diversity and economic deprivation. Scrutiny of this issue was not afforded at the Workshop.

General discussion per Workshop objective

1. To explore whether "environmental sustainability" is actually attainable, or whether we have impacted the environment beyond its self-perpetuating maintenance needs and even beyond its potential to be restored. Indeed, is sustainable development completely harmless to human life and/or to those life-support systems upon which human life itself depends? What is public health's role in these discussions?

With respect to the relationship between EI and human health, there are three basic points that are not commonly understood:

1) ultimately, human population and individual health are ultimately dependent on the integrity of ecosystems and the ecosphere (i.e., no "environment" = no population, no health);

2) healthy populations can exist in local environments that have lost their EI -- such as most urban regions -- only if healthy ecosystems exist elsewhere to support them. This is a function of technology and trade, and is a feature of human culture that uniquely distinguishes humans from other animal species dependent on their local environments. That is, human health can be maintained by healthy ecosystems (or at least productive ones) elsewhere. From this perspective, the local population imposes its ecological footprint (i.e., the "mark" left on the earth through the drawing down [or, depletion] of ecological capital beyond a local population's political boundaries; see Annex I-A) on the global commons (i.e., the planet's resources available to support the world's population) and on other regions or countries. This inter-regional dependency obscures the connection of the people and their health with the health of ecosystems; and

3) this relationship is not likely to be sustainable in the long-run. It should be noted that the various concepts of "global commons", "environmental health", "ecological health", ecosystem health", "EI", "ecological disintegrity", and the like, generally relate to the conditions of the biosphere that supports life. Indicators have been developed by agencies (such as the WWF) as standard measures that provide a sense of the health of life-support systems. All of these concepts and measures are related to public health by virtue of the link between the sustainability of human health as a function only of the sustained health of life-support systems.

Global ecological integrity is an essential overriding principle of 'sustainable development' and has been proposed as foundational in environmental ethics (Westra 1998). Development implies a more integrated social/value-based approach to continued societal change than does

'growth' (which can be an essential early component of development). Indeed, growth means "getting bigger". It implies an increase in physical scale (e.g., in material 'throughput') without necessarily any improvement in the actual experience of people. Development, on the other hand, means "getting better". It implies a qualitative improvement in structure, capacity, skill, ability, understanding, and the like, at either the individual or the social level (cf. Daly 1987). Understanding the relationship between the two concepts is the basis for assessing concerns about the consequences for human health of disintegrity. Most particularly, one can conceive of a world which adapts to global change in such a way that it develops without growing. On the other hand, the economy may well grow without developing. Indeed, equating development with growth in present circumstances could well imply that many parts of the world and/or some social strata will experience negative impacts of growth (including ill-health) without the benefits of development.

Rees' and others' work with global natural capital accounting systems (Rees, current Workshop proceedings; Rees 1996; Wackernagel and Rees 1996; Carley and Spapens 1998, World Wide Fund for Nature 1998) have independently determined that current average rates of material consumption (combined with population size) are already unsustainable. The Brundtland Commission, in 1987, acknowledged that the current paradigm of "development" (i.e., growth for growth's sake) does not lead to "sustainable development" under any reasonable interpretation of their own definition. The Commission implicitly recognised the need to avoid passing that point at which the ecological and social costs associated with further growth will exceed the corresponding marginal benefits. This is the point at which growth becomes 'growth that impoverishes' (Daly 1990) when assessed within a total social benefit-cost framework.

According to Karr (1993), the focus for sustainability ought rather to be on "society" and not on "development". After all, the attainment of a sustainable society requires attention to individual health, economic and social dimensions, as well as to the biological, ecological and environmental dimensions. The conclusion of the Karr (1993) paper states: "For centuries, the impacts of human actions were local and temporary. Today, the cumulative and largely irreversible effects of human carelessness are global in scale. The species Homo sapiens threatens natural environments, from the deep ocean to the tops of mountains, as well as the stability of the human habitat. Frenzied, uninhibited growth is transforming highly productive, self-maintaining ecosystems into barren landscapes. The widespread assumption that this transformation advances human interests compounds the tragedy of biotic impoverishment. Protection of the Earth's biota, including its EI, must become a societal priority. Our future depends on our ability to reverse the trend of biotic impoverishment. We can achieve a biologically sustainable society only if we integrate new measures of EI into our existing measures of medical and economic health. Our long term success depends on an *enlightened* environmental revolution, a set of scientific, political, and ethical transitions similar to those experienced during the agricultural and industrial revolutions."

The present consumption of the majority of people in the developed world is not sustainable based on prevailing technologies. The associated energy, material and waste flows exceed real biophysical limits to energy and material throughput in the global economy. It follows that the material aspirations of people in the developing world can not be met sustainably on any development path that assumes the use of these same technologies. How then can we address the moral imperative to improve the welfare, including material comforts, of people for whom real poverty is a daily reality, particularly in the developing world? Several studies suggest that if the world is to achieve social and ecological sustainability, we must **reduce energy and material use by about 50% overall, and by up to 90% in the high-income countries**. The International Business Council for Sustainable Development has agreed that: "industrial world reductions in material throughput, energy use, and environmental degradation of over 90% will be required by 2040 to meet the needs of a growing world population fairly within the planet's

ecological means" (BCSD 1993). The anticipated new efficiency revolution would reduce the ecological footprints of presently wealthy consumers, while creating the essential needed 'environmental space' for people in the developing world.

It should be evident from the above that securing future paths for human health and well-being is an uncertain enterprise and that a variety of options exist for their attainment. Some could result in a new, dynamically sustainable equilibrium between human activity and the natural world. But other possible pathways are inherently unsustainable, in that short-term human population health would be purchased at the expense of the long-term integrity of the ecosphere and biophysical life-support. **This is likely to be the result of today's increasingly laissez-faire growth-bound global development path** (meaning: free trade in goods, uncontrolled and speculative transfer of capital, and floating exchange rates). Indeed, any society that lauds material acquisition as its prime motivator and the open marketplace as the primary wellspring of social value is likely to experience growing socio-economic disparity, ecological destruction, and ultimately deteriorating population health on an ever-widening scale. A telling analogy is to the cancer cell where growth for the sake of growth is its mission.

Involving all stakeholders in decision-making has, as a prerequisite, the need to strengthen democracy and community. It was noted, however, that two negative impacts of globalisation are the erosion of democracy and community. Thus, international organisations such as WHO, UNEP, UNDP, ILO and others will need to create mechanisms for addressing this issue in any new "public health - EI" paradigm. These mechanisms will need to be practical at the international, regional and local levels.

Public health agencies are well-placed to take the lead in a multi-disciplinary approach to defining issues, assembling needed data, conducting and stimulating research, and influencing policies nationally and internationally. Public health needs to emphasise the risks associated with over-stressing natural resources -- nature’s services -- to the limit, because neither financial services nor human resources for health services will meet demand if life-support systems were to collapse. The consequences of, for example, ozone layer depletion, nutrient enrichment of oceans, the collapse of fisheries, civil strife, war, and malnutrition remain uncertain. Public health agencies can identify those paths of development which increase disease and ill-health, and those which promote health and prevent disease. WHO could then advocate for the latter in all global economic and development forums (similar to recently-stated objectives toward fighting world poverty). WHO, in its public health role, could raise the alarm about over-consumption by some, under-consumption by many (see UNDP, 1998), and propose remedial action and plan future options.

The concept of EI is still foreign to public health professionals. As a species, humans are seen to be in competition with other biota in the environment, rather than as being “arm in arm” with them. In public health, a separation is made between the two. Indeed, public health even now often advocates solutions that are based on individuals, with harmful effects on ecology. As one example, problems will continue to escalate through the recommended use of air conditioners for people with respiratory disease, or in heat waves, because of resulting increases in air pollution, leading, in turn, to more respiratory disease. As another example, is the spraying of DDT for malaria control and now returning as a potential endocrine disruptor. Solutions for health concerns that do not harm the environment in the longer-term are needed. For public health's role to be meaningful, trans-disciplinary expertise and multi-stakeholder interests will need to be involved if the most appropriate parameters are to be measured and modelled at the correct levels of detail in order to evaluate the impacts of any interventions. These will be different across regions of the world and even within countries. Three domains of integrity (or, its converse, disintegrity) may be needed for adequate modelling. These are the domains of individual, social, and EI. (See also Karr (1993)). Historically, the dominant societies have failed to consider these three domains, with the consequent dissociation of

humans from life-support systems. It may be shown that all three domains bear relation to one another, and that any disharmony in this relationship could be predictive of overall ecological disintegrity. Indeed, if the public health role is to be meaningful, public health will need to modify its view of human relationships to living systems in this broader context.

One participant suggested that this new realm of science (ecology/epidemiology/public health) needs a grand-unifying theory, similar to that used in geology (plate tectonics) and physics (still sought after) that can integrate the value/benefit/detriment of what we all do or contribute. Each theory might require examining tough ethical and moral questions. For example: 1) What kinds of public health activities might be worsening EI and what are improving the situation? 2) Can an EI impact be estimated for each public health activity in a city/region/global context (e.g., the extensive use of antibiotics for both people and agriculture in a region could be worse for EI, while beneficial in the short-term to human health). These are important questions that need to be answered before public health can commit to wholesale endorsement of the EI approach. At the same time, it could be argued that "grand-unifying-theories" are inconsistent with the notion of complexity, trans-disciplinarity and pluralism.

Participants cautioned that the issue of whether sustainability is achievable is very controversial because the answer depends so much on individual worldviews or perceptions (i.e., on beliefs, values, and assumptions). There simply is no scientific basis (nor can there be) for resolving such differences. However, we certainly can make progress toward assessing the potential sustainability of society under particular sets of reasonable facts, values, and assumptions. Comparing reasonable alternative scenarios for sustainability and their implications for population health might be a useful long-term activity within WHO, one that could help to clarify and focus the future role of the Organization in terms of its role in addressing concerns about diminishing EI. Certainly, human health is deemed unsustainable under *existing* paradigms.

2. To recognise what the public health consequences might be of a non-sustainable environment over the short-, medium- and longer-terms. What adaptations are feasible in the face of progressive declines?

If one accepts the ecological non-sustainability of current global trends, public health consequences in the short-, medium-, and longer-terms depend on whether we have a 'managed decline', or a 'catastrophic decline'. In the short-term, we would likely see “classical” environmental effects relating to air pollution, toxics, flooding, and famines. In the medium-term, we might see resource depletion, which could result in civil strife and even war. Longer-term possibilities are more uncertain and could include large-scale resource depletion leading to large-scale famine and societal disruption. Indeed, civil unrest has arisen from the unjust distribution of wealth or labour (cf. Mexico in the 1990s).

If catastrophic shifts can occur locally, why not globally? Some felt that as the current trends play out, we are going to experience a crash (preceded by warfare and famine). However, a crash would likely entail a series of discontinuous rapid declines. Once the first major perturbation is passed, the world would enter a new domain with an entirely unpredictable series of problems thereafter.

The concept of a "threshold" is central to understanding biological systems and is crucial for understanding non-linear relationships. Once a threshold is passed, entire systems can collapse. For example, a decline in coral reefs may gradually harm fish populations, but the dependent fish, seabirds and regional mammals may collapse once the reefs are gone. The threshold concept appears throughout this document.

What adaptations are feasible in the face of progressive declines? Generally, the global community has three options for adaptation. First, we could accept the status quo in environmental trends, trusting (and hoping) that humans will be able to adapt to these changes (making no mention of the ability of other biological systems on Earth to adapt). Second, we could implement superficial remedies through band-aid-type approaches to currently perceived problems. A third option would be to pro-actively promote substantive policy reforms requiring major paradigm shifts in socio-economic policies.

Many observers believe that humans will simply adapt to global climate change or other human-induced ecological change. This may be comforting, but just what does adaptation mean? There may be danger if "to adapt" is taken to mean that we should merely adjust to the inevitable (e.g., by applying sunscreen, moving our towns and cities, developing new crop types). By itself, such reactive "adaptation" is foolhardy and perhaps even immoral as a policy directive owing to its short-sighted approach; it will not likely be effective in the long-run, and detracts from the more serious causes of on-going degradation.

Except as considered under sub-objective 8 (on pages 17-18), relatively scant attention was paid to "life engineering" and its consequences as one form of adaptation. This technology was discussed only in the context of the precautionary principle, with reference to genetically modified organisms (GMOs), genetically modified crops and foods, and medical applications of biotechnology. It is further discussed in the essay (Annex II-3). Certainly, the notion of genetic manipulation is counter to the principle of global ecological integrity because it causes violence to integrity and hence would be seen as disrespectful of human rights and counter to the longer term interests of sustainable development.

It should be noted that evolutionary biologists exist who claim that fears about ecological degradation and the collapse of life-support systems, in the sense conveyed throughout this document, are unfounded. The considered opinion in response to this position from among those who did participate is that this concern is based on the lack of appreciation for the rate at which changes in life-support systems indeed are taking place. The time frame of the evolutionary biologist tends to be many thousands of years. The evolutionary perspective, being millennia for a recovery to establish itself in support of life as we know it today, thus could indeed be correct. However, **the time frame of concern to the participants (i.e., from the public health-related discipline perspective) was for current and future generations (i.e., decades and perhaps a century or two), and not for thousands or even millions of years into the future.**

Adaptation to ecological disintegrity involves simply resigning ourselves to high levels of disease and unemployment among most of the world’s poor. This can currently be seen in many of the developing world's cities. The passive option benefits a minority of wealthy people and seems to be embraced by more economic policy-makers in developed countries each year.

Superficial measures can be generically defined as those that treat the symptoms without addressing the disease. They often provide short-term benefits mortgaged against longer-term harms; successive generations of children would be within currently considered future time frames. Thus, short-term benefits could be seen as being mortgaged against the well-being of future generations. One example of this type of remedy is the use of voluntary or mandatory transfer payments from beneficiaries of resource “mining” to those who suffer from the effects (direct consequences) of the resource/ecological collapse. This approach has been applied in situations such as Canada with the collapse of the Newfoundland cod industry.

While simple adjustments to shifting conditions may actually be necessary in the short- to medium-terms, effective longer-term social adaptation may well require changes in values and

behaviour. These changes would be designed to avoid further climate or ecological change with a view to ultimately reversing the dangerous trends that we see taking place to many of our life-support systems. Thus, adaptation measures should be used only in the short-term, as emergency measures, and should not be incorporated into medium and longer-term strategies that may have the undesired effect of lulling the public into a false sense of security.

In the longer-term, the need to reduce population pressures and critical resource consumption to prevent global change or collapse is paramount. Longer-term adaptations would include lifestyle/equity changes to avoid EI loss with both grass roots and policy directives. As a start, we need to recognise the global commons; that is, we need to foster a better understanding of the dynamic interrelations of local behaviours and global economics. Socio-economic policy reform would involve finding ways to invest in social/human capital (so that lowered levels of natural capital are more equitably redistributed). This has the added benefit of promoting health and preventing disease (cf., Kerala, India, and Mondragon co-operatives in Spain) through reduced disparities within societies. It also would need to frame policy and behavioural changes in positive terms, not negative ones. Finding solutions that make changes attractive rather than burdensome (i.e., win-win arguments, like creating urban transportation systems that are less damaging and that promote physical exercise) will be a crucial challenge. Perhaps promoting the benefits for children will be a strong motivator. We could use the precautionary principle as a rational approach, and thereby exact a change in trend.

Attempting to answer these questions could lead to a new longer-term vision and goal for public health and public health agencies. This activity would require new research projects with a focus on 25-50 year trends in the relationships between population health indicators and local/global ecological change (or, loss of integrity). Specific case studies could be developed to test particular hypotheses and provide models for data collection and analysis. An analogous project design might be the Long-term Ecological Research Network of projects in the United States. Long-term Ecological Research Sites provide a basis for integrating monitoring of disease events and ecological parameters over the long-term; as well as case studies. Paul Epstein at Harvard University calls this "Ecological Epidemiology".

3. To explore those interdisciplinary options to build partnerships for achieving perceived necessary mitigative approaches (including potential restorative approaches) toward an environment capable of sustaining life. Should this be a major mission of public health in the 21st century?

The changes needed, which will include influencing policy, involvement in education, and ensuring a major paradigm shift, will require a broad disciplinary base and multi-stakeholder involvement. Interdisciplinarity and partnerships are obligatory for sustainability, and this reinforces the power of a paradigm shift: 1) no one discipline has more than a small fraction of the puzzle, and each must “fit in” to achieve big picture success, 2) no one country or region can proceed alone on sustainability, and 3) for global health, we need to have international cooperation in monitoring progress/regress and to correlate with global ecological and economic trends.

Partnerships are essential because the problems are embedded in complex interactions which cross all sectoral boundaries, including the private sector. Forming active and effective partnerships will require not only the relevant sciences to substantiate sound arguments for needed societal changes, but also indicators and yardsticks for measuring change. It will need social scientists and humanities experts to provide ethical/legal arguments to lawmakers. It will need NGO’s as well as industry to be able to use arguments to lead political will for changes. Some examples are included in the DPOR section of this document (Annex III).

One participant felt that the WHO environmental health activities should be tied more strongly with those of the World Bank, and that these efforts should be directed at showing the "sustainability of development". Otherwise, the scope of this objective is beyond what this document should try to cover.

