Manual On Environmental Health Indicators and Benchmarks: Human Rights Perspectives

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Human Rights Perspectives

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Foreword

Four years ago, the Science and Human Rights Program of the American Association for the Advancement of Science (AAAS) began a project to explore the intrinsic connections between environmental protection and the realization of many of the economic, social, and cultural rights enumerated in international human rights conventions and treaties. The central premise of this initiative is that it is not possible to promote human rights without at the same time working to improve implementation of environmental and public health standards and guidelines. By fostering a wider understanding of economic, social and cultural rights to include environmental protection, the project seeks to provide a broader and more meaningful basis for collaboration among organizations in the human rights, environmental and public health communities. In the past few years the project has developed a number of resources that can be accessed on the AAAS Environmental and Human Rights Resources website: http://shr.aaas.org/hrenv.

The Manual on Environmental Health Indicators and Benchmarks: Human Rights Perspectives is the most recent such resource developed by the Science and Human Rights Program. The Manual, which was drafted in close cooperation with the Global Children's Health and Environment Fund and the National Council for Science and the Environment, is a pioneering effort in a variety of ways. It draws together the fields of the environment and human health as seen from a human rights point of view. It also offers a new approach to developing human rights related indicators and benchmarks. Based primarily on a human rights perspective, the Manual provides a compilation of environmental health indicators and benchmarks to determine the state of human health in urban and rural communities around the world. Above all, the Manual provides a means through which community-based organizations, especially those located in developing countries, can begin to assess the extent of human health risks posed by a degraded environment in their community.

Like many other innovative and pioneering initiatives, the drafting of the Manual benefited from the inputs of many individuals. The Science and Human Rights Program would like especially to recognize the contribution of Dr. Karim Ahmed and his research assistants, Anya Ferring and Lina Ibarra Ruiz, who together served as authors of this document. The Manual would never have been completed without Dr. Ahmed's broad expertise in environmental sciences, his overall direction of and dedication to the project, a willingness to apply his stock of knowledge to a new subject area, and to become a human rights advocate in the process.

The Science and Human Rights Program is appreciative of the generous support provided by the Richard & Rhoda Goldman Fund that has enabled us to undertake the project to develop and promote the multiple connections between human rights and environmental protection. We would like particularly to note the assistance and encouragement provided by Helena Byrkarz at the foundation. Finally, appreciation is also extended to several peer reviewers of the Manual, whose comments helped to strengthen the manual, to Sarah Olmstead for her editorial work, and to Richard Huggard for the design and layout work for the manual.

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Table of Contents

Preface

The Program on Science and Human Rights of the American Association for the Advancement of Science (AAAS) has prepared the *Manual on Environmental Health Indicators and Benchmarks: Human Rights Perspective*, which was drafted in close cooperation with the Global Children's Health and Environment Fund and the National Council for Science and the Environment. The Manual is intended to be a compilation of a recommended set of environmental health indicators and benchmarks, selected from a human rights perspective, which provides a basis for determining the state of public health in urban and rural communities around the world. It is especially written for individuals in human rights, public health and environmental organizations residing in developing countries who are interested in organizing community-based projects for assessing the nature and extent of human health risks from a polluted and degraded environment.

The Manual is divided into several chapters covering a number of topics, which include: (a) a survey of existing environmental, public health and other related indicators and benchmarks, (b) a discussion of the selection process used in arriving at the recommended set of environmental health indicators and benchmarks, and (c) a presentation of background information on a number of major environmental health issues, such as air quality, water and sanitation, vector-borne diseases and food security and safety, along with specific sets of recommended environmental health indicators and benchmarks in each subject area. In addition, the Manual contains a collection of appended materials, such as tables and charts, annotated outline of environmental documents, treaties and conventions, summary descriptions of hazardous environmental agents, selected bibliographies and reference sources, and other relevant documentations and technical information.

The Manual's *Chapter I* ("Introduction") delineates the basic objectives and content of the document. Based on human rights consideration, this chapter discusses the major focus of this Manual in its selection of environmental health indicators and benchmarks that attempt to assess the impact of a polluted environment on the most vulnerable members of a community, such as infants and young children, the elderly and those that are infirm or chronically ill. In addition, it describes the linkage between environment, public health and human rights, including a brief outline of relevant human rights conventions and treaties that incorporate the principle of human rights to life and health.

Chapter II ("Environmental Health Indicators and Benchmarks") of the Manual includes a listing of leading international agencies and intergovernmental bodies, national regulatory agencies and non-governmental organizations, whose existing data base of environmental and public health indicators and benchmarks were reviewed and collated in the preparation of the Guidance Manual.

Chapter III ("Selection of Recommended Indicators and Benchmarks") of the Manual describes the screening process and selection criteria used to arrive at a recommended set of environmental health indicators and benchmarks. It discusses the differences between preventative and remedial indicators and explains the basis for dividing the set of recommended indicators and benchmarks into three separate categories. These include primary, secondary and tertiary indicators and benchmarks, along with supplemental use of modifying factors, such as geographic location or climate type of each region where the indicator's database is being generated and compiled. The chapter concludes with a discussion on developing a set of environmental health performance-based indices, a simple and transparent policy tool designed for both decision-makers and members of the public.

Chapter IV ("Environmental Health Structural and Process Indicators") discusses the development of structural and process indicators, along with an outline for conducting a pre-project screen, in order to assess the capacity of national, regional and/or local governments to meet constitutional mandates and carry out legislative directives to monitor regulatory laws and meet national standards and international guidelines on environmental health.

Chapter V ("Air Quality") presents background information on the adverse human health impact of a number of major air pollutants. These include carbon monoxide, sulfur oxides, nitrogen dioxides, ozone, particulate matter, lead, and hazardous contaminants found in the outdoor and indoor air of urban and rural areas in developing regions. It discusses the special vulnerability to the harmful effects of air pollutants on young children, the chronically ill and elderly members of urban and rural communities around the world. Number of recommended indicators and benchmarks on air quality: *6 Primary, 6 Secondary, 5 Tertiary, 3 Modifying Factors*.

Chapter VI ("Water Quality and Sanitation") delineates the serious health impacts of microbial and chemical contaminants in drinking water found in many regions of the world. It discusses the basis for developing existing international and national drinking water standards and guidelines and how they can be employed as environmental health indicators and benchmarks. In addition, it outlines how improved sanitation and water treatment facilities can improve the status of public health in developing regions. Number of recommended water quality indicators and benchmarks on water quality and sanitation: *6 Primary, 4 Secondary, 3 Tertiary, 4 Modifying Factors.*

Chapter VII ("Vector-Borne Diseases") provides an overview of the public health problem in developing regions associated with serious bacterial and viral diseases that are transmitted by various vectors, such as insects and animal and human parasites. Background information on a number of serious vector borne diseases found in tropical areas, such as dengue fever, malaria, schistosomiasis, are presented in this chapter. In addition, it outlines certain practical measures and behavioral changes that could be taken to prevent such disease vectors in proliferating in developing regions. Number of recommended environmental health indicators and benchmarks on disease vectors: *5 Primary, 4 Secondary, 1 Tertiary, 2 Modifying Factors*.

Chapter VIII ("Food Security and Safety") discusses the chief causes of food insecurity and scarcity in many regions of the world, which are: (a) lack of agricultural resources, (b) poor land and water management strategies, and (c) inequities in food distribution. It also presents the public health problems associated with food safety that are the result of excessive pesticide, hormone and antibiotic uses, bacterial and fungal infections, and decreased levels of vitamins, trace minerals and other nutrients in processed foods. Number of recommended environmental indicators and benchmarks on food security and safety: *6 Primary, 3 Secondary, 3 Tertiary, 2 Modifying Factors*.

In the Manual's *Appendices* and *Tables* the following items are included: (a) a list of major national and international documents, treaties and conventions on environment and public health; (b) a summary discussion on atmospheric pollutants and air quality standards; (c) an overview of bacterial and chemical contaminants found in water and drinking water standards; (d) a selected bibliography of important references, technical reports and official governmental documents on environmental health; (e) a listing of key resources and websites on the internet; (f) a tabulated spreadsheet on the existing data base of over 700 demographic, environmental and public health indicators and benchmarks, along with references and web links; and (g) a summary table that lists the selection criteria's scores of each indicators that were reviewed and collated in arriving at the set of recommended environmental health indicators and benchmarks.

Chapter I: Introduction

A. Overall Purpose and Scope of the Manual:

This manual is a comprehensive depository of information on environmental health indicators and benchmarks that provide a basis for determining the state of public health in a community. It is written to assist individuals and organizations, especially those residing in developing countries that are interested in organizing community-based projects for assessing the nature and extent of human health risks from a polluted and degraded environment in their region as primarily viewed from a human rights perspective. Although numerous environmental indicators and benchmarks have been established in recent years by international agencies and national governments, not all such assessment tools or metrics are suitable for use in developing countries. This is because of limited resources and lack of trained personnel needed for collecting data and analyzing them in many developing regions of Asia, Africa and Latin America. For these reasons, in this manual a practical set of environmental health indicators and benchmarks is recommended that may be implemented at the local and regional levels with either existing resources or those that could be obtained with modest additional expenditure of funds and training of technical staff.

B. Focus of the Manual—Vulnerable Members of the Community:

Based on human rights consideration, the major focus of this manual is the selection of environmental health indicators and benchmarks that attempt to assess the impact of a polluted environment on the most vulnerable members of a community. These include infants and young children, the elderly and those that are infirm or chronically ill. In selecting indicators and benchmarks, special emphasis was placed on air and water quality regulatory standards and guidelines, including those that pertain to vector borne diseases and food safety that were originally established by national and international agencies that took into account the health impact on individuals most sensitive to adverse effects of environmental pollutants.

Numerous public health studies have shown that infants and young children are particularly affected by low concentrations of toxic substances found in air, water, foods and a variety of consumer products. For instance, many of today's air quality regulatory standards were established for airborne pollutants that are by-products of fossil fuel combustion, such as sulfur dioxide, nitrogen oxides and particulate matter, that have adverse health impacts on infants and young children at relatively low concentration levels. Air pollutants emitted from the tail-pipes of cars, buses and trucks, such as lead and carbon monoxide, have serious impacts on children below the age of five at ambient concentration levels that are well below those harmful to adult members of the community. Many elderly individuals who suffer from chronic lung ailments, such as asthma and other respiratory illnesses, are especially vulnerable to increases of short-term concentration levels of a number of air pollutants, such as sulfur dioxide, particulate matter, ozone, etc. Thus, air quality standards for these airborne pollutants were developed by national regulatory agencies and international organizations that were based on the adverse health impact on infants and young children, and on elderly and chronically ill individuals rather than their impact on normal healthy adults.

Microbial contamination of drinking water has severe health impact on infants and young children in many developing regions of the world, where childhood diarrheal diseases from ingesting polluted water is the second most common cause of infant death. In addition, harmful pesticide residues and a variety of toxic chemical contaminants found in water, food and other consumer products have particularly insidious impact on infants and young children during their rapidly growing phase. Such early life exposures have been linked to a number of chronic illnesses, including nervous system and behavioral disorders, childhood cancer and a number of adult-onset abnormalities. Thus, environmental health indicators and benchmarks that assess the effects of air and water pollutants, microbial agents and other hazardous substances are important in determining the overall health status of vulnerable children and adults living in a community.

One of the distinctive features of a human rights approach is its focus on vulnerable individuals and communities. Because a human right is a universal entitlement, its implementation is measured by the way it benefits those who are most disadvantaged and vulnerable and the extent to which it brings them up to mainstream standards. This emphasis is apparent in the work of the various United Nations human rights treaty monitoring bodies. For instance, the UN Committee on Economic, Social and Cultural Rights evaluates the performance of States parties in terms of their initiatives to improve the enjoyment of rights by those who are disadvantaged and vulnerable.

The concern with vulnerable individuals and groups also explains why the disaggregation of data is a central requirement for human rights monitoring. Typically human rights treaty monitoring bodies require country reports

to provide data that are disaggregated on a variety of grounds: sex, ethnicity, race, and geographic areas, urban and rural breakdowns, etc. Although this principle is central to human rights monitoring, it may meet serious data limitations. Countries with relatively weak data collection systems may not have the necessary disaggregated data available in the first place. Moreover, countries that do collect data on disaggregated bases may be quite reluctant to make such data available to human rights monitors. Highly aggregated data, such as country-wide averages, are likely to camouflage disaggregated differentials. Thus, developed countries with sophisticated information gathering systems may not wish to disclose highly disaggregated data to human rights monitors because doing so could reveal serious inadequacies in realizing the human rights of vulnerable and disadvantaged groups, even to the point of constituting a form of economic or social discrimination.

C. Linkage Between Environmental Protection, Public Health, and Human Rights—International Declarations, Conventions and Treaties

Environmental protection, public health and human rights have traditionally been viewed as separate and distinct areas of public policy by both governmental agencies and non-governmental organizations. Only recently have specialists in these fields begun to appreciate the link between environmental and public health issues with issues related to basic human rights. Although the right to health care has been a pressing issue in the social justice and human rights community for the past several decades, the human rights implications of the adverse impact of a polluted environment on human health has only lately been given much attention. It has been forcefully stated that[1]

> " . . . with increasing globalization of trade and commerce in the past few decades, the environmental and public health impacts of rapid industrialization and urbanization throughout different regions of the world are now being recognized as having major human rights implications by many policy makers . . . Internationally, the right of humans to health as originally enunciated in *Article 25* of the *Universal Declaration of Human Rights* is quite clearly linked to environmental protection, where clean water, clean air, adequate shelter and food, and primary health care are no longer considered societal privileges but as universal human rights."

Today, highly polluted and deteriorating environments in urban and rural communities of many developing regions cause a number of serious human illnesses and disabilities. According to the World Bank, respiratory infections and diarrheal diseases are the primary causes of death among the poorest twenty percent of the world's population. Moreover, these widespread illnesses caused by environmental factors are considered preventable by most public health authorities. For instance, providing access to clean water and proper sanitation facilities can prevent the high incidence of childhood dysentery in developing regions. Incidences of respiratory diseases can be reduced by lowering exposures to harmful byproducts of fossil fuel combustion sources or by substituting smoke-filled cooking stoves presently being used in poorly ventilated homes in many rural areas of developing regions, such as India and China.

The health status of vulnerable members of a community is a sensitive indicator of a society's overall well-being, both at present and in the future. For example, providing safe environments for children ensures the health of future generations, which in turn contributes to the formation of stronger economies and dynamic societies. Countries that respect adherence to basic human rights are more likely to avoid practices and promote changes that lead to long-lasting, sustainable development programs in their region. In short, any action that seeks to improve the health of a human community by reducing environmental contamination in air, water and land, will benefit society at every level, whether they are social, economic or cultural in nature.

Since the end of World War II, a number of international and regional declarations, conventions and treaties have been adopted that incorporate the concept of human rights to life and health (for a summary, see Box). In the *Universal Declaration of Human Rights*—adopted by the UN General Assembly in 1948—the right to life and the right to health are enunciated in *Article 3*: "Everyone has the right to life, liberty and security of person" and in *Article 25*: "(1) Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control. (2) Motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock, shall enjoy the same social protection."

1 Ahmed, A. Karim. (2003). *Environmental Protection, Public Health and Human Rights: An Integrated Assessment - a report prepared for the Science and Human Rights Program at the American Association for the Advancement of Science*. Washington, DC: NCSE/GCHEF. http://shr.aaas.org/hrenv/docs/ahmed.pdf.

The most comprehensive and legally binding declaration of the right to health is incorporated in the *International Covenant on Economic, Social and Cultural Rights* that was adopted by the UN General Assembly in 1966 (and entered into force in January 1976). In this covenant, the right to health is stated in *Article 12*: "(1) The States Parties to the present Covenant recognize the right to the enjoyment of the highest attainable standard of physical and mental health. (2) The steps to be taken by the States Parties in the present Covenant to achieve the full realization of this right shall include those necessary for: (a) The provision for the reduction of the stillbirth-rate and of infant mortality and for the healthy development of the child; (b) The improvement of all aspects of environmental and industrial hygiene; (c) The prevention, treatment and control of epidemic, endemic, occupational and other diseases; (d) The creation of conditions which would assure to all medical service and medical attention in the event of sickness."

In 2000, the UN Committee on Economic, Social and Cultural Rights issued an authoritative interpretation of *Article 12(1)* of the above Covenant in *General Comment No. 14* ("The Right to the Highest Attainable Standard of Health") that the right to health extended "not only to timely and appropriate health care but also to the underlying determinants of health, including access to safe and potable water and adequate sanitation, an adequate supply of safe food, nutrition and housing, healthy occupational and environmental conditions, and access to health-related education and information, including sexual and reproductive health." The UN Committee stated that States Parties have core obligations to provide access to health services, essential drugs, minimum essential food, basic shelter, housing, sanitation and an adequate supply of safe and potable water. In addition to adopting adequate implementation plans through a meaningful participatory process, the UN Committee called on the necessity to develop health indicators and benchmarks: "To adopt and implement a national public health strategy and plan of action, on the basis of epidemiological evidence, addressing the health concerns of the whole population; the strategy and plan of action shall be devised, and periodically reviewed, on the basis of a participatory and transparent process; they shall include methods, such as right to health indicators and benchmarks, by which progress can be closely monitored; the process by which the strategy and plan of action are devised, as well as their content, shall give particular attention to all vulnerable or marginalized groups."

In 2002, the UN Committee on Economic, Social and Cultural Rights issued *General Comment No. 15*, which outlines the human right to water by interpreting the substantive contents of *Article 11* and *Article 12* of the *International Covenant on Economic, Social and Cultural Rights*. In this General Comment, it states that: "[t]he right to water contains both freedom and entitlements. The freedoms include the right to maintain access to existing water supplies necessary for the right to water, and the right to freedom from interference, such as the right to be free from arbitrary disconnections or contamination of water supplies. . . Whereas the right to water applies to everyone, States Parties should give special attention to those individuals and groups who have traditionally faced difficulties in exercising this right, including women, children, minority groups, indigenous peoples, refugees, asylum seekers, internally displaced persons, migrant workers, prisoners and detainees."

Earlier in 1989, the UN General Assembly adopted the *Convention on the Rights of the Child*, in which it states the child's right to health as follows: "*Article 24* (1) States parties recognize the right of the child to the highest attainable standard of health and to facilities for the treatment of illness and rehabilitation of health. States Parties shall strive to ensure that no child is deprived of his or her right of access to such health care services. (2) States parties shall pursue full implementation of this right and, in particular, shall take appropriate measures: (a) to diminish infant and child mortality, (b) to ensure the provision of necessary medical assistance and health care to all children with emphasis on the development of primary health care, (c) to combat disease and malnutrition including within the framework of primary health care, through inter alia the application of readily available technology and through the provision of adequate nutritious foods and clean drinking water, taking into consideration the dangers and risks of environmental pollution."

Health and Human Rights: Summary of International Declarations, Conventions and Treaties [2]

A number of international declarations, conventions and treaties have been adopted that incorporate the principle of human rights to life and health. The following is a brief summary of the relevant provisions of these human rights instruments:

- The *Universal Declaration of Human Rights* adopted and proclaimed by the United Nations General Assembly in December 1948. In the Universal Declaration, the right to life is recognized in *Article 3* and the right to health in *Article 25*.
- The *International Covenant on Civil and Political Rights*, adopted in December 1966 (and entered into force in March 1976) protects the right to life in *Article 6(1)*, which is stated as follows: "Every human

2 Excerpted from: Ahmed, A. Karim. *op. cit.*

being has the inherent right to life. The right shall be protected by law. No one shall be arbitrarily deprived of his life."

- The right to life is also incorporated in several regional human rights documents of Americas, Europe and Africa, namely: (a) the *American Convention on Human Rights*, (b) the *European Convention for the Protection of Human Rights and Fundamental Freedoms* and (c) the *African Charter on Human and Peoples' Rights*.
- The *International Covenant on Economic, Social and Cultural Rights* adopted by the United Nations General Assembly in December 1966 (and entered into force in January 1976), affirms the right to health in *Article 12*. (1), where " States Parties to the present Covenant recognize the right to the enjoyment of the highest attainable standard of physical and mental health."
- The *World Health Organization's (WHO) Constitution's Preamble* (adopted in 1945 and ratified in April 1948) defines the right to health, and the responsibility of individuals, institutions and governments, which states in part: "The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, political belief, economic or social condition."
- The *International Labor Organization's (ILO) Annex to its Constitution*, "Declaration Concerning the Aims and Purposes of the ILO" (adopted by the General Conference of ILO in May 1944) states in Section III , that all nations must achieve: " . . . (g) adequate protection for the life and health of workers in all occupations; (h) provision for child welfare and maternity protection; (i) the provision of adequate nutrition, housing and facilities for recreation and culture."
- The *Convention on the Rights of the Child*, adopted by the United Nations General Assembly in November 1989, states the child's right to health in *Article 24*, which reads, in part, as follows: "States Parties recognize the right of the child of the highest attainable standard of health and to facilities for the treatment of illness and rehabilitation of health. States Parties shall strive to ensure that no child is deprived of his or her right of access to such health care services."
- Other international conventions that explicitly provide right to health include: (a) *International Convention on the Elimination of All Forms of Racial Discrimination*, (b) *Convention on the Elimination of All Forms of Discrimination Against Women*, (c) *Convention Concerning Indigenous and Tribal Peoples in Independent Countries*, and (d) *International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families*.