Following the model that WHO, Rome Division, developed for its focus on climate change, global ecological integrity could indeed become a part of the agenda of WHO and its partners. This provides an example of how a regional WHO office provided the stimulus for co-ordinated action across the European Region, and thus could perhaps serve as a model for demonstrating in what way WHO could now assume the mantle of global ecological integrity.

Workshop sub-objectives 4 and 5 have been combined for the purposes of this discussion document.

4. To make public health recommendations for adaptations in anticipation of health effects associated with a non-sustainable environment. This will be scenario-based, addressing both progressive declines as well as precipitous declines in ecological capital.

5. To determine whether there is any role for national and international public health and related agencies to play in this arena, and what this/these role(s) might be.

Public health action in anticipation of a non-sustainable environment will require both urgent responses and longer-term strategies. Examples of urgent responses include famine and disaster relief. These are extremely important endeavours, but will not be elaborated on here because they fall beyond the scope of this document. For the formulation of longer-term strategies, the Workshop participants identified four complementary pillars: Raising public awareness; Data collection and analysis; Mobilising action; and, Policy formulation. The first of these is discussed here, while the latter three are discussed in the subsequent sub-objectives.

Given the high level of uncertainty coupled with possible catastrophic consequences, some sort of massive, democratic mobilisation is called for. There is a real danger of demagoguery on the one hand (which will back-fire) and bureaucratic wrangling (which will result in too slow a reaction to avert catastrophe) on the other. There are no easy solutions.

As one suggestion, the participants pointed out the need to identify medium-term and long-term scenarios, and then to have talented communicators in the production of movies /TV /video write, develop, and produce material. For example, a movie depicting paradigm shift options with their potential to mitigate the effects of global ecological change might serve to promote public dialogue about policy options. Additionally, a movie that reflects on the likely adaptations necessary in the wake of continuing environmental degradation and diminishing EI would also be useful to the end of creative discourse toward enlightened policies in support of paradigm shifts. This material should be specifically developed for targeting at each social sector (e.g., the rich, the middle class, the poor/developing, the developed world; males and females in each group specific to each culture/ethics/religious group; and a broad range of age groups from the very young to the very old). Movie development could be aided by synergies with educators.

WHO might expand its annual "State of Global Health Report" to include not only sensitive new indicators reflecting the state of the world's life-support systems for human health, but also periodically devote a special focus report to the analysis of such data. This could be helpful for uncovering both data and indicator strengths and weaknesses. In this way, data needs would be identified, and more sensitive indicators developed in relation to the most

appropriate health outcomes. Progress in coping with global health problems depends on our ability to monitor the positive and negative effects of global change on both personal and population health (not only country by country tables and statistics, but also by latitude, longitude and altitude, presenting indicators and differences). Emerging diseases, and others like malaria, cholera, dengue fever and plague, should be tracked and scenarios based on alternative policies should be developed. As an example, the biennial WRI report could be adopted as a model because of its experience in covering related issues.

For the extensions suggested to the "State of Global Health Report", national and international agencies must agree on a standardised set of variables to monitor diseases or disease risk defined broadly as the converse of WHO's definition of health. Standardised reporting methods across national borders are needed as the data are provided to WHO for this proposed expansion to its report. Similar agreements for necessary EI (including biological) indicators also must be sought.

Concerning adaptation in general, passive adaptation measures should be a choice of last resort and our priorities should rather be aimed toward policies that avoid global change with serious health implications. As noted earlier (sub-objective 2), policies that do not include prevention, but provide only adaptation through, for instance, primarily more health care resources in response to increased disease or toxic effects, are unsustainable in the long-run.

6. To identify the kinds of data that should be collected if public health sciences (including epidemiology and ecology) are to play a more useful role in evaluating the effects of progressive global ecological disintegrity on public health, and for predictive purposes.

All efforts to remove barriers to the furnishing, gathering, verification, archival and retrieval of data must be cleared if the needed data are to be available. Collection of data that would guide the charting of ecological impoverishment may be the clearest and most immediately feasible goal for this discussion document and WHO. Collation and reporting of such data should be elaborated in relation to the many inventories (e.g., WRI, UNEP, UNDP, WWF, OECD, and World Bank) that show declining resource stocks (i.e., impoverishment), especially on a per capita basis in addition to that of a resource ratio or rate basis. These results are central to the poverty issues that WHO is pursuing and which many studies show to be the dominant driver of disease.

Given a role for WHO to play in data collection/evaluation/analysis and modelling, there are two main forms for its implementation: 1) Assembling the trend analyses that may indicate progressive degradation of ecological systems (integrity) (see especially mountain regions); 2) Documenting case studies that show emerging health problems associated with areas where ecological systems are impoverished (i.e., the 1998 floods in China and Bangladesh, unstable hillsides in Honduras, China and Peru, *Pfiesteria* in Chesapeake Bay and North Carolina (see Burkholder 1992, 1991997, 1998; Epstein et al, 1998; Russell 1998) and seals in the North Sea). For example, while studies show that nitrogen and phosphorus enriched coastal waters are facilitating toxic blooms of species such as *Pfiesteria* in some coastal regions of the world, these results need to be given more emphasis in an international human health context. Single nation reports tend not to provide a complete picture.

WHO, while continuing to collect data on events such as infectious disease outbreaks, also should consider gathering additional data on their socio-ecological contexts. Indeed, contrasting similar communities without such outbreaks, and using these as controls (as a kind of grouped-incident case-control study at the outbreak level), could help to identify upstream EI features associated with the outbreaks.

Furthermore, ecological risk assessment of chemicals and environmental interventions should be undertaken; that is, the ecological ramifications and implications for the spread of pests and pathogens should be examined. Also, the full ecological and health implications of the complete cycle of fossil fuels could be revealing.

In addition, public health agencies should identify and then promote additional good measures of health (self-perceived health is probably much better than many scientists believe), and select a variety of communities to monitor in a prospective manner, collecting both health and socio-ecological data. Such studies need to be at a scale of meaningful ecological integration (watersheds, bioregions, ecodistricts), rather than in a form determined by convenient geo-political boundaries.

Family planning has been a central component in all modern public health policies. Because this activity is so crucial to issues of population growth, data on and case studies of family planning programmes that have been both successful and unsuccessful need to be used as models for what works and what does not work in developing future programmes.

Consumption indices also should be developed and utilised. Sensitive measures/indicators of the early effects from erosion of EI (outcomes) also need to be identified. Such sources as the Global Terrestrial (and Oceanic/Atmospheric) Observations System data can be used to track the loss of natural ecological capital, including, for example, tracking the disappearance of forests and changes in the Index of Biotic Integrity (IBI). Case studies of both successes and failures thus could be identified for study. The ecological footprint measures the energy equivalent required to support a concentration (or not) of human actions; the IBI measures the biota (i.e., the living system's or the life-support system's condition) in the places that the people with the footprint are living. At the same time, it can be used to measure the biological condition of places that are being influenced by those footprints from elsewhere. It is further noted that this single measure (i.e., the ecological footprint) is an energetic or thermodynamic view of the magnitude of human effects, while the IBI is a direct biological measure of the biological effects of those activities at a variety of sites measured. The IBI is, in short, a way to measure the effects and consequences of footprints in non-human biological terms.

While the WWF measures complement the ecological footprint analysis, they are narrow in the framing of biological effect and broad in the geographic area that is assessed. A broader and more integrative view of the condition of living systems and a better ability to diagnose the likely causes of degradation and how they vary from place to place are needed. These will come only from a future where measures of biological condition combine large scale and narrow measures of biological effects with more detailed and comprehensive biological evaluation such as the IBI. In essence, more than one human disease needs to be tracked, and more than aggregate counts of endangered species need to be tracked over broad areas to understand the effects of local ecological, explicitly biological, degradation.

The complementarity of Rees' ecological footprint and the IBI of Karr is noted. We need to do a better job of measuring the biological effect, as well as measuring the direct effects on human living systems by those same activities. Some of those human measures should clearly be the diseases and disease risks noted above, but, consistent with the WHO definition of health, they also should include the loss of languages, loss of community, and loss of other quality of life issues beyond conventional disease measures.

Relating to the “State of Global Health Report” (see above), there is a need for a database that includes time-series data on health outcomes using newly-developed standardised methods. To correlate trends in equity, public health statistics (e.g., population growth and density, urbanisation, resources available for and population benefiting from sanitary sewers and potable water or their relation to indicators such as algal blooms, temperature increases, heat

deaths) could be captured. We also should ask: What are the health effects associated with new settlements in new habitats? The report should monitor the extent to which nations and national health depend upon imported carrying capacity.

One example would be to consider what effects we could expect from climate change and other global changes. These effects would not simply be an increasing frequency of violent storms as a consequence of climate change, but also increased damage relating to loss of local forest cover and integrity, soil erosion, and related predisposing factors of infrastructure that would compound the extent of the damage. To capture such effects, public health agencies need to develop measures, analyses, and projection capabilities for health based on the "draw-down" of integrity and natural capital.

In addition, there could be an initial hierarchy of public health prioritisation with respect to the data captured and analyses performed, based on three levels of increasing complexity ranging from: 1) Considering a range of comprehensive indicators (with no consideration of causal relation to health); 2) Considering indicators for which there is a tentative suggestion of linkage to health; and 3) Considering further development of tools (i.e., models) for projecting global integrity change and implications for health.

Most importantly, the above data-based reports should acknowledge that we are at a stage of infancy with respect both to recognising and starting to capture information on the linkages between ecological damage and health outcomes. In particular, the global transport of pollutants and their health effects presents a more recent challenge. There needs to be a sharing of much of the data that is already, or could easily be, captured through other agencies. Developing new paradigms and methods for dealing with the data, including establishing linkages, and analysing and modelling or predicting, needs to be a priority. The present paradigm of epidemiology tends to focus on the immediate past, with some reasonable ability to forecast to the immediate future. Ecological disintegrity (or, impoverishment) and global climate change arguments should succeed in shifting the focus of epidemiology toward scenario-based risk assessments with the necessary information needed for forecasts (initially imprecise) coming from multiple disciplines. This will require the work of many other disciplines. Current limits of epidemiological methodology necessarily direct this focus toward specific diseases at the level of individuals (disease, not health), and ignore the complexity issues that are present with projecting outcomes for global public health.

That said, even within the constraints of our presently-accepted methodology, we can shift emphasis: instead of the traditional emphasis on the best-fitted statistical model, we may need to focus on outliers - those points which do not follow the fitted curve so well - in that within those points may lie answers to EI problems (e.g., Kerala, India with 1/65th of US GDP, yet among the league of first world countries concerning standards of health and literacy; see Alexander 1997 and 1998; Ratcliffe, 1978).

7. To explore needed shifts and even new paradigms for social and economic policies that might better ensure a sustainable environment for public health. The role of any NGOs in the Workshop would help to identify consumer movement roles for influencing social change at the grass roots level.

A paradigm shift toward holistic and preventive medicine is required (lifestyle related). Such changes would include greater emphasis on diet, exercise, reduced use of machines and automobiles (more use of the body) to maintain health, while reducing both costs of health care and environmental stress. As one example, it would be important to make the link between health, consumption, and transportation. However, while these are often viewed as personal judgements resulting in individual actions, it is clear that they require broad social and political

commitment to become reality. Alternatively, one is left with destructive contradictions such as people driving cars to places where they can exercise, or importing fresh vegetables from impoverished ecosystems as part of a better diet. As another example, consider the reluctance of governments to implement anti-tobacco policies because they fear job losses.

One suggestion was that an ascetic ethic should become a broad-based societal value. Under such a value, pleasures that are over-consumptive, contribute to population growth, or represent inappropriate uses of technology, would be considered as doing violence to global ecological integrity.

Ultimately, sustainability is based on systems, values and processes (Loucks et al, 1999). Integrity applies at the level of the individual (health), communities, and global systems. To reach a sustainable state, we need a model of economic performance measures that reflects fully the draw-down (i.e., progressive depletion) of natural capital. New developments leading to the creation of this model include an increased use of broad measures of national economic activity, such as the genuine progress indicator (GPI) (Loucks et al, 1999).

NGOs are crucial stakeholders for disseminating messages and influencing policy shifts toward a sustainable public health. There are many initiatives now that combine participatory action research with science and systems scholarship. IDRC (Ottawa) is funding work through its initiative on Ecosystems Approaches to Health. Popular movements to promote bicycle use, green spaces, public transport, “Adbusters”, non-consumption days, all exist. WHO's advocacy and work on global and national policy enhance the potential success of local initiatives.

There are other examples of NGOs making a big difference. NGOs can have a direct influence on politicians and the public. As an example, the International Society of Doctors for the Environment (ISDE), presented a synopsis of their work to the Workshop. Their presentation is summarised as follows: This organisation is actively present in a number of countries throughout the world. It commands a high degree of respect in such countries as Switzerland (*vis à vis* health issues related to acid rain and environment, for example), drawing from the professional credit accorded to physicians. It is not just scientific, but also lobbies hard for changes it feels are needed at the political level. ISDE can use the scientific facts and arguments from agencies like WHO in order to deliver an important message to the public. The following are examples of work they have pursued:

1) A research project on perceptions of environmental risks and coping with problems among patients;
2) The “Doctor for the Environment” programme (patient education and survey of doctor’s ecological attitudes and behaviours);
3) The “Polluted Child” programme (include in the UN Charter of Children’s Rights, the right to live in a pollution-free environment);
4) The Task Force - database network giving support in real emergencies,
5) Declarations - (e.g, against nuclear power); and
6) The Medical Alliance for a Global Environment - advocates new policies and implements laws and regulations to avert climate change and loss of biodiversity (particularly useful with respect to the present topic).

It was noted that certain stakeholders, in particular theologians and trade unions with potentially powerful access to large segments of population, were not discussed at the Workshop. In addition, certain issues were absent from the Workshop's scope and objectives. These include power and governance; possible changes in the human condition owing to the application of information technologies and the technologies impacting both on the quality of life and on the environment; and, lastly, the need to harmonise short-term and longer-term strategies.

8. To identify those shifts and new paradigms in social and economic policy that will be needed if corrective environmental restorative measures are to be accomplished in the projected time frame for the public's health.

Recognition of the primacy of natural life-support systems, the very essence of the ethics of integrity, ought to be seen as a basis for new paradigms and policies. WHO's mandate includes the protection of life and health. Hence, the ethics of integrity and the WHO mandate overlap. Thus, the step of adopting the notion of EI as part of the WHO public health agenda would not be asking WHO to do anything more than to exercise this aspect of its mandate more explicitly.

Since responses to ecological change need to be multi-level, international agencies can promote agreements to protect life-supports where they are threatened (i.e., ozone depletion, global climate destabilisation), and also help countries and communities to identify and implement local options such as, for example, decreasing greenhouse gas emissions. National and international agreements should recognise and enforce constraints on energy and resource use, while also identifying health-promoting options within those constraints (e.g., cycling, walking, healthy diets, aesthetics, lowered stress and family ties).

To achieve restorative measures, WHO might facilitate the building of a small library of work on paradigm shifts, incentives, and removal of damaging subsidies that affect trends in the relationship between EI and human health. Knowledge of these relationships would help to prevent and mitigate health problems in the long-run.

Some key shifts have already been identified and many fall under what might be termed interactive or post-normal science. Examples of reports that use past experiences as models are contained in the DPOR section of this document.

Social policy and behaviours must change, and it must be recognised that: a) economic policy can increase/decrease equity (natural capital); b) economic policy should focus on development rather than growth; c) taxes and prices need to reflect reality (i.e., "full social cost pricing and accounting") or, in other words, the cost of ecological and social change of excess resource use needs to be internalised; d) all <u>appropriate</u> means must be used to induce changes in consumer behaviour and cultural values to restore the balance between selfish-, acquisitive-, and individualistic-oriented versus community-oriented recognition of the public good and mutual dependence upon the global commons. However, it should be recognised that, both in principle and in most actual cases, there is no primary divergence between the interests of individuals and those of the community. Rather, a striking contrast has been repeatedly evidenced between the public interest at large and the policies of a few powerful industrial-financial groups (in particular international), which hamper -- often only for short-term profit -- the development of new environmentally-friendly technologies or solutions with lower environmental impact and risk to human health. The use of media by these groups is so powerful that any conceivable educational enterprise targeted at alternative behaviours is doomed to failure. These approaches probably apply more to western cultures, and to those developing world cultures that aspire to act like the developed world in material acquisitions. We must avoid the traditional economic trap whereby people are seen as "self-interested utility maximisers with insatiable desires for material goods".

It has been suggested, at least in western societies, that when behaviours are changed, changes in values and beliefs will follow. Witness, for example, our entire shift in values following the introduction of the automobile. As it stands now, we tax creative efforts while waste is given free rein. A new tax system could be revenue neutral: with a shift toward "waste taxes" and a decrease in creative income taxes to encourage creativity, consumers would shift spending to the lowest cost product when presented with eco-friendly alternatives; this tax would provide a

market advantage to eco-friendly products. Other policies based on new ecological economics could be based on new social and progressive works such as those seen in “Tax Waste, Not Work”, by Hammond et al.

Another public health role could be to acknowledge explicitly that beyond a certain GDP there is little gained in public health indicators. This recognition could be used to advocate a shift in capital from individual material gain to social capital, without any impact on life expectancy. Case studies in the real world (i.e., Sri Lanka, Cuba, Costa Rica, Mondragon, Kerala) could be used to promote such initiatives. However, it is important to avoid “longings” for Utopian solutions. There is no excuse not to act in the present, within the present framework of society to exact change. We can start by re-examining our priorities in charging for extraction/waste with natural capital. To exact these changes, we need incentives in the market to account for the liquidation of natural resources.