Chapter II Environmental Health Indicators and Benchmarks

Existing Database of Environmental and Public Health Indicators and Benchmarks

In preparation of this Manual, existing environmental and public health indicators and benchmarks, along with other relevant demographic and economic development indicators that directly or indirectly assess human health impacts, were collected from a number of multilateral agencies, national governmental bodies and international non-governmental organizations. These institutions include:

(1) World Health Organization (WHO)

(2) Pan American Health Organization (PAHO)

(3) The World Bank (WB)

(4) Organization for Economic Cooperation and Development (OECD)

(5) The United Nations (UN)

(6) United Nation's Children's Fund (UNICEF)

(7) Food and Agriculture Organization (FAO)

(8) United States Environmental Protection Agency (USEPA)

(9) World Resources Institute (WRI)

(10) Worldwatch Institute

(11) International Institute for Sustainable Development (IISD).

Below is a list of the source documents from which relevant environmental and public health indicators and benchmarks were collected from each of the above institutions:

(1) World Health Organization (WHO)

1. World Health Report 1992.
2. Linkage Methods for Environment and Health Analysis: General Guidelines. Book. 1996
3. World Health Report 1999.
4. List of indicators for Children's Environmental Health
5. Technical Paper entitled "Environmental Health Indicators: Framework and Methodologies" by David Briggs.
6. Tools for Assessing the O&M status of water supply and sanitation in developing countries. Tools No. 6 and 7.
7. Health Service Provisions. Selecting and defining national health indicators.

(2) Pan American Health Organization (PAHO)

1. Regional Core Health Data System. Indicators Glossary.
2. Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators 1995-1996.
3. Health Situation in the Americas: Basic Indicators 1995-1998.
4. Regional Core Health Data Initiative. Table Generator System.
5. Basic Indicators 1999.
6. Basic Indicators 2000.

(3) The World Bank (WB)

1. Environmental Indicators and Overview of Selected Initiatives at the World Bank.
2. The Little Green Data Book. World, Country and Summary Tables.
3. Environmental Indicators. 2001.
4. Country assistance Strategies and the Environment Indicators.
5. Country assistance Strategies and the Environment. World Bank Paper. July 2001.

6. Conceptual Framework to develop and Use Water Indicators. CIAT/World Bank/UNEP project. August 1999.
7. Environmental Indicators and overview of selected Initiatives at the World Bank.
8. World Bank Data and Maps. Data by country and Data query.

(4) Organization for Economic Cooperation and Development (OECD)

1. OECD Core Set of Environmental Indicators.
2. OECD Environmental Data. Annex Table 1 and 1A, Compendium 1999.
3. OECD Paper on Key environmental Indicators. OECD Environment Directorate. 2001.
4. Towards More Sustainable Household Consumption Patterns: Indicators to Measure Progress. OECD paper. Working Group on the State of the Environment. October 1999.
5. Indicators for the Integration of the Environmental Concerns into transport policies. OECD paper. Working Group on the State of the Environment. October 1999.
6. Advanced Air Quality Indicators and Reporting. Methodological Study and Assessment. OECD Paper. Working Party on Pollution Prevention and Control. September 1999.
7. Environmental Indicators: Towards Sustainable Development.1998

(5) The United Nations (UN)

1. Indicators for Sustainable Development: Framework and Methodologies.
2. Background Paper No. 3. Commission on Sustainable Development. Ninth Session. April 2001.
3. Indicators on Health. Population Division and Statistics Division of the United Nations Secretariat.
4. Indicators on water supply and Sanitation. United Nations Statistics Division (UNSD).
5. Development Indicators- Environment and Energy Indicators. United Nations Statistics Division news. Issue 10. January-August 2001.
6. Environment Statistics. United Nations Statistics Division.
7. Questionnaire 2001 on Environment Statistics. Water, Air, Waste and Land. United Nations Statistics Division.
8. Friends of the Chair Advisory Group on Indicators. Development Indicators. United Nations Department of Economic and Social Affairs. Statistics Division.
9. Activities and Plans of the United Nations Statistics Division and the Statistical Commission in Support of the Harmonization and Rationalization of Indicators. Report of the Secretary General. United Nations Economic and Social Council. Statistical Commission. December 2000.
10. Road map towards the implementation of the United Nations Millennium Declaration. Report of the Secretary –General. United Nations General Assembly. September 2001.
11. World Statistics Pocketbook. 2001. Book.

(6) United Nations Children's Fund (UNICEF)

1. UNICEF's Guide for Monitoring and Evaluation. Appendix C: Indicators for some sectors of UNICEF activity.
2. The State of the World's Children 2001. Table No.1. Basic Indicators.
3. The State of the World's Children 2001. Table No. 3. Health.

(7) Food and Agriculture Organization (FAO)

1. Indicators of Sustainable Development: Selected FAO Activities, 1998. Sustainable Development Dimensions.
2. Anthropometric, Health and Demographic Indicators in Assessing Nutritional status and food consumption. Sustainable Development Dimensions.

(8) United States Environmental Protection Agency (USEPA)

1. Environmental Indicators. Office of Solid Waste.
2. Risk Screening Environmental Indicators.

(9) World Resources Institute (WRI)

1. Linking Environment to Health: Indicators of Environmental Threats to Health. WRI 1998-1999.
2. Environmental Indicators: A systematic Approach to Measuring and reporting on Environmental Policy Performance in the Context of Sustainable development. 1994.

(10) Worldwatch Institute

1. The Environmental Trends that are shaping our Future. Vital Signs 1998.
2. The Trends that are shaping our future. The Triple Health Challenge. Vital signs 2001.

(11) International Institute for Sustainable Development (IISD)

1. Compendium of Sustainable development Indicator Initiatives. Selected Examples of Indicators. Environmental Indicators.

Data Organization of Existing Environmental Indicators and Benchmarks

In order to facilitate a more in-depth screening analysis, the existing indicators and benchmarks and their respective reference sources from these institutions were organized onto a tabular spreadsheet. This spreadsheet was grouped by organization name and further disaggregated by issue, indicator name, and finally type. Next to "type" classification for each indicator and benchmark is Internet reference sources (weblink URLs) and the dates when they were published. (See Table)

Chapter III: Selection of Recommended Indicators

A. Overview

Environmental health indicators and benchmarks can be used as tools for a variety of purposes. From a strictly human rights perspective, an important application of environmental health indicators and benchmarks is identifying and holding accountable entities, organizations and/or individuals most responsible for causing or allowing various adverse impacts of harmful environmental agents on human populations. For these reasons, environmental health indicators and benchmarks are essential tools for highlighting critical policy issues in the public health sector that have been previously neglected or given low priority by elected officials or regulatory agencies in a country, region or community. Human rights-based environmental health indicators and benchmarks provide channels for monitoring and information-gathering, which allow the public means to assess different policy options that are open for consideration by local regulatory officials and other national and international decision-makers. Although such indicators and benchmarks by themselves are not capable of identifying underlying societal issues related to environmental impacts on human health, they can be used as means to raise awareness about critical environmental problems in a community. In other words, they can be used as effective tools by both members of the general public and policy makers to target significant problems of environmental health where priority action are most needed.

B. Definitions of Environmental Health Indicators and Benchmarks

As defined and used in this manual, an environmental health indicator is a quantitative measure that assesses the impact of an environmental agent on the health and well-being of an adult or child living in a community. For example, the ambient concentrations of harmful agents can be chosen as an environmental health indicator, such as concentration levels of air or water pollutants for which national and/or regional regulatory standards have been officially adopted or for which international recommended guidelines have been issued. Similarly, the percentage of individuals in a community suffering from diseases that are directly related to exposure to environmental agents can be used as an environmental health indicator. For example, in a specific region the incidence of children below the age of five with diarrrheal diseases, which are caused by identifiable sources of contaminated water, can serve as an indicator of infant and early childhood health in a community.

On the other hand, environmental health benchmarks as defined in this manual are quantitatively designated goals that are formally established by legislation and/or regulation or are informally agreed upon by process of consultation among public health experts, policy makers and members of the community. Generally speaking, environmental benchmarks are often developed within a specific time-frame in a given country or region. To illustrate this, consider an environmental benchmark to phase-out the marketing and sale of leaded gasoline in a region over a five-year period. Such an environmental benchmark could be established as a matter of public policy in order to eliminate childhood neurological damage caused by harmful emissions of airborne lead in automobile exhausts in many congested urban areas. As such, in some regions it may be preferable and economically more efficient to set agreed upon environmental benchmarks rather than collecting difficult-to-obtain data on exposure-based environmental indicators as a means to determine desired public health goals.

C. Human Rights Perspective: Public Policy Factors

When employing environmental health indicators and benchmarks from a human rights perspective, several policy-related and practical factors should be kept in mind[3]:

- **Policy Relevant.** Indicators and benchmarks should measure environmental health factors that have the potential to be addressed either directly or indirectly by adoption of public policy.
- **Accessible.** Data on indicators and benchmarks should be accessible to all segments of society—different people should be able to use them and get the same results.
- **Understandable.** Information on indicators and benchmarks should be formulated in such a way that all members of the public and policy makers can understand and follow them.

3 United Nations Development Program (UNDP). 2000. *Using Indicators for Human Rights Accountability. Human Development Report*. Available from Website: (http://www.undp.org/hdr2000/english/book/ch5.pdf)

- **Consistent.** Indicators and benchmarks should remain consistent over time in order to ensure that agreed upon goals are being met, and for evaluating whether progress is being made over a specific period of time.
- **Disaggregable.** To the extent it is practicable, indicators and benchmarks should be designed so as to disaggregate data to focus specifically on young children, women and other vulnerable groups, including minority and underserved members of a community.
- **Impartiality.** Monitoring data on indicators and benchmarks should also be evaluated by independent and technically competent professionals associated non-governmental organizations and/or academic institutions in order to avoid any real or perceived conflicts of interest by government officials associated with monitoring bodies or regulatory agencies.

D. Screening Process and Applications

As discussed earlier, the tabular spreadsheet listing existing environmental indicators and benchmarks from international and national agencies and organizations is quite voluminous (over 500 separate indicators) that differ in their ability to determine public health impacts from a human rights perspective. For these reasons the first step in the selection process involves developing suitable screening criteria for selecting the most relevant environmental health indicators and benchmarks, and for developing a set of performance-based indices, based primarily on human rights considerations. A number of criteria developed in this manual reflect such an approach, and they were weighted according to their relevance in monitoring public health in the community.