However, the fact that problems with the legal aspects of integrity still remain does pose difficulties in the enactment of the necessary legislation to afford the cost of these changes. A lack of consensus exists as to the scope of integrity. Even on the health side, schizophrenic behaviour is evident from the inconsistent interpretation between the intended meaning and the implementation of WHO's definition of health. Certainly, policy makers can invoke the precautionary principle with respect to devoting resources in this direction (action and research). One need only look to paradigm shifts in social policy in Germany and Britain to see examples of where this is happening. The precautionary principle is not just a "technical tool", but a principle, the basis upon which an approved process is constructed. To state that the "precautionary approach" is a 'principle' means that international law has recognised that uncertainty is inherent to science, and that legal regulation thus must make the wisest choice among competing scientific hypotheses. The DPOR section of this document (Annex III) contains address information on the European Commission's attempts to proceduralise the precautionary approach to Genetically Modified Organisms.

9. To declare the extent to which public health researchers and/or practitioners should become involved in advocacy on these matters.

Debate emerged around the extent to which public health professionals should be involved in advocacy. Some felt that with good reporting, analysis, and interpretation, advocacy *per se* (i.e., extending beyond the domain of science and into the realm of influencing public policy) would not be necessary. Various NGOs could carry on with advocacy with a view to influencing policy as part of their mandate, using the solid data and analysis provided by WHO and its affiliates. It was noted, however, that policy-formulation -- as decision-making -- requires different levels of societal input (i.e., the individual, family, local community, national and international influences) and some of these levels have government jurisdiction while others do not. Furthermore, as democratic processes within societies evolve, policy-making is jointly developed between government and other societal stakeholders.

Thus, some felt that it is essential that public health researchers and practitioners be involved in advocacy on matters of global ecological integrity. They argued that if public health agencies do not speak for human health and well-being as crucial considerations in all socio-economic development schemes, then who will? It is essential that practitioners be recruited to help gather the evidence so that, as it becomes available (i.e., through physicians), the debate can focus on options for action, rather than on the sources and credibility of the evidence. An ethical point was raised suggesting that not to be “advocates” is also, unfortunately, to take a position. Therefore, wherever science can support it within reasonable bounds of uncertainty, WHO should offer to advocate life and health through respect for and support of our habitats.

At least one of the participants felt that WHO should not formally announce positions on this issue at this time. Such a position is always more acceptable if it comes from an NGO initiative, and WHO could do a lot behind the scenes to encourage NGOs, as was the case at this Workshop. Any report arising from the Workshop could step aside from the bold advocacy of paradigm shifts, but could suggest important new directions under the auspices of WHO's proclaimed fight against "poverty", using evidence from the effects of draining EI from "have not" countries toward the extractive countries. Issues of equity would then be presented with an ecological as well as a health dimension.

As examples, WHO could play a role in the search for solutions (i.e., policy changes) with respect to EI, recognising the WHO commitment to sustainable development, poverty, and human health, by:

a) Conducting case studies into success stories (commonalities where things do work);
b) WHO engaging in research, country programmes and multi-agency human development potential;
c) Including environmental success stories from around the world, as well as reports on unsuccessful outcomes;
d) Using Rees' ecological footprint and/or similar approaches by others to assess sustainability (current/future) status, showing what needs to be accomplished, how some countries have done so, and possibly including a fight against natural capital disparities as well; and
e) Using IBI to directly measure the current biological condition as a divergence from the condition of living systems in the relative absence of human activity.

Finally, to whom (i.e., agencies, scientists, politicians and/or the public) should the recommendations from any report emerging from the Workshop be directed? What should the recommendations be from WHO, and to whom? The Workshop participants suggested some of the following:

1) The report should be based on a mixture of science and philosophy, which could aid with a shift in culture;
2) A strategy is needed to convince politicians (and more likely the public) that action is needed;
3) New arguments and directions, and new translations from additional scientific data will be needed (WHO strategy); that is, WHO is not currently using the right arguments with the public and politicians, since there is no real understanding on the part of the public about the links between their consumption and lifestyle, the health of the biosphere, and their health;
4) The groundwork for better understanding needs to be laid, and needs to be promoted through NGOs;
5) Ethics and philosophy can and do influence public policy as seen through issues such as "political correctness" and equity;
6) Changes in public behaviour can be induced through a better quality of information;
7) Community participation in both the generation of knowledge and its uses will increase both understanding and action;
8) There is the need to recognise and collaborate with NGOs already working hard to exact these changes. Examples are provided in the DPOR section of this document (Annex III);
9) WHO should consider fostering studies on the public's perceptions of health threats, and on psychosocial determinants of health/risk behaviours; and
10) When there is enough public awareness of the links between environmental decay and hazards to health and safety (such as in many western countries), then it is unnecessary to target communications and interventions on the need for changes in lifestyles/habits; rather, it is more appropriate to focus on motivational variables, on the removal of

environmental barriers, and on the provision of resources and incentives to support the desired behaviours.

Conclusions and Recommendations

Current patterns of human consumption world-wide are unsustainable as measured by different methods such as the ecological footprints of nations, the IBI, the MFI, and the WWF analyses. Major disparities are evident across nations as to the consumption of resources. Indeed, from nation to nation, and even within industrialised nations, there are great disparities between those who reap the benefits from the consumption of natural capital and those whose livelihood and health are impacted by the degradation. The Workshop recommended a fuller understanding of the linkages, both proximate and distant, between human health and ecological integrity (EI), as well as its converse, namely, human disease and ecological disintegrity. The use of case studies to examine both situations would be informative.

Global life-support systems are inextricably tied to EI. Issues relating EI to human health and the survival of human life on Earth should therefore become fully part of the public health agenda. Co-operation among the various UN agencies would make the attainment of sustainable goals more likely. Role assignments may include, for instance, WHO taking the lead on the link between environment and health, while UNEP might lead on environmental monitoring.

Maintenance of current levels of public health in the face of declining resources and collapsing natural life-support systems will become increasingly difficult, if not impossible. Workshop participants saw the alternative of disregarding concerns about EI as equivalent to mortgaging the well-being of future generations against the greed of present generations, measured in terms of current trends in drawing down natural capital through over-consumption, population growth and the abuse and/or inequitable use of technology. Compromising the ability of future generations to meet their own needs is contrary to the principle of sustainable development as articulated in the Brundtland Commission Report.

Consequently, Workshop participants agreed that the issue of declining global ecological integrity and its consequences for public health should be included on the WHO agenda. WHO and other public health agencies will need to develop tools to monitor and evaluate ongoing changes in life-support systems, their subsequent health effects, and the effects of interventions (including empirical evidence and predictive modelling, both of which require advances in methodology). The current paradigms of economic and ecological analysis will also need to be reconsidered. Following the model that the ECEH, Rome Division, applied for its focus on climate change (http://www.who.dk/London99/), global ecological integrity could be integrated into the WHO agenda. Such a role for WHO is seen as providing hope for identifying and implementing effective paradigms for a sustainable future.

In addition, mutual or social learning will be a prerequisite to any new paradigms proposed. Messages are urgently needed that are appropriately targeted and effective for informing both the public and policy-makers of the underlying issues, and of the consequences of adhering to current paradigms. The challenge will lie in developing messages, jointly with community groups and other stakeholders, that will be both credible and able to be assimilated, and that will result in timely actions in support of agreed-upon paradigm shifts. Note that the word "education" was not used above to describe the "mutual or social learning" that is needed; mutual or social learning gives greater importance to a two-way learning process, which is more compatible with a plural and complex notion of knowledge.

The Workshop participants recognised that the role of public health in promoting health and longevity contributes directly to population growth and cannot be disconnected from population control policies. In this context, public health practices need to be linked more strongly with professionals in the education, economics, sociology, fertility and population areas.

Anthropocentrism is most likely responsible for the disregard of any relationship between human-centred activities and their impact on life-support systems. Consequently, with humans having assumed the role of directing the planet, good stewardship would require that the necessary and urgent attention be paid to issues of a sustainable future, if only out of concern for future generations. World wide application of the precautionary principle is encouraged.

One practical method for operationalising a response to declining global ecological integrity would be to improve environmental monitoring and the measures available (e.g., an index such as the 'ecological footprints of nations' complemented by the IBI). Then, public health professionals and decision-makers would have a concrete set of metrics for identifying actions/targets to be addressed at the local level. Future regional successes could be assessed in relation to such metrics.

Issues associated with consumption patterns in the developed world also need to be addressed. Inequity in the sharing of the world's resources and subsequent releases of waste products hampers dialogue on these matters. Greater co-operation between rich and poor countries is needed. The make-up of the Workshop participants was recognised as being Western, and thus all world-views may not have been reflected. Recommendations with respect to consumption, population growth and the responsible use of technology (as the three key elements in the equation explaining negative ecological impacts on a global scale) will remain contentious. This is especially so if they are seen to be driven exclusively by Western values, traditions and/or interests. The findings of the Workshop, therefore, have been subjected to a broader peer-review confined to the areas of expertise represented at the Workshop itself prior to disseminating its findings more widely through this discussion document.

This report, seen as a discussion document, therefore aims to set the basis for planning a follow-up Workshop with broader global representation. This Workshop should re-visit the numerous findings and suggestions of concern contained throughout this document, and then develop a succinct set of recommendations for public health action and research.

Written reactions to this discussion document will be welcome prior to December 31, 1999. The document is accessible on the World Wide Web Home Page of the WHO ECEH Rome Division at http://www.who.it Reactions should be directed to Colin L. Soskolne at colin.soskolne@ualberta.ca with a copy to Roberto Bertollini at rbe@who.it

Reactions also will be welcome by regular postal service. Please write to:

Dr. Colin L. Soskolne
Professor
Department of Public Health Sciences
13-103 Clinical Sciences Building
University of Alberta
Edmonton, Alberta, CANADA T6G 2G3

with a copy to:

Dr. Roberto Bertollini
Director
European Centre for Environment and Health, Rome Division
World Health Organization
Via Francesco Crispi, 10
I-00187 Rome, ITALY

Reactions to the synthesised individual Workshop contributions contained in the Annexes to this discussion document may be directed to the respective individual experts. Copies of any such communications will be appreciated by both Drs. Soskolne and Bertollini.

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List of Participants

Temporary Advisers

Dr Stefania Borgo
Piazza O.Marucchi, 5
00162 Rome
Italy

Tel. No.: +39 06 863 208 38
Fax No.: +39 06 863 208 38
E-mail: Lucio.S@mclink.it

Dr Alessandra Carattoli
Istituto Superiore di Sanità
Laboratory of Medical Bacteriology & Mycology
Viale Regina Elena, 299
00161 Rome
Italy

Tel. No.: +39 06 4990 3128
Fax No.: +39 06 4938 7112
E-mail: ALECARA@ISS.IT

Dr Patrizia Costa
Istituto Ricerche Biologia Molecolare (IRBM)
Via Pontina Km 30,600
Pomezia (Roma)
Italy

Tel. No.: +39 06 9109 3246
Fax No.: +39 06 9109 3214
E-mail: costap@irbm.it

Professor Orie Loucks
Dept. of Zoology
Miami University
Oxford, OH 45056
USA

Tel. No.: +1 513 529 1677
Fax No.: +1 513 529 6900
E-mail: loucksol.@po.muohio.edu

Dr Paola Michelozzi
Osservatorio Epidemiologico Regionale
Via di Santa Costanza, 53
00198 Rome
Italy

Tel. No.: +39 06 5168 6494
Fax No.: +39 06 5168 6463
E-mail: epiamb@sirio.regione.lazio.it

Professor William Rees
Director: School of Community and Regional Planning
University of British Columbia
6333 Memorial Road
Vancouver, BC
Canada V6T 1Z2

Tel. No.: +1 604 822 2937
Fax No.: +1 604 822 3787
E-mail: wrees@interchange.ubc.ca

Dr. H. Morgan Scott (Rapporteur)
Dept. of Public Health Sciences
13-103 Clinical Sciences Building
University of Alberta
Edmonton, Alberta
Canada T6G 2G3

Tel. No.: +1 780 492 2987
Fax No.: +1 780 492 0364
E-mail: Morgan.Scott@Ualberta.Ca

Dr Lucio Sibilia
Piazza O.Marucchi, 5
00162 Rome
Italy

Tel. No.: +39 06 863 208 38
Fax No.: +39 06 863 208 38
E-mail: Lucio.S@mclink.it

Dr Mariachiara Tallacchini
Università degli studi di Firenze
Dipartimento di teoria e storia del diritto
Piazza Indipendenza, 9
50129 Firenze
Italy

Tel. No.: +39 055 49 65 33
Fax No.: +39 055 47 47 56
E-mail: mctall@box1.tin.it

Professor David Waltner-Toews
Dept. of Population Medicine
Ontario Veterinary College
University of Guelph
Guelph, Ontario
Canada N1G 2W1

Tel. No.: +1 519 824 4120 ext. 4745
Fax No.: +1 519 763 3117
E-mail: dwaltner-to@ovcnet.uoguelph.ca

Professor Laura Westra
Dept. of Philosophy
University of Windsor
Windsor, Ontario N9B 3P4
Canada

Tel. No.: +1 519 253 4232 (ext. 2342)
Tel. No.: +1 905 303 8181 (H)
Fax No.: +1 905 303 8211 (H)
E-mail: cwestra@interlog.com

From August 1, 1999:
Professor Laura Westra
Barbara B. and Bertram J. Cohn Professorship in Environmental Studies
Sarah Lawrence College
1 Mead Way
Bronxville, NY 10708-5999
USA

Tel. No.: +1 905 303 8181 (H)
Fax No.: +1 905 303 8211 (H)
E-mail: lwestra@interlog.com

WORLD HEALTH ORGANIZATION

Regional Office for Europe

Mr Gregory Hess
Policy Development Officer, Partnerships in Health and Emergency Assistance

Tel. No.: +39 06 4877543
Fax No.: +39 06 4877599
E-mail: ghe@who.it

European Centre for Environment and Health, Rome Division

Dr Roberto Bertollini (Chair)
Director

Tel. No.: +39 06 4877530
Fax No.: +39 06 4877599
E-mail: rbe@who.it

Dr Carlos Dora
Environmental Epidemiologist

Tel. No.: +39 06 4877541
Fax No.: +39 06 4877599
E-mail: cdo@who.it

Ms Nicoletta Di Tanno
Data Processing Assistant

Tel. No.: +39 06 4877523
Fax No.: +39 06 4877599
E-mail: ndt@who.it

Mr Michele Faberi
Programme Manager, Environment and Health in Italy
Tel. No.: +39 06 4877542
Fax No.: +39 06 4877599
E-mail: mfa@who.it

Dr Marco Jermini
Food Safety Scientist
Tel. No.: +39 06 4877525
Fax No.: +39 06 4877599
E-mail: maj@who.it

Dr Maria Jose-Carroquino
Children, Environment and Health
[No longer with ECEH]
Tel. No.: +39 06 4877533
Fax No.: +39 06 4877599
E-mail: mjc@who.it

Dr Lucilla Magherini
Health Economist, Environment and Health in Italy
Tel. No.: +39 06 4877549
Fax No.: +39 06 4877599
E-mail: lum@who.it

Dr Marco Martuzzi
Epidemiologist, Environment and Health in Italy
Tel. No.: +39 06 4877520
Fax No.: +39 06 4877599
E-mail: mam@who.it

Dr Bettina Menne
Associate Professional Officer, Public Health
Tel. No.: +39 06 4877546
Fax No.: +39 06 4877599
E-mail: bme@who.it

Dr Kathy Pond
Water and Sanitation
Tel. No.: +39 06 4877544
Fax No.: +39 06 4877599
E-mail: kpo@who.it

Ms Francesca Racioppi
Associate Professional Officer, Environmental Epidemiology
Tel. No.: +39 06 4877545
Fax No.: +39 06 4877599
E-mail: frr@who.it

Dr Philip Rushbrook
Waste Management Engineer
Tel. No.: +39 06 4877548
Fax No.: +39 06 4877599
E-mail: pru@who.it

Dr Colin Soskolne
Visiting Scientist [July 1998 - June 1999]
University of Alberta, Edmonton, Canada
[see p.21 for address details]
Tel. No.: +1 780 4926013
Fax No.: +1 780 4920364
E-mail: colin.soskolne@ualberta.ca

Ms Sara Swartz
Project Manager, Health and Human Development
[No longer with ECEH]
Tel. No.: +39 06 5881530
Fax No.:
E-mail: sara.swartz@slashnet.it

Ms Candida Sansone
Administrative Assistant
Tel. No.: +39 06 4877535
Fax No.: +39 06 4877599
E-mail: cas@who.it

Annexes

Annex I: Presentations

A. Global Change and Ecological Integrity: Quantifying the Limits to Growth, by W. Rees

William Rees, University of British Columbia, Vancouver, British Columbia, Canada

Dr. Rees' presentation centred on research that has demonstrated an unavoidable conflict between maintaining ecological integrity and the prevailing growth-based global development path. This conflict springs from under-appreciated facts of human ecology that have produced an increasingly dysfunctional relationship between people and the rest of nature. The problem goes beyond poor resource management and even failed environmental ethics; rather it resides in the fundamental values and beliefs underpinning modern society.

His exposé of this dysfunctional relationship began with a critique of the neo-liberal economist expansionist worldview. This worldview sees the 'economy' as a separate system virtually free of environmental constraints. It holds that human ingenuity (technology) can substitute other factors for resources. If substitution were easy, the world could, in effect, manage without natural resources and exhaustion is merely an event and not a catastrophe (Solow 1994). Rees noted that while this argument has merit for certain familiar marketed commodities (e.g., optical fibre substitutes for some uses of copper wire), it fails in relation to the majority of the goods and services of nature (e.g., the ozone layer and protection from ultra-violet radiation; the atmosphere and reasonably constant climate; the Gulf Stream and the free heating service it provides for northern Europe). He also pointed out that many ecological problems relevant to systems integrity and human health have less to do with depleted sources than with over-loaded sinks (e.g., climate change from excessive greenhouse gas accumulation; endocrine mimicry from the bioaccumulation of contaminants in air, water and soil). In the final analysis, humans have no readily available substitutes for most of the life-support services of nature.

The expansionist worldview also argues that the surest way to maintain environmental quality is through increasing incomes (i.e., sheer economic growth). This argument too is flawed. It ignores the fact that the relatively clean environments of, for example, high-income cities can be explained in part by the export of waste (often to the developing world), and to the exploitation of extra-territorial resources, including the global commons. Indeed, the wealth enjoyed by populations in the developed countries derives from the ecological capital and 'natural income' of the less developed world and the common natural heritage of humankind.

The belief in near-perfect substitution, combined with trade, leads expansionists to argue that the concept of carrying capacity is irrelevant to humans; in effect, economic growth can continue indefinitely, free of material constraints. In contrast, Rees argued that despite modern technology, human beings and their industrial economies remain dependent on uncounted biophysical 'goods and services' provided by nature. Trade and technological advances merely foster the illusion that the economy is becoming 'decoupled' from the ecosphere, by distancing consuming populations from the impacts of their lifestyles. The fact is that even present human demand is eroding the integrity of the ecosystems producing many essential goods and services. This is clear even from newspaper reports on matters ranging from the collapse of local fish stocks to the increasingly erratic global climate. Carrying capacity will therefore likely become a central issue in global development in the 21st century. There is virtually no possibility that an industrial society of up to ten billion people can live sustainably on Earth at current "Northern" levels of consumption under the assumptions of the prevailing economic development paradigm.

An ecological worldview would instead see material economic activity as a manifestation of human ecology subject to the laws of nature including thermodynamics. Dr. Rees stated: "What we call 'the economy' is really an expression of human ecology; it is, in part, how society organises to extract and allocate resources and to otherwise exploit nature. Remarkably, however, economic theory virtually ignores the biophysical context for economic activity. Interestingly, like economists, most classically trained academic ecologists, also tend to set humans apart from nature. They prefer to study pristine ecosystems unaffected by people. The double irony here is that economists (human ecologists) study people exclusively, but have inadequate theory (e.g., ignore thermodynamic laws and complex systems theory) while 'official' ecologists study other species exclusively, but have much stronger theory. Consequently, neither discipline is able to cope adequately with human-induced global ecological change.

Rees stressed certain basic ecological facts pertinent to integrity and sustainability: Humans are large, adaptable, social mammals that live in groups. We have correspondingly large energy and material demands and all resources entering the human economy come from nature. The 'competitive' or 'entropic exclusion principle' holds that energy appropriated from global flows for direct consumption by humans are irreversibly unavailable to other species or to maintain ecosystems' structure and function. Moreover, very few unmodified local habitats are productive enough to support even modest groups of people living in permanent settlements for very long. The biophysics of these facts dictates that all human groups – even pre-agricultural groups – inevitably reduce the biodiversity and ecological integrity of their immediate environs and significantly disturb a much larger area around it. In this respect we are a true 'patch disturbance' species, a distinction shared by other large mammals ranging from beavers through elephants to other large carnivores.

One result is that wherever humans have invaded and settled on Earth, extinctions of flightless birds, ungulates, and other easy-to-hunt species have occurred. The impact escalates with improvements in hunting technology and ultimately agriculture. Indeed, there are many examples of whole agriculture-based cultures that collapsed from depletion when the demands of their growing populations exceeded the long-term carrying capacity of their local and regional ecosystems. In today's world, trade and technology buffer people from the effects of overexploiting their local 'environments', creating the illusion that carrying capacity is constantly expanding. However, trade merely enables us to import carrying capacity from 'elsewhere' while technology accelerates the rate at which we use resources of all kinds. This tends both to increase the total human load and distribute it all over the planet ensuring that if human demand continues to expand, any modern collapse would be global.

In this light, it is worth considering our notion of 'production'. Ecologists recognise green plants as primary producers – they produce very complex materials such as proteins and carbohydrates from very simple chemicals (carbon dioxide and water) via photosynthesis. By contrast, ecologists would classify humans primarily as consumers. People are at best 'secondary producers', in that economic production invariably requires the *consumption* of much larger quantities of primary resources first produced by nature. All of the material consumed is, of course, ultimately returned to the ecosphere in degraded form as waste. Increasing levels of resource consumption and waste disposal degrade both the productive and assimilative capacities of ecosystems. Thus, from the ecological perspective, industrialisation, economic growth, and globalisation have effectively extended human "patch disturbance" to the level of the ecosphere.

The consumer life-styles of people living in high-income societies are made possible by fossil-fuel-based energy. Abundant cheap energy has increased people's material consumption by a hundred-fold, or more, above pre-industrial levels. The problem is that, from an 'ecological economics' perspective, the material economy is an inextricably integrated, completely

contained, and wholly dependent growing subsystem of a non-growing ecosphere. It is also a complex, far-from-equilibrium, self-producing system subject to the second law of thermodynamics. Modern interpretations of the second law show that all such self-producing systems are 'dissipative structures' – they can maintain or increase their internal order only by importing available energy/matter from their host environments and by exporting degraded energy/matter back into them. That is, complex systems develop and grow "at the expense of increasing the disorder [entropy] at higher levels in the systems hierarchy" (Schneider and Kay 1994).

When the second law of thermodynamics is applied to the economy, it implies that continuous population and material growth must inevitably result in the 'disordering' of local ecosystems and eventually the ecosphere. Given this fundamental laws of biophysics, we must ask ourselves: "Is there enough natural capital on Earth to maintain our material standards for 9 - 10 billion people at European or North American material standards"? The answer is simply, no. Dr. Rees and his students have developed 'ecological footprint analysis' to estimate the total area on the Earth's surface required to support the resource consumption and waste assimilation by various specified human populations. (In effect, 'ecological footprinting' estimates the size of the modern human "patch".) They have shown that high-income cities typically have an ecological footprint up to several hundred times larger than the geographic area of the city itself. Indeed, many so-called "industrialised" nations usually require the biophysical services from an area of land and water ecosystems several times larger than their domestic territories to maintain their current lifestyles (Rees 1997, Rees and Wackernagel 1996). For example, Italy's ecological footprint is approximately eight times larger than the entire country. High-income countries are therefore running massive 'ecological deficits' with developing countries and the global commons. Indeed, the aggregate eco-footprint of the global economy is already about 30% larger in some dimensions than the productive area of the entire planet. This means that material growth currently is being supported by the depletion of both renewable and non-renewable stocks of natural resources. (Other studies including European [Dutch] 'ecological space' analysis, come to similar conclusions [see Carley and Spapens 1998].)

At the present world population, there are only about 1.7 hectares (ha) of productive land and water available *per capita* on Earth to provide for human needs (this assumes that about 12% of total land area is set aside as wilderness reserves). Current average demand in high-income countries is much higher at four to seven or more ha *per capita* which means that the rich are using more than their fair share. Right now, we would need two or three or more Earth-like planets to raise the present world population to western European material standards sustainably. In this light, it is easy to see why some analysts are concerned that global ecological decline has serious implications for geopolitical instability: intractable situations generated by population growth and rising material demands (e.g., competition for water, food and other resources) may lead to civil strife and war.

The implications of an ecological world-view for urbanisation and prospects for sustainable cities are profound. Urbanisation is not only an economic or demographic process, it is also an ecological phenomenon. Several features of world urbanisation are important to note. According to the UN: 1) there will have been a 50% increase in urban populations to about 3 billion in the past decade alone (to the Year 2000); 2) some 5.1 billion people will be residing in cities by 2025, an increase of 70% in the first quarter of the 21st century, and: 3) thus, in the next 27 years, more people will be added to the world's cities than the total human population in 1930.

Most of this urbanisation is occurring in developing countries. By 2015, most large cities will be in the developing world that is ill-equipped to cope with such a massive population shift. In this light, it is important to see these urban areas in terms of their ecological impacts: cities are

intense nodes of consumption and waste generation. As such, they pose immense challenges in such traditional areas of public health as air quality, water supply, and sanitation in impoverished cities. This alone may lever the WHO to upgrade existing and initiate new public health responses to urban migration patterns in the developing world.

Given global change and accelerating urbanisation, what are the prospects for 'sustainable cities'? At present, cities are seen as centres of economic activity ('engines of growth'), as socio-cultural hotbeds, as the seats of government, and the like. Indeed, they are the crowning achievement of modern civilisation. Yet, for all that, cities are inherently unsustainable on their own. We must begin to contemplate cities as ecological entities. Many people tend to think that urbanisation implies that humans are becoming less dependent on nature … that we are leaving the land behind. In reality, rural land and ecosystems are being used more intensively than ever to support urban populations. In ecological terms, a city is the human equivalent of a livestock feedlot: the primary production supporting the population occurs elsewhere and is transported to the 'feedlot' for consumption; wastes generated within the 'feedlot' are similarly disposed of 'elsewhere.'

In order for 'the city' to be considered truly sustainable, it must be redefined to include the productive area outside of the urban core. The city-as-system encompasses the vast area outside the built-up zone that 'feeds' the city proper and assimilates its wastes. At present, we tend to see urban green spaces mostly in terms of their aesthetic value, ignoring their biophysical functions.

Dr. Rees further noted that while cities are ecologically problematic, they also offer several advantages from a sustainability standpoint. For example, the high population densities and economies of scale facilitate the use of sanitary sewers, piped water, recycling programs, public transportation, and the like, while reducing direct *per capita* land requirements. From an industrial ecology standpoint, urban centres allow for the efficient re-manufacture, re-use, and re-cycling of waste products, energy co-generation schemes, and the like. Some cities, such as Graz, Austria also are reducing their external ecological footprints by, *inter alia*, banning private automobiles from the city centre.

Dr. Rees presented an economic argument (based on standard micro-economic theory) to show how the world could have exceeded ecological carrying capacity without knowing it based on conventional measures. Simply put, theory suggests that when the global economy reaches a certain scale, the marginal ecological (and social?) damage costs associated with further material growth will approach and exceed the marginal benefits. Unfortunately, economists are generally much better at measuring and quantifying the tangible benefits of growth (e.g., jobs, income, and increases in GDP) than the costs. This is because many of the costs are not readily identifiable, may not be evident until long after the cause is well entrenched, are difficult to measure when identified, and virtually impossible to evaluate or price. (Consider, for example, stratospheric ozone depletion and associated damage costs – including negative health effects – or the uncertain, but potentially catastrophic costs associated with increasingly erratic climate.) This means that if this simple micro-economic argument were applied to the macro- (i.e., global) scale, we would probably have good estimates of the benefits, but would not be able to account fully for the costs of growth. The analysis would therefore encourage growth beyond the optimal scale for the economy. This would be growth whose net impact is negative; ecological economist Herman Daly refers to this as growth that makes us poorer rather than richer.

There are no doubt local and regional economies in which growth is already growth that impoverishes in just this way. The point is that an economy that is growing does not necessarily mean that it is becoming better. Daly (1990) makes a clear distinction between 'growth', which means a mere increase in size, and 'development', which implies positive

change or progressive improvement. Development does not depend on growth.

The over-riding ecological problem globally is that we have already exceeded the long-term carrying capacity of Earth and are living by depleting remaining natural capital (resource) stocks. Accordingly, even the Business Council for Sustainable Development has concluded that a 90% reduction in material throughput, energy use, and environmental degradation in the high income countries is needed by 2040 to meet the needs of a growing population fairly within the planet's ecological means. In short, energy and resource use in the developed North must decrease if we are to meet our moral obligation to bring the world's poor up to an adequate material standard.

The market alone will not stimulate the kinds of technological efficiency gains needed to meet this goal. Recent studies of some of the world's most efficient market economies show that meaningful dematerialization, in the sense of *per capita* and absolute reductions in resource use, simply is not taking place. It seems that government intervention in the form of 'ecological fiscal reform' will be needed to stimulate the private sector to develop the necessary material efficiencies. In general, this will involve high and accelerating taxes on the primary energy and material inputs to production, accompanied by equivalent reductions in payroll and income taxes (to maintain revenue neutrality and give consumers more money to compensate for higher prices). No one country is likely to succeed in this by going it alone. Rather, ecological tax reform must be a global initiative.

This is only one example of how preserving biological diversity, human population health, and prospects for civil human existence may depend less on learning better to manage resource systems than it does on learning to manage ourselves. Note in this context, however, that even the fiscal reforms advocated above do not significantly challenge the prevailing growth paradigm. They are really just a further expression of confidence in traditional technological fixes (growth can continue if it is more efficient) and if they succeed at all, it will be in merely buying a little more time for a fundamental shift in personal values and social behaviour. In the final analysis, we may find that sustainability resides in rediscovering that quality of life and human welfare is not as dependent on the accumulation of goods as it is on the personal security and satisfaction that we gain from healthy family life, personal relationships, and a strong sense of community. These things are being lost in the global growth competition that is almost literally consuming the planet.

Discussion

Concern was expressed about the seemingly hopeless task of addressing the very contentious issues of population growth and consumption. It was noted that neither population nor consumption was allowed on the agenda at the Rio summit. However, it will be futile if we ignore the future implications of today's actions. While population is certainly a contentious issue,real questions must be asked about what are sustainable levels of populations, and at what levels of consumption.

The World Wide Fund for Nature (WWF), working independently of Dr. Rees' methods, has released a report which notes a rapid decline in Earth's life-support systems. The WWF findings are entirely consistent with those of Dr. Rees. A note was made of the current WHO Director General, Dr. Gro Harlem Bruntland, in terms of her comments about the joint WWF-International Union for the Conservation of Nature (IUCN) report. She is quoted as having said: "This quantifies for the first time a scary decline in the health of the world's forest, freshwater and marine ecosystems. It shows we have lost nearly a third of the Earth's natural wealth since 1970". Unfortunately, these comments do not include reference to the link between continued human (public) health and the integrity of the ecosphere. However, this link between Dr. Bruntland's recognition of the serious state of the natural world and the head

of WHO may bode well for the public health significance of this issue being recognised in the future.

It was suggested that the criticisms of the neo-liberal economist approaches might not be fairly spread to those with more human-based view points (i.e., Keynesians). Dr. Rees clarified that he was referring largely to the mainstream economists who have refused even to review the works of such eminent ecological economists as Herman Daly. That said, Rees sees no room for latitude in economic theories that refuse to acknowledge the very basic thermodynamic laws of physics. Human-centred politics cannot be maintained. Quite simply, looking at energy unit inputs for maintenance of human life (e.g., Calories/Joules), means that the more people there are on Earth, or the more units of energy per person, the more energy units will need to be taken from other species and ecosystems to maintain those humans.

B. A Community-Based Ecosystem Approach to Health, Socio-economic Development and Environmental Integrity, by D. Waltner-Toews

David Waltner-Toews, University of Guelph, Guelph, Ontario, Canada

Dr. Waltner-Toews began his presentation by describing a Canadian research initiative, of which he was a part of an inter-disciplinary team, looking at ways of evaluating and improving the health of agro-ecosystems in Canada. The strategy of that initiative was to combine a systems approach (science) with an evaluative framework (health) in assessing the integrity or status of ecosystems, inclusive of human activities.

He noted three critical mistakes in this approach. The first was to assume that a single systems description of agricultural landscapes and communities was possible. The second mistake was to assume that measurable indicators sufficient to assess system status (health) could be determined based on external objective observation. The final mistaken assumption was that health and medicine are comparable or even interchangeable ideas. Examining this last assumption further reveals contrasts between the seemingly inseparable domains of medicine and health. Juxtaposition of a sampling of tenets from these two concepts reveals a multitude of contrasts. In brief, medicine is built around ideas of authoritative expertise and compliance, whereas health inherently requires empowerment and co-operative action, with necessary expertise distributed widely in the population. The achievement of sustainable development requires a shift of thinking away from medicine (revitalising dysfunctional relationships) to health (strengthening adaptive relationships) and a step into the uncharted territory beyond the neat rules of biomedical science.

The first two assumptions were falsified when researchers recognised that socio-ecological systems were complex and could be described and understood from a variety of non-equivalent legitimate perspectives. The constraints to finding solutions to ecosystem problems include: 1) scale, 2) perspective, 3) values, and 4) feedback loops and non-linear change. For example, individuals are members of families, families of neighbourhoods, neighbourhoods of communities, and so on; furthermore, yards and farmsteads are parts of watersheds, which are parts of larger ecologically defined landscapes, and so on. For each such a nested hierarchy (often called a holarchy) one may find that people in different cultures -- and different groups within a culture (men, women, children, business people, health workers) -- value different things. Thus, to determine a set of goals and indicators of health or sustainable development for an inhabited or managed ecosystem requires a matrix-like approach to biophysical, social, and economic indicators for each of the societal/ecosystem levels in the hierarchy of organisation from the local through to the global level. Obviously, because of differing cultural values at greater levels of aggregation, the task of identifying common goals and indicators increases exponentially.