Each of the five criteria listed below is weighted with a number ranging from 0.5–1.5 signifying its level of importance with respect to human rights relevance. For instance, criterion (II) received a higher weighting factor (1.5) than the other selection factors since it highlights the environmental health impacts on children and other vulnerable groups. The selection criteria, along with the reasons for choosing them, are given as follows:

I) Does the indicator or benchmark measure the environmental impacts on human health of the general population? *Weight: 0.5*

- Are the environmental impacts on human health clearly established?
- This criterion was weighted with a score of "0.5" because it highlights the status quo of the general population and not the vulnerable members of the community.

II) Does the indicator or benchmark measure or highlight the impacts on children and other vulnerable groups? *Weight: 1.5*

- To reflect an explicitly human rights criterion, the environmental impacts of the most vulnerable groups are given the highest weighting.
- The impact on children's health is of particular importance. Infant's and young children's bodily functions and immune systems are constantly developing, and are thus more prone to serious impacts from harmful environmental agents than adults. Measuring environmental health in children not only highlights the impact of a particularly vulnerable group, it provides evidence of the impact of a polluted environment on future generations.
- This criterion promotes the need for disaggregation of vulnerable populations.

III) Can the indicator or benchmark be linked to the source of environmental health problem? *Weight: 1.0*

- It is important that indicators and benchmarks are developed where the environmental source can be properly identified. Without being able to identify an environmentally harmful source, performance-based indicators are meaningless in terms of remedying the public health problem. For instance, an indicator such as "infant mortality rate" serves only to draw attention to a broad societal and public health problem; such an indicator does not reflect the complexities attributed to infant mortality, since there are many causes contributing to this problem.
- This criterion promotes policy relevance, disaggregation, accessibility, impartiality of monitor, and the need for consistent monitoring over time.

IV) Can the indicator or benchmark be applied (addressed/enforced/monitored) by regulatory agencies and other government institutions? *Weight: 1.0*

- If an indicator or benchmark cannot be applied within a regulatory or legal context, it cannot be used as a performance-based indicator that measures the capability of a government agency to meets its regulatory responsibilities.

- This criterion seeks to determine whether an indicator or benchmark can be used to provide performance measurements of regularity agencies over specific time periods.

V) Does the indicator help to determine institutional gaps in achieving already established national regulatory standards and/or international guidelines? *Weight: 1.0*

- This criterion assesses whether established national regulatory standards and international guidelines that measure human health impacts of contaminated environments, such as those adopted by United States EPA or WHO, can serve as a suitable benchmark when a country has not developed its own national environmental health standards (i.e. air/water quality/toxic substances, etc).

Application of Selection Criteria

Each item from the collated list of 500 existing indicators and benchmarks was analyzed applying the above mentioned criteria and given an individual score number, wherever possible (See Table). If an indicator met the requirements of criteria (I), (II), and (III), but not (IV) and (V), it was given a weight of "3." If the indicator fulfilled the requirements of criteria of (II) and (III) only, it was given a weight of "2.5," and so on. The following examples illustrate how the screening process using the given criteria was applied:

Illustrative Examples:

Indicator #1: "Percent of population with access to adequate sanitation services (urban and rural)

Source: UNICEF

(a) Does the indicator measure the indirect/direct impact on human health of the general population? This indicator does measure a potential impact on the general population's health. Without access to adequate services of sewerage, many waterborne diseases are easily spread. (Score: 0.5).

(b) Does the indicator measure or highlight the impacts on children and other vulnerable groups? No. This indicator only measures the potential impact on the general population, because it does not disaggregate to specify where access to adequate sanitation services is lacking, and who is affected. (Score: 0)

(c) Can the source of the problem/issue be identified? Yes. The source of the problem is lack to adequate sanitation facilities. (Score: 1).

(d) Can the indicator be applied (addressed/enforced/monitored) by regulatory agencies or other institutions? Yes. Governments should be able to collect data on whether or not their sanitation infrastructures are functioning properly, and locate areas where they do not exist at all (Score: 1).

(e) Does the indicator signify a gap in achieving already established national regulatory and/or international guidelines? Countries that have established benchmarks for developing sanitation services in the community would receive a score of 1 for this criterion. (Score: 0 or 1).

Overall Weight: 2.5 or 3.5

Indicator #2: "Annual Withdrawals of Ground and Surface Water"

Source: UN Statistics Division

(a) Does the indicator measure the indirect/direct impact on human health of the general population? This indicator does not measure any potential impact on the general population because the health effect of the environmental condition is not apparent. (Score: 0).

(b) Does the indicator measure or highlight the impacts on children and other vulnerable groups? Since the indicator does not measure and impact on the general population at all, it cannot measure impacts on children and other vulnerable groups. (Score: 0)

(c) Can the source of the problem/issue be identified? This indicator would not differentiate between water extracted for sanitation and drinking purposes and that related to agricultural and/or industrial consumption. It merely tells us that people are using more water than is available in supplies of surface and groundwater. (Score: 0).

(d) Can the indicator be applied (addressed/enforced/monitored) by regulatory agencies or other institutions? Since it is not clear whom or what is responsible for the annual withdrawals of ground and surface water, there is no one and nothing to regulate. (Score: 0).

(e) Does the Indicator signify a gap in achieving already established national regulatory and/or international

guidelines? Most countries have rules and regulations governing how much surface and groundwater may be extracted, and by whom. (Score: 1).

Overall Weight: 1.0

After every indicator had been weighted satisfactorily according scale of the five indicator selection criteria, only the indicators which had scored at a level of "3.5" or above were set aside for serious consideration. A closer inspection of the over 70 indicators which remained led to some interesting observations. First, there appeared to be two types of indicators: those that identified the source of a problem, and those that identified a symptom. These were categorized into preventative and remedial indicators, respectively (see discussion below). Secondly, both preventative and remedial indicators varied according to availability of data. To express the variety of data available among indicators and benchmarks, they were thus grouped into one of three categories: primary, secondary, or tertiary (see below).

E. Preventative and Remedial Indicators

As mentioned above, once the initial selected indicators or benchmark had been drawn out of the pool of 500 using the above-mentioned criteria, a pattern of two types of indicators began to emerge: preventative and remedial. The "type" categorization used followed the "DPSEEA framework" developed by David Briggs that had previously been prepared for the World Health Organization. [4] The acronym "DPSEEA" represents six categories of markers or activities: (1) **D**riving Force, (2) **P**ressure, (3) **S**tate, (4) **E**xposure, (5) **E**ffect, and (6) **A**ction. Most indicators or benchmarks listed under the DPSEEA scheme that fall under driving force (**D**) or pressure (**P**) categories are bellwether or "warning" signs in that they foresee adverse health consequences that result from environmental impacts before the effects are manifested. These were categorized as preventative indicators, which implies that if the public health issues that are identified were adequately addressed, their anticipated adverse health outcomes could be prevented. On the other hand, those listed as state (**S**), exposure (**E**), and effect (**E**) types signify current health risks whose environmental impacts are not adequately addressed, and therefore categorized as remedial indicators.

In other words, preventative indicators are those that identify the sources of the problem, while remedial indicators are those that address the symptoms of the problem. For example, in developing an indicator for water and sanitation services, we have: (i) a preventative indicator that measures "percentage of population in the community with access to adequate services of sewerage", and (ii) a remedial indicator that gathers environmental health data on the "annual incidence of diarrhea morbidity in children below the age of five." From a human rights perspective, these two indicators complement each other—they illustrate both the necessity to prevent the causes of environmental stress and to seek remedial means to address human disease symptoms. In terms of follow-up action (A) in formulating public health policies and regulatory priorities, these indicators suggest the importance of focusing resources to provide clean water and sanitation services in the community to prevent or reduce cases of childhood diarrhea morbidity and mortality in the long run, while at the same time assuring that the plight of children currently suffering from water-borne diseases in the short run is given proper medical attention by the community.

F. Primary, Secondary & Tertiary Indicators and Benchmarks—Availability of Data and Modifying Factors

A common difficulty in developing performance-based indicators and benchmarks is the lack of availability of environmental monitoring or public health data gathered by national or regional regulatory agencies. This is especially true in many developing countries, where because of lack of financial and technical resources and severe personnel constraints, it is often difficult to collect monitoring data to assess the severity of environmental health problems. For these reasons, environmental health indicators and benchmarks recommended in this manual have been organized into three separate categories—primary, secondary and tertiary – that allows for determining data collection priorities, while providing flexibility in the development of appropriate environmental health indicators and benchmarks. The overall categorization scheme is based on the ready availability, cost-effectiveness and overall practicality of the recommended indicators or benchmarks:

- **Primary Indicators.** Primary indicators and benchmarks are those that are more or less readily available, since the collection and storage of their databases are generally carried out by national regulatory agencies and/or by regional or international monitoring bodies. Primary indicators are based

4 Briggs, David. (1999). *Environmental Health Indicators: Framework and Methodologies*. Geneva: Nene Centre for Research, University College Northampton, WHO. Available online at: http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf

on data that is presently being collected by national and local governments, usually in accordance with duly enacted regulatory standards/guidelines or other legal requirements. In addition, these indicators and benchmarks may be formulated into performance-based regulatory indices by direct comparison to applicable international/national standards and guidelines or socially accepted norms and timetables.

Example: Safety of Public Water Drinking Supply: Enteric Bacterial Contamination. A number of regulatory agencies, both at the national and local levels, routinely monitor the presence of enteric or coliform bacteria in drinking water supplies, based on nationally adopted standards or based on WHO's safe drinking water guidelines. In such cases, the use of this widely available primary indicator of the health risks of local sources of potable water should not be too difficult to delineate and implement.

- **Secondary Indicators.** Generally speaking, national or local government agencies may not invest significant resources in the collection of environmental or public health data if no regulatory standards or guidelines regarding a specific environmental problem exist. Thus, an indicator or benchmark may be placed in a secondary category if: (a) there is a lack of legislative or regulatory priority in developing environmental health standards or guidelines, or (b) cost-effective or practical data collection strategies are not available at the present time in certain regions of the world. In such cases, monitoring data on secondary indicators could only be collected if more technical and financial resources are mobilized to address environmental problems at the national or local levels. On the other hand, secondary indicators as defined here could also be formulated as reasonably reliable surrogate or indirect measurements of environmental health risks, especially when it is not practical or cost-effective to collect monitoring data for primary indicators or benchmarks.