This complexity requires a different way of thinking about disease and health, away from traditional single factor or uni-directional multi-factorial causal models, and toward those that incorporate a series of feedback loops leading to the disease. This will involve a shift away from reliance on disciplinary expertise and professional authority (where knowledge is assumed to reside only in designated individuals) toward a sense of collective, negotiated understanding, not only across scientific and scholarly disciplines (economics, ecology, health), but across normal boundaries set up between "lay people" and researchers (Funtowicz and Ravetz 1994).

The skills needed to exact this collective approach to complex problems include: 1) personal skills (caring), 2) social skills (working with humility on complex issues), 3) intellectual skills (ability to ask why, ignoring traditional scientific disciplinary boundaries), and 4) professional health-care skills. To evaluate any system, one must be able to describe that system (a clinical examination), understand how it "works" (its physiology), and apply a set of evaluative criteria to those aspects of the system deemed to be important. To improve the system, one must alter the internal dynamics in such a way that desirable outcomes are achieved without major negative side effects. All of this sounds deceptively biomedical. It is not.

Investigation and evaluation of socio-ecological systems, with people inside them rather than outside spectators, neither follow the rules of researchers studying closed "pristine" ecosystems (an organism analog) nor those of social researchers who can view the world in a purely constructivist manner. In socio-ecological communities, we are constrained by the necessity to incorporate the often contradictory and conflicting demands of multiple physical scales (individuals, families, neighbourhoods, fields, farms, watersheds), multiple perspectives (economic, environmental, nutritional, women's, men's, rich, poor), feedback loops and non-linear changes which cross all temporal and investigative boundaries (e.g., disease effects of economic development policies mediated through ecological changes over periods of decades), and conflicting values (longevity, health, wealth, efficiency, efficacy). The resolution of these issues requires a public, democratic science combined with the ability to adapt and respond to local conditions.

Local adaptation can occur only when feedbacks (from economic activities to health and ecological consequences, for instance) occur at manageable temporal and spatial scales. Therefore, the most appropriate site of action would seem to be local, geographically defined communities. Regional and global policies respond to local catastrophes far too late; therefore, the role of global policies should be to facilitate local, ecologically responsive policy development. An adaptive Methodology for Ecosystem Sustainability and Health (aMESH), drawing on theories of complex adaptive systems and participatory action research, is currently being implemented and tested in communities in Peru, Honduras, Kenya and Nepal. Drawing on both Participatory Action Research and Complex Systems Theories, aMESH links ecology, health and economics, but also research and action. The UNDP already has expressed an interest in looking at this as a way of implementing programmes aimed at Sustainable Livelihoods. This presents an opportunity for WHO to engage in important cross-sectoral linkages to achieve multiple, inter-related goals. Dr. Waltner-Toews' group also has created a Network for Ecosystem Sustainability and Health, which is in the process of linking these communities and researchers.

Discussion

There is likely a strong argument to be made for relationships between empowerment of communities and needed changes in behaviour. For example, why do some communities value different things and behave differently toward similar questions affecting ecological integrity? Do any generalisable policies exist which could be applied at the WHO (or national) level, with respect to its dealing with communities. Information provided to communities in a "top-

down" fashion is simply not enough. Process and discourse, without information, are not sufficient either. Both aspects (i.e., informed process and discourse) are required. This necessitates a democratic (inclusive) and transparent science, free from authority, thriving on the collective knowledge of experts.

The undemocratic principles of international trade agreements, in prohibiting local communities from working for sustainable solutions, were noted.

C. Introduction to Antibiotic Resistance, by M. Jermini

Marco Jermini, World Health Organization, ECEH, Rome Division, Italy

Dr. Jermini provided a brief overview of antibiotic resistance in pathogenic bacteria. The implications of a continued trend toward increasing resistance of infectious bacteria, and the possible links (and possible analogy) to decreasing ecological integrity wherein new strains of *Salmonella* and *E. Coli species* are appearing to become more prevalent, were considered by the participants following both the presentations of Dr. Jermini and Dr. Carattoli.

Antimicrobial use spans not only medications for human health, but also medications or feed additives in agriculture, pets, and aquaculture. The animal health market for antimicrobials is very large. The presentation focussed mostly on two major groups of pathogens and their acquired resistance: 1) *Salmonella* and *Campylobacter species*, and 2) *Enterococci*. The former two genera are exhibiting increased resistance to a family of antibiotics called quinolones, while the latter is mostly to glycopeptides.

In terms of the glycopeptides, Vancomycin is a major concern for resistance. It has marked similarities with a livestock growth-promoter called Avoparcin in both structure and function. There exists a theory that the resistance in Vancomycin resistant entrococci (VRE) could be transferred from animal to human strains. VRE bacteria have been identified in livestock at rates of 16%-40% in poultry and 15%-38% in pork. Interestingly, VRE prevalence in vegetarians has been much lower than in meat consumers, suggesting the possibility of a link with dietary choices.

The critical issues include the following: 1) antimicrobial-resistant pathogens are appearing more rapidly than ever before, 2) the resistance problem is global in nature, 3) it is becoming exceedingly difficult to identify alternative therapy modalities in the face of antimicrobial resistance, and 4) antimicrobial resistance problems <u>are</u> a public health problem. Necessary steps for public health to take, in the face of this emerging issue, include surveillance, education, regulations, and more research.

D. Molecular Mechanisms of Antibiotic Resistance, by A. Carattoli

Alessandra Carattoli, Istituto Superiore di Sanità, Rome, Italy

Dr. Carattoli continued presenting the empirical evidence relating to antimicrobial resistance by describing the molecular mechanisms by which resistance is conferred on bacteria, and how that resistance can be shared.

Resistance to antibiotics can arise either from new mutations in the bacterial genome or through the acquisition of genes coding for resistance. The major mechanisms for bacteria evolving resistance include: 1) mutations changing the target of the drug, 2) reduced uptake or

active efflux of the drug from the cell, 3) inactivation of the antibiotic by enzymatic modification, and 4) metabolic bypass of the inhibited reaction. The spreading of resistance to antibiotics among bacteria is facilitated by the presence of resistance genes on transferable genetic elements such as plasmids or conjugative transposons (i.e., glycopeptide resistance in enterococci), and by the use of antibiotics acting as selective agents for these genetic elements.

Discussion

There could be a strong argument made for the selection pressure that has been exerted, in how we have chosen, and are forced to raise and manage livestock populations in the face of globalisation and integration within the agribusiness empires. Indeed, it was pointed out that there are now only 4 slaughterhouses in the USA providing virtually all of the meat processing. Dissemination of antimicrobial-resistant bacteria through these channels thus might well be enhanced.

WHO could advocate that no antimicrobial used in livestock should also be used in humans. Recognise that many of the management schemes for intensive livestock production have been built-up over the years based on a heavy dependence on antimicrobials to cover the losses from, for example, the stress of travel and overcrowding. The need is to shift the public's behaviour toward a more ecological approach to livestock rearing, with full knowledge of the implications of such an approach toward improving ecological integrity, and indeed human health. An example could be made of the Bovine Spongiform Encephalopathy (BSE) situation in the United Kingdom and how it resulted in a switch in preference in dietary choices.

One cannot ignore the fundamental issues of scale. The pressures from globalisation are enormous, and the implications for heading off these sorts of massive risks are huge. There must be a change in the pattern of human behaviours toward patterns of consumption which have a sense of understanding of issues relating to present and future consequences of the personal choices that are made.

E. Rivers as Sentinels: Using the Biology of Rivers to Measure Ecological Health, by J. Karr

James R. Karr, University of Washington, Seattle, Washington USA

The Workshop participants viewed a recently completed 25-minute video--*Fresh Waters Flowing*.

When humans enter a watershed and alter the landscape, they alter the web of life in rivers. *Fresh Waters Flowing* explores the connection between humans and streams, revealing the links between human influences and the ability of a stream to support healthy biological communities. The video makes the point that healthy waters are necessary to support human affairs and it introduces the concept of a multi-metric biological index--the index of biological integrity (IBI)--as an integrative measure of ecological health. *Fresh Waters Flowing* demonstrates the importance of a stream's biological integrity, and shows how measuring the biological condition can be a powerful tool for maintaining and restoring the health of watersheds.

Like common economic indexes or a suite of lab tests used to diagnose human health, an IBI consists of multiple measures (called metrics) each describing one aspect of a site's biological condition. Researchers choose particular measures to incorporate into IBIs because those measures reflect specific and predictable responses of organisms to human activities across a landscape. These responses behave somewhat like the dose-response relationships measured by toxicologists, or the association between the presence of a certain disease and, for example,

blood cell counts or elevated body temperature.

But one would not expect a doctor to rely on only one specialized test to diagnose overall health; rather, one assumes that multiple measures will allow for a more accurate diagnosis. Patterns emerging from these multiple measurements enable the doctor to recognize the signature of a particular ailment or to suggest more targeted measurements if a certain disease seems a likely cause of impairment. Only then can treatment be prescribed. Multi-metric biological indexes, calculated from ambient biological monitoring data, provide a similar integrative approach for measuring the biological condition and for “diagnosing” causes of degradation in complex ecological systems.

The same logical sequence applies in compiling multi-metric economic, health, social, or biological indexes. First, identify reliable and meaningful response variables through testing; then measure and evaluate the system against expectations; finally, interpret the measured values in terms of an overall assessment of "system condition". The resulting index (for economic or ecological systems) or diagnosis (for patients) allows practitioners to understand the overall condition, and to make informed decisions that will then affect the health of those economies, patients, or ecological systems.

The choice of measures included in a multi-metric IBI reflects an attempt to represent many perspectives about ecological health. Indeed, the best multi-metric indexes combine measures of condition in individuals with measures of structure and function, the parts and processes, of those systems. Key biological features should be tracked to detect changes in the identity and number of species present in standard samples; ecological processes such as nutrient dynamics and energy flow through food webs; and the health of individuals, which influences survival and reproduction. These features provide a comprehensive picture of ecological condition. Benthic invertebrates and fish are particularly appropriate for use in a river IBI; vascular plants, cryptogams (mosses, lichens, etc), and insects are being used in the development of terrestrial IBIs.

Studies on all continents but Antarctica have shown that as humans alter watersheds and water bodies, shifts occur in taxa richness (biological diversity), species composition (identity of species), individual health, and feeding and reproductive relationships of fish and invertebrates. These general patterns provide powerful tools to diagnose ecological health as well as track the progressive degradation of streams adversely affected by human activities. Furthermore, they can also be used to gauge the success of efforts to rehabilitate damaged ecosystems.

This unique index is used by school groups, citizen volunteers, researchers, and government agencies to track local, regional, and national ecological health. In the Pacific Northwest (USA), a group (www.salmonweb.org) has emerged as a network of volunteers to compile an annually updated assessment (analogous to a blood test in human beings) of the condition of the region's circulatory system, its rivers. The purpose in this region is to preserve and restore wild salmon and their habitat.

Discussion

A multi-metric index such as IBI promotes a holistic approach to the measurement and analysis of the ecological condition. It also avoids dependence on diagnosis of narrow and unreliable surrogate measures such as levels of chemical pollution. IBI can be used to measure and understand the biological consequences of diverse human activities from chemical pollution to logging, livestock grazing, agriculture, recreation, and urbanization.

Among ecologists there is an argument about whether or not ecological integrity should be defined primarily in natural historical terms as the biological condition of "a biota that is the product of evolutionary and bio-geographic processes in the relative absence of the effect of

modern human activity" (Karr 1996). Ulanowicz proposes an alternative systemic concept of integrity, which emphasises that EI should be defined functionally, regardless of wildness or similarity to natural state. This "systemic" perspective on integrity focuses on the *capacities* of ecosystems. From this perspective, a system has EI if it can perform necessary functions, withstand stress, and have the capacity for on-going evolutionary development through the maintenance of a sufficiently diverse gene pool. It does not matter, therefore, if the system looks nothing like its pre-human state (Miller 1998). James Karr has indicated that he does not want his IBI to be deemed exclusively an index of either functional (or, systemic), or structural integrity, because this would effectively box it in. His view of the IBI is that it is an integrated multi-metric measure of integrity (embracing, holistically, the concepts of both functional and structural integrity, as well as the concept of individual health).

Whereas the IBI for salmon streams uses a 'standard' for pristineness that precedes human intervention, the agroecosystem health project at the University of Guelph, Canada, instead developed indicators of diversity in systems where people live. This too can provide an indication of a form of degradation of integrity. However, it was noted that the IBI does not include agriculture or forestry as part of the highest measure of integrity. Thus, human usage at the level of hunter-gatherer societies would not be detectable beyond the expected normal variations. It becomes evident that similar arguments to those in the preceding paragraph (about the exact integrity definition that would apply in this context) again may be raised here.

F. Impoverishment of Ecosystem Integrity and Community Health: A Tragedy in Appalachia, USA, by O. Loucks

Orie Loucks, Miami University, Oxford, Ohio, USA

Dr. Loucks began his presentation by noting that natural resource systems form a 'commons' around us. He said that the commons should be thought of as natural capital, and suggested that measures of whether and how much is being degraded are a means of determining its integrity. However, studies that report on the state of ecosystem health at a national level, or even for large regions, fail to capture local variation in ecological integrity and its consequences for the health and well-being of communities. Dr. Loucks' presentation then moved to a case study and analysis of the impacts of long-term ecological impoverishment in the Appalachian mountain region of the USA.

Intense use of Appalachian resources (including timber, coal, and electricity) by population centres outside the region for fibre, energy, commerce and waste disposal has been documented by others. Dr. Loucks' presentation reported on the consequences of these extractive uses for ecosystem integrity, regional sustainability, and community health in the source regions of the USA. The Appalachian Mountains extend 2,000 km from Alabama to New England. It has been a region of intensive development for timber and coal to supply urban centres of the eastern USA. Because of the high topography, it also is a sink for ground-level ozone and acid deposition originating in the industrial centre of the U.S.

Emissions of pollutants, such as SO_2 , is high from the states whose resources are being exploited, (e.g., from Appalachia), while receiving or neutral regions experience lower impacts. Thus, that portion of acid deposition exacerbates the consequences of extractive development in donor regions. A variety of measures, including calcium cycling, decomposition by soil macro-invertebrates, and tree growth, all show degradation, and thus a loss of ecological integrity.

Mean Functional Integrity (MFI) is defined as the mean condition of two or more ecosystem functions, referenced to historical conditions, and scaled to a common range. When functions

are impaired beyond the natural range of variability, MFI expresses whatever portion of full integrity is present. The remainder of Dr. Loucks' presentation then sought to answer how much diminishment of integrity is consistent with long-term health. Results from multiple study sites in Appalachia and surrounding states show a contrast in ecosystem integrity between regions from which resources (natural capital, such as timber, coal, and coal-fired electricity) are extracted and regions that receive these resources. Multiple measures from long-term monitoring and tree-ring records show receiving regions with a recent MFI of 47 (%), while extraction-dominated regions have a regional MFI of only 18, both in relation to a reference condition of 100 established for measured conditions 20 to 40 years ago. A related secondary measure of integrity, the long-term death rates of trees, also can be used to express MFI. These results show MFI in the 1960s was 92 (%) for resource-receiving states, while for exporting states it was 82 (%); by the 1980s-1990s MFI for these states had declined to 47 and 22, respectively. Reference regions within the USA that neither import nor export resources, showed a recent tree-based MFI of 81.

Several measures of regional "community health" can be evaluated in relation to this pattern in ecosystem integrity. Low integrity, resource depleted regions show *per capita* GDP of $13,400, and the proportion of adults with high school graduation is 65%, while resource-receiving regions have a GDP of $23,900 and graduation of 78%. Non-importing or exporting regions are comparable to the receiving region, with a GDP of $21,900, and graduation at 75%. *Per capita* spending on research and development was lowest in exporting states, and highest in importing regions. Individual human health is related to regional integrity through the load of pollutant emissions. Sulphur dioxide emissions for the exporting, importing, and reference regions, respectively, are 10.1, 4.8, and 1.9 tons per 1,000 km^2, the expected inverse of ecosystem integrity. Pollutant concentrations for the human population, however, are 5.7, 6.4 and 3.5 (micrograms/m^3) for these regions, and the excess mortality rate among humans (per 100,000 people) is 21, 24 and 13, respectively. Other data show that the people of Appalachia also are medically under-served. Still other measures of health are needed.

Dr. Loucks contends that inequities in resource allocation, and costs relating to the loss of natural capital, need to be recompensed to the communities impacted by the losses. This is being done, to some degree, through transfer payments and federal support for improvement in health services, but these costs actually should be incorporated in the pricing of natural capital as it is removed. The continued pattern of draining natural capital and impoverishing one region for the benefit of another, can be corrected in the market place by ensuring that recovery from export fees reflects the loss in natural wealth in a region. As a proposal for action, Dr. Loucks suggested two major mechanisms. First, there needs to be co-ordinated national, state, and local documentation (or, monitoring) for regional transfers of natural capital and transported pollutants (using an OECD-like framework). Second, there needs to be a shift in the tax burden to the industries, products, and individuals that choose to externalise their costs in the form of impaired integrity of ecosystems and the local communities. A variety of approaches are being seen in the current literature, including pollution taxes and resource depletion fees, proportional to the loss of integrity induced. These programs should be introduced to compensate exporting regions for the loss of natural capital.

Two areas of action are needed. First, national governments should implement international standards for comprehensive monitoring of the movement of natural capital and pollutant burdens between smaller nations, and within larger nations. Several countries in Europe and the OECD are beginning to take these steps. Secondly, using the above data and established approaches in economics, national governments should quantify the magnitude of the "free rider" problem (exploitation of a commons for the gain of a few at the expense of many) on both a between-nation and a within-nation basis. Export fees or pollution taxes, proportional to the externalities generated by free riders, should be established on a multinational basis as part of trade agreements.

Discussion

Transfer payments can work both regionally and nationally, but have failed in the international arena. Certainly, the example provided in the presentation suggested a more regional approach within developed countries that could work. In the past, North-South transfer payments have been in the form of repayable loans, with the net transfer always being in the South-North direction (including wealth, labour, and materials). Perhaps a partnership of WHO and the World Bank could look at the sustainability of development schemes in the developing nations, and the long-term health effects that these developments may have, looking beyond the current paradigm of simple causal links.

The issue of the inadequate methodologies currently available, and their application to these types of health linkages was raised. Conventional approaches are directed at simple relationships, like air pollution levels and health outcomes. However, in more traditional epidemiology, where there is truly a causal link between the loss of natural capital (ecological impoverishment) and health, its effect would likely be lost, and considered instead as simply owing to socio-economic features. Such is the danger of applying more traditional methods of health assessment to such complex systems. Interpreting causal relationships remains very difficult and complex.

The issue of whether or not the loss of natural capital is truly recompensable via monetary transfer payments was raised. Obviously, nature's services are not recompensable, at least not morally. The appropriateness of the retention of financial stock in urban areas when natural capital has been drawn down in remote places was questioned. Thus, the remaining natural capital often becomes priced far higher than what the remaining user community can pay.

Dr. Loucks was asked to expand on some of the data pertaining to macro-invertebrates (the worms) performing essential ecosystem services in the soil. He showed that the populations and biodiversity of these biota in the Appalachian region have declined dramatically (60-90%). Many invertebrates have disappeared. As a rule of thumb, he stated that an ecosystem can afford to lose only some 15% of species before the systems destabilise unpredictably.

Other serious issues arose with respect to whether we can ever expect to know the linkages between ecological integrity and human health. Perhaps the health indicators are too crude? Or the health effects are not detectable until "collapse". Many different scenarios should be posed and hypotheses tested in future studies. An additional problem with these studies is that one country can essentially buy its health by exporting the pollution to another country, and by having goods manufactured there under less stringent environmental standards.

G. Global Ecological Integrity and the Ethics of Integrity, by L. Westra

Laura Westra, University of Windsor, Windsor, Ontario, Canada

The "ethics of integrity" propose a holistic approach, based on post-modern science, to the major aspects of the global ecological crises that we face. The work of a currently-held Social Sciences and Humanities Research Council of Canada (SSHRCC) grant has been divided among co-investigators and collaborators. Primary among the problems addressed is the one of human health and the preservation of life in general. The other aspects that have been researched include the sustainability of human centres of culture (cities), and the activities that support basic human survival, such as agriculture, fisheries, and forests.

Dr. Westra began her presentation by referring to the term 'integrity', and how it has existed in many forms of legislation for years (e.g., US Clean Water Act). Hence its use in defining the health or status of ecological systems is neither new, nor radical. Ecological integrity (EI) is an

umbrella concept that includes in various proportions and which cannot be specified precisely, the following:

1) Ecosystem health and its present well-being. This condition may apply to even non-pristine or somewhat degraded ecosystems, provided they function successfully as they presently are. Ecosystems that are merely healthy may encompass both desirable and undesirable possibilities, and may be more or less limited in the capacities they possess. It is for this reason that health alone is not sufficient.

2) The ecosystem must retain the ability to deal with outside interference, and, if necessary, regenerate itself following upon it. This clause refers to the capacity to withstand stress. This definition makes the distinction between non-anthropogenic stress, as part of billions of years of development, and anthropogenic stress, which may be severely disruptive.

3) The systems' integrity reaches a peak when the optimum capacity for the greatest number of possible ongoing development options, within its time/location, is reached. The greatest potentiality for options is fostered, for example, by biodiversity (within contextual natural constraints).

4) The system will possess integrity, if it retains the ability to continue its ongoing change and development, unconstrained by human interruptions, past or present. (Westra 1994).

<u>The Principle of Integrity:</u>

The first moral principle is that nothing can be moral that is in conflict with the physical realities of our existence, or cannot be seen to fit within the natural laws of our environment.

Dr. Westra has proposed a principle that is general enough to ground any and all other principles we might want to espouse, but which stipulates a basic condition, thus ensuring that environmental concern is present from the beginning, rather than being a hard-to-fit afterthought. Thus, the connection between ecosystem and biological integrity as an ultimate value (based primarily on life and life-support) leads to the articulation of the principle of integrity (PI) which demands categorical respect for that principle. In addition, second order principles (SOPs) that guide the application of PI in practical terms are described below (in brief):

1) In order to protect and defend EI, we must start by "embracing complexity";
2) not engage in potentially harmful activities;
3) accepting an interactive dialogue between science, law, stakeholders, bringing out clearly values and principles;
4) accepting an "ecological worldview" by reducing our ecological footprint and rejecting our present expansionist worldview;
5) accepting the elimination of many present practices and choices, and the current emphasis on technical maximality;
6) the necessity for zoning and restraints: hence not only accepting limits on the quality of our activities, but also the quantity;
7) we must respect the individual integrity of single organisms (or micro-integrity), in order to be consistent in our respect for integrity, and also to respect and protect individual functions and their contribution to the systemic whole; and
8) given the uncertainties embedded in SOPs 1, 2, 3, the "Risk Thesis" must be accepted, for uncertainties referring to the near future.

Growing out of these principles of integrity, is the need for societal institutions to hold integrity principles first and foremost. Forms of institutionalised environmental violence which contradict these principles include, for example: increased exposure to UVA/UVB because of ozone layer thinning, exposure to direct impacts of global climate change, such as floods, extreme temperatures and other weather changes, exposure to toxic waste, plus many others.

Dr. Westra then made reference to a need for an environmental Bill of Rights, which might explicitly recognise Nature's services, and humankind's dependence on those services. There is a dichotomy in approaches to Nature, both anthropocentric and non-anthropocentric. We need to recognise that Nature's services, and EI are nothing that we can buy or sell, and that loss of this will lead to effects on human health. Ecosystem integrity can provide the necessary services.

The novel aspects of this approach are many: a holistic, non-anthropocentric starting point, the attempt to reconcile and harmonise somewhat different ecological approaches, including complex systems theory and other non-Newtonian science, and the determination to emphasise the interface and interrelations between apparently disparate problems.

It is the latter aspect that is particularly relevant to the present WHO Workshop. Dr. Westra and her co-investigators' research has shown that there is no aspect of modern human life that is unaffected by our affluent technological lifestyle, anywhere; and vice versa, there is no aspect of our modern lifestyle that is not affecting all aspects of life globally. The way that we pursue cultural endeavours in large cities; the way that we practice agriculture and fisheries and, in fact, the contrast between the hazardous "western diet" and the starvation conditions in the South; the tools and equipment that we use and take for granted -- all of these have strong negative impacts on our health (broadly defined), and on life-support systems that are needed to maintain health.

What does this approach contribute to previous scientific and ethical approaches? Because of the elimination of reductionism and the serious effort to reassess what we do holistically, this has led to an agricultural scientist discussing the causes of many diseases; it has helped an ecologist to discuss health and North-South justice implications of affluent Western diets; it has forced a philosopher to recognise a pattern of institutionalised violence, and another to detail arguments in defence of biocentrism, and yet another to refute cornucopianism. In essence, this research has shown a multidisciplinary team both the commonality and complementarity of our disparate approaches.

As James Karr says in his video: it is a matter of <u>life</u>, not only for epidemiologists, but also for ethicists, conservation biologists, ecologists and others. The protection of life and health are central mandates for the World Health Organization (WHO). WHO is positioned to offer a uniquely strong voice to call a halt to all environmental attacks on life and health. WHO has both the influence and the respect required to counteract the all-pervasive insidious powers of multinationals, international agreements and trade protection and regulations from which most of the attacks originate. WHO can interject an authoritative scientific voice to "risk assessment" procedures that are often based on economics, or on "contingent valuations" (i.e., elicited preferences) (Westra, 1998), instead of being based on science. Hence, WHO is well-positioned to take its place at the forefront of the defence of life.

Discussion

Too many people are buying into the "buffers" approach (see second order principle) which can be more a museum approach if consumption patterns are ignored. "Set-asides" will eventually be taken over by desperate people. The idea of buffered areas cannot succeed

without examining population growth and consumption.

A concern was expressed about how a principle such that “life is paramount” could be consistent with life itself, which for other than primary producers, requires the taking of another’s life. Indeed, what would be the implications for growing populations, and sustenance for all? Dr. Westra replied that population controls would have to be applied in a fair and equitable manner.

Bold statements indicating “no trade-offs” with respect to chemicals thought to impact on reproductive health might apply to such things as carbon dioxide emissions, known to lead to climate change. How can we reconcile a “no-compromise” approach with these types of emissions, which are associated with virtually every human activity?

H. The Principle of Integrity: International Perspectives, by M. Tallacchini

Mariachiara Tallacchini, Università degli studi di Firenze, Firenze, Italy

The aim of this presentation was to analyse if, and to what extent, a coherent idea of individual and environmental health has been implemented. This was done from the perspective of the related legal principles, both at Italian/European and international levels. A ‘coherent idea’ means, more precisely, that the ethical/legal principles relating to the definitions of individual human health, and of environment and environmental health/sustainability, are a logically consistent cluster of principles. If such consistency does not exist, the contradictions between the principles involved were to be examined. Finally, an evaluation of the kind of a legal tool (how useful) the principle of integrity could be in reconciling and providing sound meaning to the existing human/environmental health related principles, was provided.

An analysis of the main normative contradictions/inconsistencies between ethical/legal principles mentioned above revealed several areas of concern. First, there exist inconsistencies in the definitions of the human body and of human health. Second, there are inconsistencies in the definitions of environment. Third, there are inconsistencies in the definitions of sustainability. In terms of contradictions, there too are several. There are key contradictions between human health and environmental health. So too there are contradictions between environmental protection and trade/market protection. This contradiction extends to additional contradictions between environmental protection and biological patentability, and finally to contradictions between trade/market protection and biological patentability. In summary, these contradictions arise because the legal statements almost always hang between a more objective and binding definition, and one that is subjective and loose.

Actually, the legal language around health makes this a difficult area. On the one hand, we find a 'shared' definition of health as being an harmonisation between the individual and the environment. On the other hand, we find an 'autonomous' definition of health as one where individuals have the right to define themselves as 'private' entities with their health not being at all dependent on the environment. With regard to legal definitions of sustainability, we can find in tension human needs versus the maintenance of natural resources. And, concerning the relationship between the environment and the market, which takes precedence in decisions where a balancing of competing interests is not achievable? As long as these indeterminacies exist, it always will be possible to choose the loosest meaning for a so-called healthy environment. Several examples were provided for each of the aforementioned inconsistencies and contradictions at both the European and international levels.

The second part of Dr. Tallacchini’s analysis focussed on an analysis of the theoretical reasons for the illustrated contradictions/inconsistencies. These theoretical reasons are typically related to the values and the scientific knowledge embodied in each of the respective laws pertaining

to the protection of environmental and human health. The initial area of concern relates to problems with a cognitive axiology (that is, the alternative of having knowledge about values, or whether we are obliged to assume a relativist and non-cognitivism position). These also relate to problems with the ranking of the different principles involved (that is, which principles take precedence and thus must prevail over others), as well as to problems with the ranking of individual versus communitarian rights. A second major area, leading to the aforementioned contradictions and inconsistencies, arises from problems with the legal epistemology of science. Indeed, the kind of scientific statement that is assumed valid under the law has not yet been adequately clarified; that is, we have no standards for the criteria that must be met to legitimise science.

The problem is made even worse when the law deals with risks and uncertainties; here, the scientists are divided about the interpretations of the scientific data or about the possible outcomes, and it is the law that has the final word in stating the official scientific position. It also raises questions about democracy, because there is a lack of public participation in the decisions of the experts, and by the same token, the choice of the experts lacks democratic transparency.

The third part of Dr. Tallacchini's analysis dealt with the different legal sources of the idea of integrity and the different (past and present) uses and interpretations of these. This included the codified meanings of integrity and the usefulness of the new legal framework of EI as a possibility for overcoming the contradictions between legal environmental principles.

The presentation included many examples of specific statements and various laws that clearly illustrate the problems outlined above.

Discussion

The question of the impact of the harmonisation of laws between countries at an international level was raised. Dr. Tallacchini pointed out that law is sometimes not so powerful when spread amongst so many different values or normative systems. Indeed, in order for laws to be effective you need not only media and publicity, transparent procedures, and agreement between experts and authorities, you also need a political will (of the people) for the laws to work.

One participant pointed out that the law in practice may be ahead of moral practice. This was countered by the argument that there exist many laws or statements in the constitution of countries that may not be followed in practice. As an example, in Germany there exist very progressive laws. It would also appear that it is ahead somewhat over other European countries in the success of its accomplishments.

A discussion ensued which examined the issue over laws and more regulations, particularly as it relates to biotechnology issues such as DNA manipulation, patenting life-forms, and other problems. The problem too seems to be that the very people carrying out these practices (the biologists) don't seem to be willing to discuss the issue from a legal/ethical standpoint. Perhaps these scientists become too dependent upon the system wherein they are beholden to private scientific inquiry, and turn from public interest to profit-making in the economic realm.

I. Toward Measuring Whether Ecological Disintegrity Impacts Human Health, by C. Soskolne

Colin Soskolne, University of Alberta, Edmonton, Alberta, Canada; and Visiting Scientist, World Health Organization, European Centre for Environment and Health, Rome Division

The relationship between EI and human health was approached, for the first time, in an aggregate data, cross-sectional study design conducted by Lee Sieswerda for his Masters thesis just completed at the University of Alberta, under the supervision of Colin Soskolne. Dr. Soskolne warned that the study should be interpreted with caution, given the methodological and data limitations associated with this pioneering work.

A correlational, aggregate data study design was employed to determine, on several levels of aggregation as the data permitted, if declines in human health could be linked to the large-scale deterioration of EI. Selected surrogate measures of EI (e.g., land disturbance) and socio-economic confounders were modelled in three linear main effects regression models with life expectancy, infant mortality, and percent low birth weight as dependent health outcomes respectively. Most of the data used in this study were obtained from the World Resources 1994-95, the World Resources 1996-97, and the associated Database Diskettes. All analyses were based on available data relating to individual countries (i.e., analyses were based on data points relating to the same jurisdiction). The objective of the study was to test the hypothesis of an association between EI and human health

The results were presented using added-variable plots. GDP per capita, a socio-economic rather than an EI variable, was the single strongest determinant, positively influencing health, and required special handling. Indeed, the GDP variable tended to overwhelm all other variables with respect to the three selected health outcomes. Indeed, subsequent analyses also included stratification by three categories (i.e., low, medium and high) of GDP. Conversion of natural areas to human use was associated with improving health, deforestation was associated with worsening health, and percent species threatened and land protection had no relationship in this exploratory analysis. High GDP countries may be experiencing some negative impacts. Being exploratory, however, the models developed require cautious interpretation and further examination, especially in relation to outlier countries that influence trends. Longer-term data would enhance future modelling. Current available work in this area suggests that many methodological advances will still need to occur.

We anticipated that there would be a positive association between improving human health and improving EI (or, conversely, diminishing EI would be associated with poorer health). However, it becomes apparent that this converse scenario would be true in the real world only if the local population depended on local resources and had overshot local carrying capacity, (i.e., was suffering food and resources shortages). In the present analyses, many high-income countries attained wealth and health initially by greatly disturbing their own landscapes, and then, subsequently, by using their wealth (now generated in the high-end financial and technical services sectors), to appropriate the biophysical output/input of distant lands. Knowing this, one might thus hypothesise in a future study of this type that rich, healthy populations would inhabit greatly modified landscapes with low EI. Indeed, this would be consistent with the present findings. In fact, the present study could be interpreted as showing how technology and trade insulate (rich) populations from the ill-effects of local ecological disintegrity, thus blinding them to their *de facto* continued dependence on EI -- or at least ecological health -- somewhere else. Of course, a time lag exists between the drawing down of natural capital and any postulated collapse in life-support systems that would negatively impact human health. During this interval, continued excess consumption, population growth, and the inappropriate uses of technology will be seen as aiding human health when assessed by measures such as life expectancy.

Discussion

A graph contained in the World Development Report 1993 (page 34) was examined, wherein stratification of data points for many countries, evaluating GDP and life expectancy, revealed a consistent non-linear relationship between the two variables. Indeed, beyond a certain level of GDP, the benefits, in terms of increased life expectancy, seem to plateau. This could be interpreted as suggesting that once a population reaches a certain level of wealth, its health status does not improve. However, within those very populations, there are other co-factors which influence health, including the income distribution within countries.