Example: Percent of Automobile Fleet with Catalytic Converters. At present, the use of catalytic converters for tailpipe control of nitrogen dioxide emissions in automobiles is not a widely enforceable legal requirement in many developing regions. However, such air pollution regulatory requirements are increasingly being adopted or considered in a number of developing countries. Thus, the determination of the proportion of automobile fleet that are fitted with catalytic converters may be deemed to be a fairly accurate surrogate environmental health indicator or benchmark for assessing or setting goals on the air pollution health risks of nitrogen dioxide exposures to inhabitants residing in cities and surrounding regions.

- **Tertiary.** Tertiary indicators are those risk assessment tools that could be used to identify significant environmental health problems, where presently little or no data are currently being collected. In some instances, tertiary indicators as defined here have yet to be developed and evaluated before they can be utilized effectively. The chief difference between secondary and tertiary indicators or benchmarks is that the former could be implemented once national or local regulatory standards or guidelines are adopted and technical/financial resources become available.

One additional complementary item in utilizing environmental health indicators and benchmarks are the use of modifying factors and baseline data. These considerations are not intended to be incorporated in the development of indicators or benchmarks as such, but rather can be seen as auxiliary factors that should be taken into consideration when determining selection priorities and in interpreting information derived from primary, secondary or tertiary environmental indicators and benchmarks.

- **Modifying factors.** The identification of modifying factors that are present in a region may help guide the selection of environmental health indicators or benchmarks. This is because modifying factors, such as the nature of geographic terrain, prevailing weather conditions, human population densities, prevalence of commercial and industrial units, etc, would provide either more or less weight in the selection of an indicator or benchmark than would otherwise be the case. For example, the modifying factor of "geographic location and climate type" can exacerbate the effects of the air pollution from exposure to nitrogen oxides or ozone. This is especially true if the region being considered lies within a closed mountainous terrain that lies within a subtropical climate regime, such as Southern California or the Mexico City metropolitan region. On the other hand, if the region in question lies within the flat and drier plains of North America's midwest temperate climate, the modifying factor would be of lesser consequence in exacerbating the effects of air pollution.

G. Environmental Health Performance-Based Indices

Regulatory action to address environmental health concerns rests primarily on the performance of national or local governments, and thus, performance-based indices under any proposed environmental health indicators project should be structured around this concept. For these reasons, environmental health performance-based indices are devices that can be used to compare current environmental health monitoring data to generally accepted international and/or national regulatory norms, standards and guidelines.

For example, an air quality monitoring program of a country may possess extensive atmospheric ambient concentration data for annual averages of sulfur oxides and nitrogen oxides that could be compared against WHO's recommended air quality guidelines or the legally established national air quality standards. Thus, an air quality performance-based index could be established defined as follows: the numerical ratio of the air concentration levels of a given air pollutant divided by its established international air quality guideline or national regulatory standard. For example, if air concentration levels of sulfur oxides in a given region frequently exceeds WHO's air quality guidelines for the air pollutant—say by over two or three fold—then the sulfur oxides air quality performance-based indices (such as 2.6 or 3.1) may be used as a highly transparent and practical tool for decision makers in setting priorities for achieving environmental and public health goals in the community. Similarly, other environmental health performance-based indices may be used to compare public health trends, both spatially and temporally, i.e., between different urban and/or rural areas, or to monitor monthly or yearly progress in meeting regulatory standards or agreed upon benchmarks. Above all, environmental health performance-based indices are simple to understand and interpret. Thus, members of the public and policy making community alike can employ them for taking short term preventative and remedial actions, and for establishing long term public policy goals and objectives.

Chapter IV: Structural and Process Indicators of Environmental Health

A. General Considerations

Human rights indicators may be categorized in several ways. The approach proposed by Paul Hunt, the UN Special Rapporteur of the Commission on Human Rights on the right of everyone to enjoy the highest attainable standard of physical and mental health, while specifically directed to indicators for the right to health, is relevant to other economic, social and cultural rights. [5] Hunt distinguishes between three types of indicators: structural indicators, process indicators, and outcome indicators:

- *Structural indicators* address whether or not appropriate infrastructures are in place that are considered necessary for, or conducive to, the realization of a specific human right. Specifically, structural indicators evaluate whether a country has established the proper institutional framework and adopted public policies and constitutional provisions, and whether it has enacted relevant legislation and regulatory standards that are required to implement those rights. Most structural indicators are qualitative in nature and therefore are not based on the acquisition of detailed statistical data; thus, a number of structural indicators may be evaluated by a simple yes or no answer. However, in many instances such a simple evaluation may not be appropriate for deciding whether to conduct an environmental health monitoring project. In such cases, a more thorough capacity assessment of a region's environmental laws and regulatory infrastructure should be evaluated before commencing a monitoring project
- *Process indicators* assess the degree to which activities that are necessary to attain specific rights-related objectives are being implemented and the progress of these activities over time. The types and amounts of governmental input are one important kind of process indicator. Process indicators are variable and require statistical data.
- *Outcome indicators* assess the status of the population's enjoyment of a right. They show the "facts" and measure the results achieved. Many of the Millennium Development Goal indicators are outcome indicators. Like process indicators, outcome indicators are variable and require statistical data.

B. Structural and Process Indicators: Pre-Project Screen

Before commencing a field-level project with the help of this guidance manual, community-based groups and human rights organizations should undertake a preliminary assessment of the national, regional and/or local government's capacity to carry out legislative directives and monitor regulatory laws and standards. We recommend that a survey of legislative and regulatory laws in the field of environmental protection and public heath be carried out, including developing an inventory of resources, personnel and administrative infrastructures that are available to implement and monitor regulatory guidelines and standards. For instance, a pre-project screening questionnaire should be developed, in which information should be obtained on a set of structural indicators (as outlined below) that assists in evaluating the current ability of government agencies to implement and/or collect monitoring data on environmental health indicators and benchmarks as presented in this manual.

Structural and process indicators on environmental health may be divided into the following categories of constitutional mandates, legislative and regulatory laws, and administrative and infrastructure capabilities:

1. Is there a Constitutional Mandate?—To assess whether there are provisions in the national constitution of a country that sets forth goals and rights of individuals and communities to a safe, clean and healthy environment.

For instance, the Indian Constitution, which was adopted in 1949, sets forth two overarching principles: (a) fundamental rights and (b) fundamental duties. Under fundamental rights, the Indian Constitution provides the "right to constitutional remedies", which allows matters of highest public concern to be brought directly to India's Supreme Court, and under fundamental duties, the Constitution requires specific obligation to "protect and improve the natural environment." [6]

5 Paul Hunt, *Interim report of the Special Rapporteur of the Commission on Human Rights on the right of everyone to enjoy the highest attainable standard of physical and mental health*, United Nations General Assembly, Fifty-eighth session, Agenda item 117 (c), 10 October 2003, United Nations General Assembly, paragraphs 14-29.

6 Indian Constitution website: http://www.legalserviceindia.com/constitution/const_india1.htm

Similarly, the South African Constitution, which was adopted in 1996, provides each citizen of the country the right to a clean and healthy environment. Under Section 24 of the Constitution, it states: [7]

Everyone has the right: (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—(i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

In addition, under Section 27 of the South African Constitution, every citizen has a right to "health care services" and "sufficient food and water"; and, further, ". . . the state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realization of each of these rights."

In general, structural indicators on constitutional mandates should assess provisions to:

(1) Protect individuals and communities from harmful agents in the environment;

(2) Provide a clean, safe and healthy environment—air, water and land;

(3) Allow redress of grievances when harm occurs.

2. Is there Sufficient Legislative Authority?—To assess whether legislative laws and statutory authority by national, state (provincial) and local (county, municipal) governments have been enacted to protect the natural environment and safeguard human health.

In general, structural indicators on legislative authority should determine whether statutory authority has been conferred on administrative and regulatory agencies to carry out programs on protecting human communities from adverse impacts of a degraded environment and harmful products in the following areas:

- **Clean Air legislation**—with legally enforceable provisions on (i) widespread, common air pollutants, (ii) highly hazardous substances, (iii) long-range and transboundary pollutants, (iv) indoor air pollutants, (v) control of air emissions from industries and motor vehicles
- Clean Water legislation—with legally enforceable provisions on (i) safe drinking water, (ii) restoration of recreational water uses, (iii) microbial and toxic substances, (iv) program to curtail water effluent discharges
- **Toxic Substances and Hazardous Wastes**—with legally enforceable provisions on (i) priority list of toxic substances, (ii) health-based environmental standards and guidelines, (iii) clean-up of spills and hazardous wastes, (iv) control on imports and exports of harmful substances and products, (v) toxicity testing of old and new chemicals, (vi) risk assessment and risk management
- **Agricultural Chemicals and Pesticides**—with legally enforceable provisions on (i) safety evaluation and registration of toxic agricultural products and pesticides, (ii) guidelines on consumption and use, (iii) storage and disposal of agricultural products and pesticides

3. Are there Adequate Administrative Infrastructure and Regulatory Capacity?—Here determination of whether government agencies at the national, regional or local level have necessary financial and human resources, technical expertise and monitoring facilities, and public education and community outreach programs to fulfill their regulatory duties and responsibilities as delegated to them by legislative assemblies as legally binding statutory authority. Structural indicators on the administrative and regulatory responsibilities and duties should examine the infrastructure and capacities of government agencies as follows:

- Budget Appropriations of Regulatory Agencies—which should include review of (i) annual allocation of funds to implement regulatory programs on environmental health, (ii) salary structure of administrative and technical staff, (iii) funds allocated for monitoring and surveillance programs, (iv) funds for education and training of agency personnel, (v) funds for public participation and community outreach.
- Human Resources of Regulatory Agencies—which should include review of a number of personnel involved in regulating environmental health programs: (i) assignment of administrative and support staff, (ii) full- or part-time agency scientists, engineers and other technical professionals, (iii) retention of outside consultants, specialists and academic experts, (iv) composition and size of advisory bodies and technical review panels.