There was some concern that the results of this study might be portrayed, or misconstrued, as suggesting that ecological disintegrity is disconnected from human health. Rather, it might instead be suggested that rich countries are not living off their own natural capital. Indeed, if some of these wealthy jurisdictions had to rely on their own natural capital they could not survive. Regardless, the way these results are described in subsequent scientific papers is very important. Simply looking for other "more sensitive" indicators of population health would likely not change the perceived relationship; nor would the use of another indicator of population "wealth" (other than GDP) likely change the relationship with the health indicators.

The ambiguity of the conclusions is truly a concern. Perhaps they will be resolved when researchers are able to distinguish between the proximate and the distant environment. Indeed, it is very likely that the EI of local environments is disconnected from health, provided that access to trade is available (and that the local population has something to trade). At least this would apply through a time interval that operates between the drawing down of ecological capital and exceeding thresholds beyond which life-support systems no longer are capable of supporting life.

Researchers should not be looking for traditional linear relationships. Discerning relationships between EI and health will likely require approaches using such devices as multiple non-linear analyses, neural networks, and complex systems analyses. Indeed, it would be wise to include expectations of such things as "catastrophic folds" as possibilities for the ultimate human health impact of ecological degradation.

The idea of rejecting outliers with influence was cautioned against. It was suggested that there was perhaps more information present in those countries than meets the eye. For instance, what is it about countries with high GDP and poor health outcomes that affects the outcome? Conversely, what aspects of poor countries with high health status allows these countries to function at a much higher level? It is the latter group that may provide the key to adaptations necessary as EI is harmed, and voluntary or involuntary reductions in such indicators as GDP occur. On the other hand, the exclusion of outliers may be appropriate depending on the question being addressed.

The ability of epidemiology as a discipline to detect any changes in health status relating to EI was questioned. The evidence is right around us, that humans can thrive in degraded ecosystems. Even on a global basis health changes may not be detectable. Indeed, this may well point to the theory that negative impacts on health, if and when they occur, will likely be catastrophic and not manifest as a gradual decline. Health outcomes may more likely be tied to such events as civil strife, war, and famine, than to any particular measurable index of health status like life expectancy. The causal relationship that we would be looking for is likely not correct under any current epidemiological paradigm. On the other hand, psychosocial indices of health may be sensitive enough as early indicators of declines in population health (e.g., mental health) status.

The ecologist's view of the problem with this analysis was twofold: 1) the next level of

analysis would have to be at a more bio-regional level, not a country level, and 2) the ecological indices used in the present analysis really did not represent EI as a whole. Indeed, besides the issue of convenience, the indices did not come close to addressing the criteria for functional or biological indices as set forth by either Orie Loucks or James Karr respectively. A great deal of refinement of these indices would be required before such analyses (as presented herein) would be likely to yield valid results. As an example, the use of "land conversion" to human use was criticised as a very modest metric of exposure. Other measures (more valid) would be required to determine which regions/countries are moving to a threshold of failure.

While there was not a clear positive finding suggesting that people's health is adversely affected by the use of their natural resources, the converse is also true: namely, that people cannot indefinitely improve their health simply by extracting natural capital.

The likely prohibitive expense to be expected with studies at progressively more refined units of investigation (i.e., regional health, local health, individual health) was noted. National level health statistics are readily available, but perhaps "wash-out" effects would be present in such an approach. It was noted, however, that the very statistics collected on "health" still tend to reflect the model of disease, and not that of the health being measured.

Annex II: Subsequent Creative Insights

1. Sustainable Health (or what's the point of all this work?), by D. Waltner-Toews

A poem following a Workshop on Global Ecological Integrity and Human Health at the World Health Organization, European Centre for Environment and Health, Rome Division, December 3-4, 1998

From red brick and creamy marble,
empire layered on calumniated empire
nudged up and buckled down
by roots, shovels and greenery
there abide

these three:
earth's abundance,
our handiwork,
the echo of voices at a feast.

In a Roman restaurant, at dusk,
we sit among friends, our hands like frail rafts
over the rush of tongues, speaking
of artichokes, economy, and wine.
In the air over our heads, like flocks of Roman blackbirds
waving their black, lacy blues against the ruined skyline,
despair and hopes pulse, mingling.
The light spills out the open door
Silvery fish across the cobbles,
the last fish of a vanishing school,
into the night. The darkness, like a Roman cat,
slips in, waits in the shadows
among the leather coats and scarred wooden chair-legs.

Without the produce, there is no life.
Without our handiwork, we wither, one by one.
Without the fellowship, there is no reason.

In this is our health,
what all the work is for, or for nothing:
to nurture our hopes
from the gifts of earth's breathing
and the stones of broken empires,
the salad from our plates whispering
wisdom to us, our green and rusty, fraying, mother tongue,
her breath warm with vinegar and olives.

2. Public Health: A Threat To Global Ecological Integrity? (DRAFT: 08/01/99), by G. Hess

An essay following a Workshop on Global Ecological Integrity and Human Health at the World Health Organization, European Centre for Environment and Health, Rome Division, December 3-4, 1998

In the light of sustainable development, a secure global ecological situation is far from certain. Are current trends in development, particularly the promotion of world-wide economic growth, ecologically sustainable? Can the earth sustain current and likely increasing levels of resource exploitation?

The international public health community has a significant responsibility to anticipate the public health implications of the links between development trends and global ecological integrity. What are the implications of a depleted or destroyed natural environment for public health? What are the health implications of increasing population and consumption in a world of finite resources? What role does public health play in the dynamics of population, consumption and ecological integrity? What should the public health community be doing?

Are current development trends ecologically sustainable?

There are very compelling arguments and evidence to demonstrate that we are indeed depleting our natural resource base. The implications of this trend are that we will not be able to sustain life and lifestyles as we currently understand them to be. As population and consumption continue to grow, dependence on finite resources and abuse of natural environments will inevitably lead to food shortages, water scarcity, diminished air quality, species extinction and the like. Intuitively the argument makes sense. Relating an analogy used by David Suzuki, "if we inherit a bank account with a thousand dollars that earns 5 percent interest annually, we could withdraw fifty dollars or less each year forever. However, suppose we start to increase our withdrawals, say up to sixty dollars, then seventy dollars, and more each year. For many years, the account would yield cash. But it would be foolish to conclude that we could keep drawing more from the account indefinitely."[1]

Irrespective of when the account will be overdrawn, core issues of ecological integrity include consumption and population (which are also key components of development). Technology can be considered an influencing variable on each of these pillars of ecological integrity. However, discussion of these issues, their impacts and appropriate balances are generally framed in a very white, Euro-centric context. Ironically, it has been global application of western principles which has generated most of the problems we are trying to address. This paper contends that continued application of western approaches will result in limited or no success in arresting global environmental degradation. Further, public health has an essential and feasible role to play in shifting paradigms of public policy formulation and application.

Pragmatism versus philosophy

Western culture is driven by pragmatism not philosophy, as demonstrated in the relationship between behaviour and beliefs. Western culture tends to act out of practical (and usually short-term) considerations as opposed to value or belief systems. Consequentially, our beliefs are very often derived from (or sequential to) our behaviour. What were the values, beliefs, or principles underlying the colonisation of North America, South America, Africa, Australia, New Zealand, and parts of Asia? What are the values, beliefs, or principles underlying globalisation and free market expansion?

[1] Suzuki, David. Earth Time. Toronto: Stoddart Publishing Co., 1998. Page 133.

Thus is our approach to environment and now to resolving the problems of environmental damage. In regards to environment, we have behaved in an uncontrolled exploitative manner and are only now stimulating public debate of what the environment means to us (i.e. what are our values and beliefs). Had we operated the other way round, e.g. out of the belief of the sanctity of the environment and man's place within it, we would not be in this position. In essence, this is a moot point since we cannot reverse time nor can we change overnight. However, it is critical to recognize and understand the distinction between behaviour-driven principles and principle-driven behaviours if we hope to achieve a sustainable balance between development and ecological integrity. The most severe consequence of behaviour-driven belief systems is a separation of man from nature. It is this artificial separation, if maintained, which will unfortunately and irreparably continue to tip the balance of development toward destructive behaviours.

Developmental colonialism

Precisely because current motivations and methodologies in public health are western-based and culturally homogeneous, they perpetuate *developmental colonialism:* forced or incentive-induced behavioural changes which consequently erode or destroy pre-existing cultural values, beliefs and principles. Global issues in both social and natural sciences are framed in western methodologies, excluding most notably the populations subject to influence. Just as political and economic colonialism forced behaviour changes upon indigenous populations in an effort to change the values and beliefs of that culture, development programmes are equally culpable of subversive colonialism and results will be equally disastrous.

Development programmes provide incentives to change local norms in favour of foreign behaviours, altering natural balances and eroding values and beliefs. In the ecological integrity debate, cultures that have been irreversibly altered by contact with western culture are being directed exploit natural resources, to seek non-traditional employment from foreign-controlled corporations, to control population growth, etc. Thus, for reasons of western behaviour and irrespective of cultural norms, "developing" countries are being forced to adapt fundamental beliefs and values.

This stems from a faulty premise which maintains that improved health and well-being are dependent upon western-style economic development. However, as Suzuki points out:

> "…global economics is ultimately destructive because it is fatally flawed: it externalizes the natural capital and services that keep us alive, while glorifying human inventiveness as if it allows us to escape finite limits and manage our biophysical surroundings; it assumes endless growth is possible and necessary and represents progress; it does not value long-term social and ecological sustainability; it rejects caring, co-operation, and sharing as irrational, while promoting selfishness; and it cannot incorporate the reality of spiritual needs.
>
> It is breathtaking hubris to force this single, monolithic concept as salvation into every part of the world."[2]

Perhaps unintentionally and unwittingly, public health is complicit in the application of this model. Public health has uniformly promoted economic development as a primary means to achieving health. Furthermore, just as economists can be chastised for creating economic models that conceptually exclude the environment, so too can the public health profession be chastised. Public health strategies have tended to disregard the ecological consequences of their various interventions, continuing to view mankind above natural systems. Traditional public health interventions have focussed predominantly upon mankind as an independent entity, and not in the context of our living environment.

[2] Ibid. p 74.

As an example, in our efforts to improve human health, we have engaged in a process of selective ecological disintegrity (consciously altering or destroying ecosystems). The hypocrisy of such measures is glaring. In malaria-prone areas, it is acceptable to eradicate mosquitoes as a measure to protect human health. In the Pacific northwest of North America, eradicating mosquitoes would be considered a violent act of ecological destruction, removing a valuable element of the ecosystems. Can we continue to manipulate nature to promote short-term gains in human health? Who draws the line between acceptable and unacceptable disintegrity? When we create niches in nature through selective disintegrity, can we be surprised that these niches are filled by other and potentially more harmful substitutes?

Aims and values of public health

What is the aim of public health? It would seem from both its measures and interventions that the goal of public health is to make man impervious to nature by making people immune to disease and by increasing longevity. In such a framework, elements of nature are implicitly classified into resources for and threats to human health. As long as public health continues to value human health above any other element of nature, public health will continue to treat nature as a commodity of human health and sacrifice the environment for the short-term health of man.

Take, for example, an introduction to "Health 21 – health for all in the 21st century", the strategic blueprint of the World Health Organization's Regional Office for Europe, the European branch of the global public health agency. Its stated mission is "to achieve full health potential for all" under which there are "two main aims: to promote and protect people's health throughout their lives; and to reduce the incidence of the main diseases and injuries, and alleviate the suffering they cause".[3] As a sub-sector of a greater environment, these are fine aims. However, the context in which they are couched is self-defeating in the long run. The context is comprised of several assumptions: that economic development and health are universally concomitant; that western standards are the benchmarks of development; that economic growth is not limited; and that (in spite of countless examples to the contrary) man has the wisdom to appropriately and harmlessly manipulate the natural environment to serve our own ends. The document contains only passing reference to the environment (Target no. 10, and only as a means to promote economic growth), makes one general mention of health suffering as a consequence of environmental mismanagement (page 12), and makes no mention of ecosystems or man's place within them.

Indeed, the overwhelming western views of health and well-being are so laden with culturally objectionable definitions that it is no wonder many cultures feel railroaded into foreign and demeaned lifestyles. For example, WHO strategy states that "[health] is a benchmark for progress toward the reduction of poverty, the promotion of social cohesion and the elimination of discrimination" (p 6). Yet, many westerners who have interacted with native populations unsullied by "development" will assert that they are exceedingly socially cohesive and non-discriminatory even though they do not meet western criteria of "good health". Native Americans, as an example, are well founded in their belief that the introduction of western values through development have reduced social cohesion and introduced previously unrecognised means of polarisation between groups. Furthermore, progress, poverty and the associated stigmas are western inferences. Listen to the words of a traditional Indian woman of the Crow Nation (Montana, USA):

> "Progress is a dirty word to Indian people who have to use it to further their livelihoods and lower the poverty levels on their respective reservations. If you live on this earth, you are a part of it. The major difference is that the

[3] World Health Organization Regional Office for Europe. Health 21 – an introduction to the health for all policy framework for the WHO European Region. European Health for All series; No 5. Copenhagen, Denmark, 1998. Page 6.

> western world has made things easy for its inhabitants. Everything is too easy. A lot of them do not wish to be alone or to be in nature where they are not in control. When they are in control then they are happy and that's where development is born. Money is power and buys them their happiness where we (Indian People) survive on next to nothing because we are secure knowing that our environment will help us when we need it. For the western world, that security is not there because they are not willing to let the money go. Poverty is a trait that has given us strength in survival and has given us the time and insight to Mother Earth and her many wonders which we fully enjoy because we know how she works. Poverty is a nasty word to someone who covets money but to us it is a place we have always been and have dealt with it. That is why money is not important to us as it is to some because you can always make money but life is irreplaceable."[4]

Ironically, although poor health (e.g. diabetes, obesity, alcoholism, accidents, etc.) on Indian reservations in North America can be attributed largely to disrupted lifestyles, the prescription for improving health on the reservation is more "progress": the creation of material wealth through economic development.

What role for public health?

What's wrong with this picture? Using conventional public health measures (life expectancy, education levels, immunisation rates, access to health services, GDP per capita), the most healthy people in the world live in noisy, relatively violent, polluted concrete environments with limited exposure to the elements of nature. They live longer, are better immunised, have proportionally fewer deaths due to infectious diseases, are better educated, have better access to medical care and have a higher standard of living (as measured by income and consumption).

Using these indicators as principal measures of public health will continue to promote a de facto separation of man from nature and continue to provide inappropriate support to destructive global trends. If we wish to reverse these trends, our challenge is then "how can public health place man in nature?" Or much more accurately, *"How can public health adapt its methodologies to appropriately acknowledge man as part of a greater environment?"* This is an extremely fundamental shift for the public health and larger public policy communities.

To do so, would require different sets of indicators and evaluators, or at least mainstream adoption of currently available public health indicators. Community health indicators must be more than the average of individual disease and mortality statistics. New measures are required to assess *health as a balanced system of individuals, communities and the environment.* In this way, the primary role of public health must be the creation of healthy sustainable communities and ecosystems, not the enhancement of the immunity of man to all forms of illness and accident. The changing paradigm would require explicit recognition of humankind's niche in a greater environment and of our natural limitations.

Bio-diversity models may be one example of the type of measurements public health professionals could seek to adapt. Other measures do already exist but are not recognised as priority indicators in public health assessment. For example, in the past twenty years, per capita consumption in the United States rose by 45 percent. Over the same period, the quality of life as measured by the Index of Social Health decreased by 51 percent.[5] Yet the prevailing wisdom (and oft-heard assertion) is that people are healthier if they are living longer and wealthier.

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[4] Faith Bad Bear, Crow Tribe, Montana USA. Personal correspondence 9/12/98.

[5] New Road Map Foundation. *All-Consuming Passion: Waking up from the American Dream.* As quoted by Suzuki, page 96.

The basis for selection of health indicators can be attributed directly to value systems of the dominant scientific culture. In this case, it is western culture which has artificially extracted mankind from our environment and elevated aggregate individual health above the health of communities and ecosystems. Suppose, for example, we valued vibrant intact ecosystems more than income or longevity. If this were the dominant cultural value, health, development, progress and poverty would take on entirely different meanings. Public health cannot dictate global value systems. But it can ensure that its values and actions do not conform to or affirm philosophies which are ultimately destructive to life on earth.

3. Nature in the Era of its Technical Reproducibility: An Anthropological Turn?, by P. Vineis

University of Turin, Turin, Italy

An essay following the author's review of the draft report from the Workshop on Global Ecological Integrity and Human Health at the World Health Organization, European Centre for Environment and Health, Rome Division, December 3-4, 1998

One of the reasons for concern in the current environmental situation is the changing attitude of men and women toward nature, induced by an increasing involvement of scientific research with technological and commercial exploitation. In the nineteenth century, natural science was perceived not only as a tool for producing objective knowledge, but also as a source of answers to traditional philosophical questions. Nature was surrounded by an "aura" of respect, although in a somewhat distorted way, in that the traditional religious "aura" (sense of magic and fear) was substituted by an appreciation of the regularity, beauty and power of nature. The nineteenth century scientist (say, Darwin) was an amateur with wide cultural interests, not necessarily pressured by technological or entrepreneurial commitments. More often than not, they conducted their scientific experiments themselves, mixing scientific activity with a craftsman's ability.