7 South African Constitution website: http://thor.sabinet.co.za/netlawpdf/netlaw/CONSTITUTION%20OF%20THE%20REPUBLIC%20OF%20SOUTH%20AFRICA%20ACT.htm

- Level of Scientific and Technical Expertise—which includes a review of (i) level of education and training of in-house scientific and technical staff, (ii) mid-career training opportunities and educational sabbaticals, (iii) production of technical reports, manuals and journal articles, (iv) assistance from outside experts and advisory bodies.
- Monitoring Facilities, Field Stations and Laboratories—which includes a detailed examination of an agency's implementation program with respect to: (i) establishment of monitoring and surveillance network at the national, regional or local level, (ii) numbers and types of monitoring units and field stations, (iii) adequate scientific laboratories and equipment, (iv) cooperative monitoring programs with academic institutions and research organizations.
- Public Education and Outreach Programs—which include a review of an agency's involvement in establishing: (i) public education and information programs on environmental health issues, (ii) inclusion of public members on advisory committees and local review boards, (iii) funds allocated for community outreach program, such as public meetings, educational seminars, grants to grass-root organizations, etc

4. Additional Information: Although environmental health structural indicators primarily examine the legal authority, administrative infrastructure and overall capacity of government agencies to carry out their responsibilities and duties, they should be placed within the larger context of other public policy and good governance indicators, such as:

- Legal and Regulatory Implementation Indicators

For more information, see website of the International Network on Environmental Compliance and Enforcement: http://www.inece.org/

- Good Governance and Public Participation Indicators

For more information on this critical set of public policy indicators, see website of the World Resources Institute: http://www.wri.org

C. Ability to Carry Out Monitoring Program: Practical Considerations

In reviewing information obtained in the pre-screening questionnaire on structural and process- related indicators, several practical factors should be kept in mind in order to assess the ability of community-based organizations in a region to conduct an environmental health monitoring project with the use of this guidance manual:

(1) Accessing data on Primary Indicators or Benchmarks—To assess whether the manual's recommended environmental health primary indicator and benchmark data are accessible from existing governmental and non-governmental monitoring sources. These include regulatory bodies, public health agencies, hospitals, clinics, agricultural extension services and other academic and medical institutions, which collect, analyze, process and store environmental and public health data at the local, regional or national level. Such data should include environmental exposure data on ambient concentrations of air and water pollutants, microbial contaminant levels in drinking water, acute and chronic disease incidence and prevalence data, and information on malnutrition, food safety factors and agricultural chemical use.

(2) Obtaining relevant information for developing Secondary Indicators and Benchmarks—To assess whether relevant background information required to construct surrogate secondary indicators and benchmarks are available from government regulatory agencies, academic or research institutions, and private sector business or manufacturing industries. For instance, in order to determine the risk of childhood lead poisoning from exposure to motor vehicles emissions in urban regions, it is necessary to obtain data on the percentage of sales of leaded gasoline in a region, which are derived principally from regulatory agencies and/or oil refineries and commercial retail outlets. As recommended in the guidance manual, market sales and distribution information of leaded gasoline provides critical information in developing surrogate (or indirect) indicators or benchmarks for monitoring childhood lead poisoning at the local or national level.

(3) Assessing internal capacity for planning and implementing monitoring program—Before undertaking the planning phase of the self-conducted monitoring program, community-based organizations should assess their internal capacities—both legal and scientific—to carry out the tasks of the program. In some instances, a working partnership may be necessary between local, regional or national organizations with complementary levels of expertise, such as having staff members (or outside consultants) who are well-

versed in legal, regulatory, scientific or engineering fields of knowledge. The ability of entering into such symbiotic partnerships may be an important consideration before planning and implementing the monitoring program.

(4) Obtaining adequate funds and technical resources for conducting long-term monitoring program—A crucial factor in carrying out a self-conducted monitoring program is to assess whether adequate funds and technical resources are available over the long term, i.e., over a 3 to 5 year period. In order to assess changes in environmental health trends in a region, a monitoring program should not be carried out over a short (one to two year) time frame, since monitoring data collected over such a time period provides only a brief snapshot of overall progress or lack of progress in the health status of a community. However, if long-term funds cannot be initially assured or guaranteed it is best to commence the project with the understanding that such financial and technical resources may reasonably become available in the future.

(5) Developing a quality control and quality assurance system in the monitoring program—A necessary and crucial factor in developing the monitoring program is to delineate a well thought out quality control and quality assurance system. Such a system would include such features as the proper tagging and handling of environmental sample, identifying its chain of custody, placing it in proper storage, etc. Similarly, good laboratory practices for analyzing environmental samples, based on national or international guidelines, should be adhered to in all circumstances. If the data on environmental indicators and benchmarks are primarily obtained from government agencies, it may be necessary to ascertain whether the monitoring body itself followed a well- established quality control and quality assurance program.

Chapter V: Air Quality

A. Overview

The air that we breathe daily is comprised of 21% oxygen and 78% nitrogen, with the remainder consisting of trace amounts of rare gases. Air pollution causes some gases in the atmosphere to exist at higher than normal conditions, and can be seriously harmful to human health. Examples of these include: nitrogen oxides (NOx), sulfur oxides (SOx), carbon monoxide (CO), particulate matter (PM), photochemical oxidants (e.g., ozone) and lead (Pb), along with a variety of airborne heavy metals and volatile organic compounds (VOCs).

Air pollution can occur as a result of natural conditions, such as ash from volcanic explosions, sand storms, or forest fires. Natural geomorphic terrain, such as low valleys surrounded by mountains, temperature, and wind speed can also exacerbate already polluted surroundings in a region. More serious, however, are the anthropogenic, or human, causes of air pollution that are directly linked to energy consumption, industrial emissions and vehicular exhausts in heavily congested urban areas. It is often a combination of both natural factors as well as human activities that lead to highly unhealthy conditions in air quality (for more details, refer to Appendix A.)

B. Impact of Air Pollutants on Human Health

Air pollution has a variety of negative effects not only on the environment, but on human health as well. In addition to impairing lung and respiratory systems, inhaled air pollutants are absorbed by circulating blood and dispersed throughout the rest of the body. Emissions of sulfur oxides (SOx) and nitrogen oxides (NOx), formed from combustion of fossil fuels, cause acid rain that occurs over long distances reaching up to 1,000 kilometers from the emission source. Acid deposition affects the chemical balance of soils and can cause damaging leaching of minerals and nutrients crucial to the growth of trees and plants. Furthermore, residue from air pollutants can be found on plants and water consumed by humans, thereby contributing to further levels of harmful exposure through ingestion. Automobiles, industrial activity, and electrical plants are the main sources in the production of harmful gases, such as sulfur oxides, nitrogen oxides, and carbon monoxide (CO).

It should be noted that a recent White House study (September 2003) by the Office of Management and Budget (OMB) states that the benefits to human health from reducing air pollution from manmade sources far outweigh the costs of regulating it. The report concluded that the health and social benefits of enforcing tough new clean-air regulations during the past decade within the U.S. were five to seven times greater in economic terms than were the costs of complying with the rules. The findings overturn a previous report that officials now say was defective, and provide the most comprehensive federal study ever of the cost and benefits of regulatory decision-making.

Outdoor and Indoor Air Pollution [8]

Air pollution continues to be a major environmental problem in many regions of the world today. In the past two to three decades, with increasing urbanization and industrialization in developing countries, the steady decline of air quality poses a significant threat to health for large segments of human populations. In many urban areas of Asia, Latin America and Africa, deteriorating air quality has been associated with rapidly rising population growth and increased use of motor vehicles, coupled with inadequately regulated emissions of air pollutants from industrial plants and power generating facilities. Annually, air pollution accounts for an estimated 3 million deaths, which is about 5% of the 55 million deaths that occur worldwide each year.

The World Health Organization (WHO) estimates that as many as 1.4 billion urban residents globally are exposed to outdoor polluted air that exceeds WHO air quality guidelines, including guidelines for sulfur dioxide, nitrogen dioxide and particulate matter. In addition, in many heavily populated regions, such as China and India, indoor air pollution poses an even greater threat to human health, especially among women and children who tend to spend more time at home. Indoor air pollution often occurs when residents living in poorly ventilated homes are exposed to excessive smoke and a variety of airborne pollutants that arise from fuel burning sources, such as cook-stoves and other heat producing devices. It is estimated that some 3.5 billion rural residents globally are exposed to high levels of indoor air pollutants, which have been designated by the World Bank as one of the four most critical public health problems worldwide (the other three are waterborne diseases, HIV/AIDS and tobacco use and smoking.)

8 Excerpted from: Ahmed, A. Karim. *op. cit.*

In the past several decades, air quality has generally improved in many developed countries in North America and Europe. However, the continuing elevated levels of certain air pollutants in urban and industrial areas still remain a major public health problem in developed regions, especially among young children, the elderly and other vulnerable segments of the population. For instance, in the United States, air pollution continues to account for approximately 60,000 deaths each year, caused principally by gaseous and particulate emissions from motor vehicles and other fossil fuel burning sources. In developed countries, greater attention has been paid by regulatory agencies in recent years to reduce the concentration of fine particulate matter and photochemical oxidants in the atmosphere, which cause a number of serious acute and chronic respiratory diseases. Among the major sources of high levels of airborne fine particulates (less than 2.5 micrometers in diameter) in developed countries are electric power generating plants, metal refining processes and diesel-engine motor vehicles.

C. Outdoor Air Pollutants

(i) Carbon Monoxide (CO)

Automobile or industrial plants that combust materials of biological origin such as wood, coal, and oil incompletely decompose organic carbon present in these fuels into carbon monoxide. Availability of adequate oxygen is thus required for most materials to burn completely into carbon dioxide (CO_2)—the more oxygen available, the more efficiently the fuel burns. For these reasons, CO emissions can be reduced by increasing the level of oxygen available during the combustion process to ensure that the fuel is properly combusted before being expelled as partially decomposed smoke, while producing high concentrations of carbon monoxide. The purpose of using catalytic converters in automobile tailpipes is to mix more oxygen into the fuel tank to ensure that gasoline is more efficiently burned, producing lower levels of CO in the exhaust. Health Effects of odorless and colorless carbon monoxide include hypoxia, dizziness, neurological deficits, and neurobehavioral changes, among others symptoms.

(ii) Nitrogen Dioxide and Ozone

Nitrogen dioxide (NO_2), as a component of nitrogen oxides (NOx), is emitted from anthropogenic sources, such as electric power generation, industrial processing and automobile exhausts. NO_2 is, however, not only a primary pollutant in itself, but produces another airborne pollutant, ozone (O_3) (a major component of photochemical oxidants), making it a secondary air pollutant as well. When NO_2 enters the lower atmosphere (troposphere) it breaks down photo-chemically under ultraviolet light to form nitrogen oxide (NO) and atomic oxygen (O). The atomic oxygen reacts with oxygen molecules (O_2) already present in the atmosphere to form ozone (O_3), a highly toxic substance that is harmful to human health. *Health Effects* of nitrogen dioxide include weakened respiratory systems and lung function, chronic cough, bronchitis and conjunctivitis. Short-term acute effects of ozone include increased airway responsiveness and inflammation, aggravation of pre-existing respiratory diseases such as asthma, and increased incidences in respiratory distress.

(iii) Sulfur Dioxide (SO2)

Sulfur dioxide (SO_2), a component of sulfur oxides (SOx), is also a primary and secondary pollutant. Further oxidization of SO_2 leads to sulfur trioxide (SO_3), which reacts with water vapor to form sulfuric acid (H_2SO4), an important contributor to atmospheric fine particle acid aerosols (acid rain). The combustion of coal for domestic heating and cooking as well as industrial purposes, such as coal fired power plants, contributes significantly to sulfur dioxide in the air. Diesel fuel used in trucks and buses is a major problem, as diesel fuel contains high amounts of sulfur. Not only is the sulfur from diesel fuel in itself highly toxic, but it also inhibits other automotive filtering systems, such as particulate traps and catalysts, from properly functioning. [9] *Health Effects* of sulfur dioxide include aggravation of illnesses in those with already weakened respiratory function, such as asthmatics, who are particularly susceptible to the adverse impacts of this air pollutant.

9 National Resources Defense Council (NRDC). *Reducing Diesel Sulfur Levels to Reduce Urban Pollution*. Available online at: http://www.nrdc.org/air/transportation/psulfur.asp.

(iv) Lead (Pb)

Lead has been used throughout modern history for a broad range of purposes, ranging from cosmetic products and paints to water piping. However, its harmful effects on human populations have only been determined in the past fifty years. Historians have now postulated that the fall of the Roman Empire can be traced to the high amounts of lead used in drinking vessels and other materials in certain sectors of their society. Today, one of the greatest sources of lead in the air occurs as a by-product of leaded gasoline used in automobiles. Lead is used to increase the octane rating in gasoline as an anti-knocking agent. [10] In the past two decades, most developed countries in North America and Western Europe have phased out lead additives in gasoline while implementing sodium-based additives capable of achieving the same anti-knock goals. Many developing regions of the world, unfortunately, still include lead additives in their gasoline. *Health Effects* of lead are especially severe on young children, as it is capable of affecting their nervous systems that are still in the process of development, and can lead to long-term cognitive difficulties. Lead exposure in adults as well as children can lead to central nervous problems, increased blood pressure, mental deficits, brain damage and death.

(v) Particulate Matter (PM)

Particulate matter can occur either from naturally occurring sources in the air, such as volcanic ash, dust, and plant materials, or as a product of human activities. Particulate matter occurring from human activities such as combustion of fossil fuels in industry (through secondary conversion of sulfur oxides into acid aerosols) and from motor vehicles (particularly from diesel-powered engines), are generally lighter and finer than those originating from natural sources. Fine particulate matter (less than 2 micrometers in diameter) is especially dangerous to human health as it is small enough to pass through the respiratory system's clearing mechanism which is capable of blocking only coarser particles, allowing it to penetrate deeply into the lung where it can remain indefinitely. In addition, fine particles are capable of remaining in the atmosphere for relatively long periods of time and can move over large distances, resulting in acid precipitation into lakes and streams. *Health effects* of particulate matter include shortness of breath, bronchitis, asthma, and pre-mature deaths.[11]

D. Indoor air pollution

Although air pollution is most commonly associated as an outdoor concern, many regions of the world have significant health risks associated with indoor air quality. Many developing countries are especially at risk from the effects of indoor air pollution, as the highest air pollution exposures occur inside homes in these regions. Indoor air pollution is a major contributor to mortality rates in developing countries, comprising 84 percent of the 3 million deaths due to air pollution worldwide. [12] Many households in developing countries, such as China and India, rely on biomass and coal in open fires or stoves for their indoor heating and cooking needs, often without proper ventilation. When air pollution occurs in the home environment it can be especially dangerous for women and children who spend most of their time indoors, where airborne substances are released in proximity to their living quarters. In addition, toxic air hazards in the workplace can have similar consequences as those found in the home, as exposures to air pollutants are much higher indoors than in the outdoor environment, where the airborne substances may disperse more readily.

E. Human Exposure to Air Pollutants

(i) General Considerations

The ability to anticipate the daily habits of an area's inhabitants is important in terms of understanding what type of air pollution they are most at risk. Urban populations have different exposure problems than those living in rural areas, as do populations in temperate zones versus those living in cold, arctic conditions. Urban populations, for example, are closest to sources of ambient outdoor air pollution, yet they also tend to spend most of their time indoors, both at work and home. Climate and geographic location will determine how often an individual is likely to spend outdoors or indoors with the windows open. Socio-economic status is of importance, especially with the

10 World Bank Group. (1998). *Removal of Lead from Gasoline: Technical Considerations. Pollution Prevention and Abatement Handbook*. Washington, DC: World Bank Group.

11 Ahmed, A. Karim (2003). *Ob Cit.*

12 World Health Organization (WHO). 2001. *Strategy on Air Quality and Health*. Geneva: WHO.

poorest segments of the population, who live in congested urban areas and are most at risk from exposure to air pollutants.

Another factor is that the local concentrations of airborne pollutant depend on the sources and rates of dispersion. Variations from day to day in air quality are more a result of meteorological conditions than the intensity of source emissions. For example, air pollutant dispersal is minimal when cold, still weather conditions exist, however dispersal rates will increase with strong winds and frequency of ground turbulence.

Exposure to air pollution is measured as a product of concentration of the pollutant and the duration of exposure in a given region. The amount of time spent indoors or outdoors should be considered when determining exposure risks to air pollutants. For instance, most urban people spend a large fraction of their days indoors and are thus more exposed to indoor air pollution, while those living in warmer, more rural climates spend most of their time outdoors.

(ii) Vulnerability of Children, Elderly and Chronically Sick

Those most at risk to the adverse effects of air pollution are children, the elderly, those with an already weakened respiratory system, asthmatics, and those who are exposed to high concentration of air pollutants for extended time periods. The more economically disadvantaged sectors of society are also those that suffer most from living in degraded environmental conditions. Generally speaking, the severity of risk depends on a combination of factors: the source of air pollution, physical and chemical characteristics of the pollutant, the overall extent of exposure, and the availability of health care within immediate access.

(iii) Data Collection—Choice of Air Quality Indicators

Monitoring of harmful airborne substances is a necessary prerequisite to regulatory control of air pollution. Such monitoring systems should be carried out at various locations and over extended periods, since the airborne concentrations of harmful gases and particulate matter vary with distance and time. If air concentration levels in different countries are to be compared, a common system of comparison is crucial. The WHO uses air concentration units in terms of 'mass per unit volume' given as milligrams per meter cubed (mg/m3). This system is applicable to both airborne gases and particles whereas the volume-mixing ratio, i.e. parts per million or billion (ppm or ppb), is applicable only to atmospheric gases.

The main sources of information on air pollution in developing countries is generally derived from WHO's Air Management Information System (AMIS), which is based on voluntary reporting of air concentration data in the municipalities and urban centers of WHO member states.

The three most commonly measured pollutants are particulate matter (PM, reported as Total Suspended Particles, TSP or as PM10), nitrogen oxides (NOx), and sulfur oxides (SOx). Other harmful air pollutants (e.g., ozone, lead and carbon monoxide) are not widely measured and therefore data on these are often not available, or if available they may not be comparable from region to region. For these reasons, "surrogate" measures of the air pollutants such as lead exhausts from automobiles (e.g., indirectly measured as the ratio of unleaded/leaded gasoline available on the market) have been employed as alternate indicators and benchmarks in many regions of the world.

F. Recommended Environmental Indicators and Benchmarks of Air Quality

Basis for Selection:

One set of recommended primary indicators is based on human exposure to airborne concentration of three widely occurring air pollutants in the urban environment, namely nitrogen oxides, sulfur oxides and particulate matter. At present, these three air pollutants are monitored by regulatory agencies in most regions of the world, including in many cities and urban centers of developing countries. Thus, it is likely that data on the air concentration levels of one or more of these airborne pollutants are accessible from official government sources. Moreover, it is possible to carry out multi-year trend analysis of the extent of outdoor air pollution in a community where monitoring of these air pollutants has been being carried out over a period of time. In addition, development of primary indicators on air quality include obtaining data on the prevalence of the population with acute respiratory infection and chronic obstructive pulmonary diseases, since these ailments caused by bacterial and viral agents are often exacerbated by air pollutants found in a degraded environment. Finally, development of primary air quality indicators should attempt

at establishing the percent of children below five years that are potentially exposed to high airborne lead levels in a community or region.

In many developing regions, where data on primary environmental health indicators may be missing or difficult to obtain, a number of secondary indicators are recommended that could provide indirect, but nevertheless adequate interim assessment of the impact of degraded air quality on a community. As an indirect measurement of nitrogen oxides arising from motor vehicles in urban areas, the percent of cars, trucks and buses with catalytic converters, which control the tail pipe emission of nitrogen dioxides, can serve as a surrogate air quality indicator or a policy-mandated benchmark. Similarly, determining the percent of sales of unleaded gasoline in a country or region could serve as a surrogate indicator or benchmark that assesses progress made in decreasing the impact of airborne lead on the health and well-being of young children in a community. Another indirect measurement of urban air quality in both developed and developing regions is determining the percent of diesel-free motor vehicles on the road, since diesel engines in general emit a high proportion of fine particulate matter into the atmosphere. The percent of the highly polluting two-stroke engines in auto rickshaws and motorized tricycles in many cities and towns of developing countries can serve as an indirect measure of urban air pollution, especially where their use is universally prevalent. Another surrogate measurement of urban and industrial air pollution is the determination of the percent of combustion sources (industrial, commercial, residential) that use coal as their primary fossil fuel, which in many unregulated or poorly monitored regions of the world is a major air emission source of sulfur oxides and particulate matter. As a complementary and inverse surrogate measurement of air pollution from industrial, commercial and residential sources is determining the percent of combustion units in a region using natural gas as an alternative cleaner burning fossil fuel.

In the development of tertiary outdoor air quality indicators and benchmarks, data on the distance and amount of time spent by an average commuter traveling to work in an urban region could provide significant information of potential motor vehicle related air pollution in a community. Similarly, the percent of an urban population using mass transportation or non-motorized means to travel to work can also provide a useful indicator or benchmark on the state of outdoor air quality of a region. For assessing indoor air pollution in many urban and rural areas of both developed and developing regions, development of two tertiary indicators or benchmarks are recommended: (i) percent of household using clean cooking stoves or heating fuel sources, which produce significantly reduced amount of particulate matter indoors, (ii) percent of workplaces and households with adequate ventilation, which assists in reducing exposure of workers, adults and young children to a variety of indoor air pollutants.