Today the situation has changed considerably. Science has undergone a process of "secularisation", which is accompanied by a parallel change in the public's perception of both scientific activities and nature. Recent books, such as Turney's "Frankenstein's Footsteps" (1), or Collins and Pinch's "The Golem at Large" (2), draw our attention to the fact that the last century has seen a progressive interplay between science and technology, the public's expectations, and the role played by the mass-media. We can interpret this change in the context of the well-known essay by Walter Benjamin, "Art in the Era of its Technical Reproducibility" (3). According to Benjamin, in this century, an important shift has occurred, from art as a special support to religious belief (and therefore surrounded by a religious "aura"), toward a post-auratic art. This shift was not only because of the general secularisation of Western societies, but more specifically, it arose from the technical reproducibility of artwork. In this way, art came to lose its "appearance of autonomy" from the productive world.

In the case of science, its "auratic era" was positivism, when nature still was the object of respectful attention and a source of answers to philosophical questions. The appearance of the autonomy of science was expressed by the strongly held view of the neutrality of scientists. Now, the situation has radically changed: the expansion of technological applications and the dependence of scientific activities upon productive and military structures has led to the almost complete loss of any autonomy. However, a characteristic of post-auratic art and science, if we follow Benjamin, is the re-creation of a false sense of autonomy for the sake of the public. Benjamin refers to movie-making as an example of post-auratic art. While actors are involved in fragmented and passive roles under the control of technology (i.e., they have lost the unitarian, versatile subjective abilities of theatre actors), the mass-media creates an artificial personality around actors. The cult of the artist aims to preserve a charm of personality that movie-making as an industry has destroyed.

Similarly, although the scientist continues to be portrayed by the mass-media as a strong independent personality, science-making has totally modified its characters. Nature itself is almost completely "humanized", but its "aura" is artificially re-created in TV advertisements and movies. Under positivism, nature was mirrored by human reason: laws existed objectively "out there", and the mind was able to reflect, through a kind of isomorphism, the objects of scientific observation and the laws of their functioning. The autonomy of the scientist was justified by the existence of an "archimedean vantage point" in the observation of nature. Today, not only is the observation of nature largely mediated by instruments that are

industrially produced, but nature itself is reproduced in the laboratory (one trivial example is the amplification of DNA, routinely performed by thousands of laboratories in the world every day). This process has dramatic consequences for how we perceive nature. Nature has become somewhat absorbed into the system of production, so that nothing at all is left outside of what is capable of "instrumental reason".

Living in an era of "post-auratic science" has important anthropological implications. If nature can be reproduced with technical tools (think of Dr. Craig Venter's claim of being able to create life from molecules), if damage to nature can be fixed just like any traditional machine can be fixed, what are we to expect about people's respect and sense of wonder toward nature? Although this might seem a rather pessimistic point of view, I believe that we cannot ignore the anthropological consequences of the new scientific-technological complex, particularly in the life sciences.

That the preceding considerations are not too far from reality is clear if we consider what some experts have written about genetic manipulation. Howard Kaye (4) has written that "… the idea that we are essentially self-replicating machines, built by the evolutionary process, designed for survival and reproduction, and run by our genes continues to gain", and claims that "by challenging – through genetic manipulation - the conception of ourselves as unique, precious, free, and responsible beings, worthy of respect because of our special nature, we are … also undermining the beliefs embodied in our laws, customs, and institutions, and even in our everyday experience and social interaction".

Berlain and Lewontin (5), in turn, draw our attention not only to the symbolic modifications in our relationships with nature and with ourselves, but to the distribution of power. They note that the direct consequences of genetic manipulation (particularly in agriculture) might be the reinforcing of existing monopolies (that would acquire unprecedented power) and the unequal distribution of resources in society. In particular, they wonder -- with regard to the first consequence -- whether "we want to let the biological part of our humanity be appropriated by some multinational enterprises by attaching a legal, biological and contractual privilege to it".

Are we facing an unprecedented anthropological change in our perception of nature? Does this perceptual change comprise the loss not only of the sense of wonder, but even of a minimal sense of respect for processes that can be artificially reproduced and fixed according to technological protocols? Will "magic bullets" be found for all of the world's ills? Such shifts in our perceptions of our universe could explain the growing distancing of human health from its very life source, the ecosphere.

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4. Genocide, Epicide, Ecocide, Ecology and Public Health: A Thought Piece, by E. Richter

Hebrew University - Hadassah, Jerusalem, Israel

An essay following the author's review of the draft report from the Workshop on Global Ecological Integrity and Human Health at the World Health Organization, European Centre for Environment and Health, Rome Division, December 3-4, 1998

Historical context: Ten years from now, a historian going through the archives of WHO ECEH, Rome Division Office, will notice that the Discussion Document arising from the Workshop (named above), of which this essay forms an Annex, was produced. This document was conceived, drafted, written, edited and released during the prodromal and acute stage of the mass killings, rapes, and expulsions during the war in Kosovo. All these horrible events were happening a taxi ride, shuttle train and short flight from the WHO Rome Office.

Today, no statement on environment, ecology and public health can ignore genocide. The implicit assumption of this essay is that respect for human life is an absolute value. By failing to explicitly define the principle of respect for human life as an absolute value, the Discussion Document could sow the seeds of misuse. Neither "ecology" nor "sustainable development" should be allowed to serve as a justification for junk ethics in the way that eugenics and compulsory sterilization foretold the Holocaust. The scenery around Treblinka is very green to this day, and gas chambers were, relatively speaking, low polluters, and quite sustainable as ecological enterprises.

WHO is uniquely positioned to state this principle that respect for life is an absolute value. In so doing, it must recognize the dangers of sliding down the slippery slope of appearing to sanction or condone policies that justify loss or destruction of human life so as to preserve the ecosystem.

Background: We aim to mesh public health, the practitioners of which promote health and prevent disease, together with ecology, the practitioners of which work to preserve the sustainability and carrying capacity of the environments around us. The Discussion Document expands on concepts articulated by McMichael. (1) It addresses the question: How is the protection of an individual's or community's health reconciled with the need for preserving local, regional and global sustainability and carrying capacity, and vice versa?

The Kosovo war, and other wars of genocide and mass killings since the Holocaust -- Cambodia, Bosnia, Rwanda-Burundi, southern Sudan -- underscore the role of ethnic conflicts which are not ecological in origin in producing genocide and ecocide, and, for want of a better term, epicide. These conflicts have been too severe in their impacts and long-term repercussions to be dismissed as temporary perturbations.

Validity of the Prognosis: The Discussion Document predicts a major impending -- and possibly abrupt -- ecological bust world-wide, and presents values and strategies for its prevention or management. This bust is predicted to occur possibly by about 50 years from now, following more than 500 years of population growth, technological expansion and economic boom achieved by humankind's squandering of its ecological capital. The scenario is one in which "healthy individuals and populations can exist in local environments that have lost ecological integrity; their level of health is maintained by healthy ecosystems that exist elsewhere". The bust means that public and personal health will collapse as a result of catastrophic impacts on planetary life-support systems.

The following 2 x 2 table summarises the inherent lack of sustainability of current trends: the Malthusian scenario will reappear. The Four Horsemen -- famine, pestilence, war and conquest -- will re-emerge. There will be a multitude of small-scale wars, and for many, life will again be nasty, brutal and short.

	Sustainability: i.e., Prevention of Ecological Disruption, Bust, Breakdown (Resource Depletion, System Disruption, Contamination, etc)	
Economic/Public Health - Boom /Prosperity/Stability	**Yes**	**No**
Yes	A	B
No	C	D

In the past, many societies moved from C, i.e., being poor and sustainable, to A, being rich and sustainable. The Discussion Document notes that we have moved from A to B, and will then move to D, as environmental capital becomes further depleted. By contrast, there are still some places in C -- presumably "backward" economically -- which are being exploited and which will also be dragged into D. Much of the developing world is already in D. The challenge ahead will be to climb back into A, or to have Malthusian forces drag many of us back into C -- and others back into B.

Boom, Bust and Equity: A decade ago, some predicted boom and others predicted bust and suffering. Current conventional wisdom holds that the first prediction was the more correct, based on the fact that more people are living better than ever before, even if many more are actually worse off. Are those who cried wolf then crying wolf now? Or is another decade of boom a postponement of the inevitable?

Will there be new forms of economic growth to serve the needs of a growing world population fairly? There are plenty of case studies to suggest this is possible. The case studies from Kerala are perhaps the most instructive in the developing world. In the developed world, northern Europe seems to have taken some steps toward sustainability. In the West, an increase in GDP has been disconnected from an increase in energy consumption. The same beneficial results can be expected to hold true for crop yield and pesticide use, mobility and air pollution, as well as water supply and quality. But ethnic strife and the re-emergence of extremist movements could undermine these desirable trends.

Some say that the recent big busts -- the world-wide financial crisis -- are only partly ecological in origin. Their roots lie mainly in corruption, backward government, lack of democracy, governmental instability, discriminatory fiscal policy, high interest rates, structural problems in their financial order, and, most importantly, civil unrest and breakdown resulting from ethnic conflict. But not from depleting resources. These problems, in fact, often predate ecological abuse and breakdown. Yet the doomsday predictions of the 1998 world-wide financial crash linked to ecological breakdown were proven wrong, because the global banking system lowered interest rates, provided debt relief, performed other actions to shore up vulnerable countries and intervened with what are called structural reforms. Had the world system collapsed, we certainly could have expected war, famine, pestilence and plague on a terrifying scale.

Genocide, Epicide, Ecocide and Ecology: The extermination of one ethnic group, tribe, nation, or group of persons by another is the ultimate public health disaster. Genocide, or attempts at genocide (and which I call epicide), remains the biggest and most grotesquely visible of modern public health problems. Since World War II, genocide and epicide would

seem to have adopted a very low-tech guise, as they are now carried out by marauding bands of thugs, "para-militaries" and toughs equipped with machetes, mallets, hammers, rifles, knives, shovels, hoes, pistols, rifles and machine guns. What is the role of ethnic conflicts, hate, religious and political fanaticism, and the conflict between Jihad and MacWorld in promoting ecological upheaval and disruption, and vice versa? (2)

Before the outbreak of mass killings and genocide in Kosovo, Cambodia, and Bosnia, the land and its occupants were far from being depleted of good soil and water resources, as well as reasonably good air and food supplies. However, in Rwanda-Burundi (3) rapid population growth and pressures on land-use were already emerging prior to the mass killings; in southern Sudan, where mass killings and war have persisted for some 15 years, subsistence poverty has been a dominant fact of life. In each of these situations there was a conspicuous lack of respect for human life, respect for the values of others, live and let live, democracy, respect for human rights, law, civil order and civilization's restraints. Here, we are dealing with a "local" or "regional" tragedy in which Serbia and Kosovo have moved from B and C to D. One million people have been on the run, and thousands, mostly male, are reported to have been slaughtered. In all of this, however, there have been no water shortages, soil erosion or loss of fertility, floods, earthquakes, industrial or chemical disasters, or even massive toxic spills. Rather, it has been historical memories that have produced a public health disaster with minimal environmental upheaval -- so far.

Can epidemiologists examine ethnic strife, not just as a dependent variable in one big ecological process, but as the driving force itself in producing pressures for local and regional catastrophe, disarray and breakdown? Can epidemiologists predict the risk markers that foretell genocide and ecocide? Can epidemiologists spell out the early warning signs that genocide is starting, so as to prevent a recurrence of the disgraceful performance of the international community in Cambodia, Bosnia, Rwanda-Burundi, southern Sudan and now in Kosovo? Do we need an international epidemiological intelligence service -- insulated from political agencies -- for reporting the early warning signs of genocide? The most obvious risk indicator is a history of previous wars and regional ethnic, religious, cultural and tribal conflicts.

Ethnic Conflict, The Arms Race and Environmental Degradation: Ethnic and tribal conflict, when they translate into either war, the arms race, or the manufacture of arms (conventional, nuclear, biological and chemical), become a driving force which usually has devastating environmental impacts. Furthermore, there is a diversion of resources away from public health and environmental protection. We cannot ignore the environmental impacts of the military-industrial complex just because information on these impacts is usually classified. Ecocide in the former Soviet Union was a major factor in the loss of the carrying capacity of huge areas. The public health impacts were horrific, as seen in the Chelyabinsk disaster in which nuclear waste actually exploded, not to mention many other disasters. (4) Ecologists need to interact with political scientists to examine the origins, driving forces and pressures associated with sustaining the arms race, identifying its impacts and recommending ways to resolve conflicts in non-destructive ways.

Strategies: The ethos of untrammeled economic development, ethnic conflict, greed, unemployment and workers' very legitimate fears of unemployment is what drives economic development, and often it can be expected to produce compromises with both ecological conservation and sustainable development. The tension between full employment and economic growth on the one hand, and environmental sustainability on the other, is well-known. There are many case studies that describe this tension. Yet economic stagnation can serve as a barrier to the major investments needed for sustainable development.

Workers cannot be expected to support new paradigms unless there is protection of earning power to provide for their families. Much-needed new paradigms are proposed for development in the Discussion Paper. These imply a complex restructuring of the workforce and economy in ways that protect the weak, without polarizing the fight for individual dignity, employment and employability on the one hand, and sustainability on the other. The role of unemployment in fanning the flames of ethnic hate -- the emotional driving force of genocide, chaos and ecocide -- is well-known to all.

The two other stakeholders for building new paradigms are children and women. While mature adult males tend to play a leading role in ethnic conflicts, it is the young adult males who carry out nearly all the mass killing. This places women and children at special risk for the effects of the violent by-products of ecological abuse, and in terms of their being victims of ethnic conflict and genocide, they do, in fact, share equal rights with men. What is the role of UN agencies in partnering with workers, children and women in ways that protect their rights as part of any new paradigms?

Education: Education for any new paradigm will be needed to support its values and vice versa. There is a role for WHO in penetrating and seeding the educational system to promote the dignity of the individual, respect for human life and human rights as the criteria for judging all activities aimed at achieving sustainability.

Conclusion: Any new paradigms should be based on the ethical principle of respect for life and its support systems, namely, fertile land, clean water and clean air. I suggest the need to draw upon the great religious, philosophical and ethical traditions to restate the imperative of any new paradigm: respect for life, which means respect for the systems that sustain life. Loving thy neighbour as thyself now means loving the land, water and air which sustains him, her, and me. Our support systems are being abused, depleted and scarred by the tidal forces of global economic development. But let us not forget that ethnic conflict and religious strife, which all too often draw on “tradition”, religious or cultural “self-expression”, or “ethnic superiority”, can lead to genocide -- the worst type of public health disaster -- without ecocide. This is the message of Kosovo to this document’s readers.

References:

1. McMichael, A. Planetary Overload, Global Environmental Change, Cambridge U Press, 1993
2. Barber B. Jihad and MacWorld
3. Brown L, et al. State of the World: 1998, WW Norton, 1998
4. Medvedev, Z. Nuclear Disaster in the Urals, Vintage Books, 1980

Annex III: Directory of personnel and organisational resources (DPOR)

(Note: This list is merely a beginning. Thus, it is neither complete nor representative)

Pertaining to the Foreword on page x:

The Club of Rome: http://www.clubofrome.org/cor_history.htm (7/5/99 update)

Pertaining to sub-objective 3 on pages 11-12:

UNDP initiative on sustainable livelihoods, Naresh Singh, Senior Advisor on Poverty and Sustainable Livelihoods
FAO sustainable food security programme
Private sector partners (e.g., Gordon Conway, who developed ideas of agroecosystem analysis while working for IDS (Sussex) and Ford Foundation, now president of Rockefeller Foundation)
European Society for Ecological Economics (e.g., Mario Giampietro, Istituto Nazionale della Nutrizione, Department of Technological Assessment; e-mail addresses: giampietro@inn.ingrm.it; and, through September 1999, at: iehe34@blues.uab.es)

Pertaining to sub-objective 8 on pages 17-18:

A report called "Risk Management and Governance" by Bruna DeMarchi and Jerome Ravetz (Institute of International Sociology - Gorizia; Contract No. 13133-97-08 FIED Final Report) uses the Seveso incident, BSE, and genetically-altered maize as cases to examine the changing relationships between science, politics, and the public
Other key recent references are those by Funtowicz and Ravetz (1994), Roling and Wagemakers (1998), and Berkes et al (1998). Many of these are cited in Waltner-Toews' "The Ragtime Biosphere Symphony", in the chapter on post-normal science. An activist and transparent and democratic science is the only sustainable option. The DeMarchi and Ravetz report also has a full list of references and lists two web sites
1) http://ta-www.jrc.it/ulysses.html (English and Italian), and
2) http://ta-www.jrc.it/indrisk.html (Italian)
The text entitled "Barriers and Bridges to the Renewal of Ecosystems and Institutions" by Gunderson, Holling and Light (1995) speaks clearly to the issue at hand.
For more information on the European Commission's attempts to proceduralise the precautionary approach (both on GMO [Genetically Modified Organisms]: A4-0239/97 and A4-0070/970) see web site address
http://www.europarl.eu.int/dg1/A4/en/default.htm

Pertaining to sub-objective 9 on pages 18-20:

There is the need to recognise and work with NGOs already working hard to exact these changes, such as the New Road Map Foundation and the Media Foundation (publishers of "Adbusters")
The Dirk Gently Group is an ad hoc, international group of scholars, primarily based in Europe, which is working on the basic theory of decision-making under conditions of complexity and uncertainty (much of this information can be accessed at: http://www.ovcnet.uoguelph.ca/popmed/ecosys/).
The Network for Ecosystem Sustainability and Health is working to link communities and researchers implementing many of these ideas. Web address is:
http://www.ecologistics.com/nesh/