Summary of Recommended Indicators and Benchmarks:

(i) Primary Indicators
- Ambient Air Concentration of Nitrogen Oxides (NOx)
- Ambient Air Concentration of Sulfur Oxides (SOx)
- Ambient Air Concentration of Particulate Matter, PM (TSP or PM10)
- Prevalence of Population with Acute Respiratory Infection
- Prevalence of Population with Chronic Obstructive Pulmonary Disease (COPD)
- Percent of Children Below Five Years with Potential High Lead Exposure

(ii) Secondary Indicators
- Percent per Automobile Fleet with Catalytic Converters (nitrogen dioxide exposure)
- Percent of Unleaded Gasoline Available on the Market (lead exposure)
- Percent of Cars, Trucks, Buses with Diesel-free Engines (particulate matter exposure)
- Percent of Motorized Vehicles with Two-stroke Engines (air pollutant exposure)
- Percent of Industrial, Commercial and Residential Use of Coal (sulfur oxides, particulate matter)
- Percent of Industrial, Commercial and Residential Use of Natural Gas

(iii) Tertiary Indicators
- (Outdoor) Average Commuting Time and Distance
- (Outdoor) Percent of Urban Population that Uses Mass Transit
- (Outdoor) Percent of Urban Population Using Non-Motorized Transport
- (Indoor) Percent of Households Using Clean Cooking Stoves and Heating Fuel
- (Indoor) Percent of Workplaces and Households with Adequate Ventilation

(iv) Modifying Factors

- Rate of Urban Growth
- Geographic Location and Climate Type
- Population Density

Chapter VI: Water Quality and Sanitation

A. Overview

Throughout the last century, water use has been growing at more than twice the rate of the population increase, and already a number of regions are chronically short of available water resources. As populations continue to grow, lack of clean water supplies will soon be recognized as the world's most critical concern. While seventy percent of the Earth covered by water, the reality is that 97.5 percent of all water on earth consists of salt water, leaving only 2.5 per cent as fresh water. Of the amount of non-brackish freshwater available, seventy percent of it is frozen in the icecaps of Antarctica and Greenland leaving less than one per cent of the world's fresh water readily accessible for direct human uses. [13]

Intense water scarcity tends to occur in economically volatile areas that have low amounts of freshwater but increasingly high levels of population, which is particularly the case throughout the Middle East region. In these areas, most available water supplies are used for agriculture, as neither the extra water nor the financial resources exist which would enable a shift in development away from intensive irrigation and into other sectors that would create employment and generate the income needed to import food. [14]

In fact, irrigation for agricultural purposes accounts for seventy percent of water taken from lakes, rivers, and groundwater sources on a worldwide basis. The result is that at least one-fifth of all people do not have access to safe drinking water, while more than one-half of the world's population lacks adequate sanitation, most of whom are poverty-stricken. The effects on human health are also costly: at any given time, an estimated one-half of the people in developing countries are suffering from water or food associated diseases caused either directly by infection through the consumption of contaminated water or food, or indirectly by disease-carrying organisms (vectors), such as mosquitoes, that breed in stagnant water pools. Heavy chemical pollution from industrial discharge and agricultural and urban runoff also render water unsuitable for consumption, further decreasing the available amount of existing safe drinking water. [15] (for more details, refer to Appendix B.)

Global Water Crisis [16]

The lack of clean water resources and sanitation facilities looms as one of the most serious environmental health problems faced today by a large fraction of the world's population, especially those living in developing regions. Around the world, water supply and sanitation facilities are rapidly deteriorating and are operating at a fraction of their installed capacities. This situation is particularly serious in many developing countries of Asia, Africa, and Latin America, where the poor have very limited access to clean water supplies and sanitation facilities. This poses serious and life-threatening diseases to the population, especially among infants and young children. The situation is even more pronounced in rural areas of developing regions, where the problems of water resources and inadequate sanitation facilities largely remain unresolved for a large majority of the population. Added to this is the rapid industrialization and urbanization of a number of highly populated developing countries (such as China, India, Brazil, and Mexico) where in the past few decades, water contamination by a variety of toxic chemicals and hazardous wastes has aggravated an already serious water pollution problem related to microbial diseases.

The World Health Organization (WHO) has estimated that 1.1 billion people lack basic access to drinking water resources, while 2.4 billion people have inadequate sanitation facilities, which accounts for many water-related acute and chronic diseases. Some 3.4 million people, many of them young children, die each year from water-borne infectious diseases, such as intestinal diarrhea (cholera, typhoid fever and dysentery), caused by microbially contaminated water supplies that are linked to deficient or non-existent sanitation and sewage disposal facilities. In addition, many freshwater streams, lakes and groundwater aquifers around the world are increasingly becoming contaminated with industrial discharges and agricultural runoffs that carry high concentration levels of toxic chemical substances and hazardous wastes. These contaminated water sources

13 United Nations *Comprehensive Statement of Freshwater Resources of the World*. Available online at: http://www.un.org/esa/sustdev/freshwat.htm.

14 WRI, UNEP, UNDP, WB. (1999). *World Resources 1998-99. A Guide to the Global Environment*. New York: World Resource Institute (WRI), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), World Bank (WB).

15 United Nations *Comprehensive Statement of Freshwater Resources of the World* http://www.un.org/esa/sustdev/freshwat.htm.

16 Excerpted from: Ahmed, A. Karim. *op. cit.*

contain a number of highly toxic heavy metals, pesticides, fertilizers and other agricultural chemicals, along with a variety of persistent organic pollutants (POPs) and disinfection by-products, many of which remain intact in the environment for long periods of time and bioaccumulate in the food web. The presence of these chemical substances in surface and ground water resources is linked to many acute and chronic illnesses, ranging from severe skin and liver disorders to developmental abnormalities, neurological diseases and human cancer.

Broadly speaking, the global problem of water resources and sanitation may be generally looked upon as consisting of: (1) increasing scarcity of water supplies with rising population, (2) uneven and inequitable distribution of water resources and sanitation facilities, (3) high water pricing rates and charge schedules, (4) prohibitive costs associated with operating and maintaining sanitation facilities, (5) insufficient funds available for building water treatment and sewage disposal facilities, (6) lack of availability of appropriate and innovative water treatment technologies, (7) failure to implement water conservation programs, (8) poor management in protecting aquatic ecosystems, (9) inadequate prevention of microbial and chemical contamination of surface and ground water resources from human activities.]

B. Sources of Water Contamination

The quality of drinking water can be determined through the intensity of its exposure to human technology and natural systems. The first is through the costly services of human technology, which offers treatment systems, purification processes and desalinization, among others. The second is through natural systems, where water is cleaned and purified as it filters through the Earth to replenish ground aquifers. The best approach to obtain safe drinking water relies on a combination of both systems. Although natural watersheds and ground cover provide an automatic filtration system for water, these systems are often highly exploited. Storm-water runoff plays a particularly large role in the health of watersheds, and can vary from region to region.

For example, during a rainstorm, surface runoff in an urban area can accumulate numerous debris in its path. Oil slick and leakage from automobiles, scattered leaves and other organic matter, as well as random garbage in the street are found most frequently in runoff systems. In times of heavy rainfall, or if the storm water runoff system is inadequate in matching the pace of its urbanizing surroundings, the storm water can become direct runoff, meaning it is deposited directly into freshwater bodies without being filtered or treated. The extra organic matter can lead to an increased state of eutrophication, whereby the amount of nutrients in a water body increases, demanding more and more oxygen in order to decompose; decreasing the quality of water while degrading natural ecosystems. In urban or other areas where there is a serious shortage of natural land cover due to deforestation or impervious surfaces (i.e. road and parking area pavements), the degree of storm water runoff systems flooding will be that much more extreme.

Storm water runoff found in rural areas can be similar to its urban counterpart, although it usually consists of primarily agricultural runoff, such as nitrous oxides and pesticides. If no regulations on farming practices exist, anything found on the crops is likely to be found in the freshwater supplies. Additionally, if unsustainable farming is practiced, much sediment due to erosion is often found downstream of plots, further endangering the ecosystem of the freshwater body. [17] Industrial pollutants, such as wastes from chemical plants, and municipal wastes are often dumped directly into fresh waterways, such as rivers, lakes, wetlands and estuaries.

C. Drinking Water Standards

Generally, safe drinking water standards all over the world are based on the World Health Organization (WHO) guidelines for water quality, whose primary goal is to ensure "all people, no matter what their stage of development…have a right to have access to an adequate supply of safe drinking water." [18] WHO water quality standards are meant to promote safe and acceptable standards of water quality that countries can feasibly achieve via appropriate treatment and distribution systems. The primary aim of the standards is to protect public health from the effects of contaminated drinking water. Notwithstanding the original objectives of promoting and maintaining human health, however, the WHO does make an effort to ensure that the guidelines are not so stringent or technologically advanced that more developing nations would have no hope of achieving them.

17 See Natural Resources Defense Council's Clean Water and Oceans webpage: http://nrdc.org/water/default.asp .

18 Drinking water standards can be viewed online at the WHO Water and Sanitation homepage: http://www.who.int/water_sanitation_health/GDWQ/index.html

The guidelines outline the lowest threshold amounts that are allowed of certain substances. There are also a separate set of more rigorous guidelines for vulnerable groups, like children and the elderly living in areas of poverty without access to environmental hygienic facilities. Yet in spite of these efforts to account for different circumstances, individuals can still vary widely in immunity and rate of infection. Thus, the degree of illness may not be uniform among groups of individuals depending upon factors such as environment, age, sex, history of health, and degree of immunity. In addition to the WHO drinking water standards, the United States Environmental Protection Agency (USEPA) also provides a source of information on drinking water guidelines. [19]

There are mainly three components used for testing which are the most crucial to the successful outcome of safe drinking water for the public: microbial contaminants, chemical contaminants, and "nuisance organisms."

- **Microbial contaminants:** these refer primarily to bacterial disease found in human and animal excreta. The most dangerous of all contaminants, no amount of microbial contamination is tolerated because any amount of ingested bacterial pathogens may result in acute illness. Microbiological contamination tests can have varying results in accuracy, however, because the growth medium and the conditions of incubation, as well as the nature and age of the water sample can influence species isolated and the count. The two most common pathogens used in microbial testing that are indicators of fecal contamination are E. coli and thermo-tolerant coliform bacteria, since these pathogens always indicate the presence of animal and human excreta.
- **Chemical Contaminants:** Unlike microbial testing, where the analysis depends on a search for viable bacterial organisms not confined to any group, chemical and physical analysis is defined within the boundaries of a chemical entity or a physical property. Also unlike microbial pathogens found in feces, there may exist a concentration dose for most chemicals acutely toxic to human health below which no health effects may occur. The WHO guidelines for drinking water regarding chemical contaminants are based on an approach called the Tolerable Daily Intake (TDI). This is "an estimate of the [minimal] amount of a substance in food and drinking water expressed on a body weight basis that can be ingested daily over a lifetime without appreciable health risks." The TDI approach is also used by the WHO to monitor the dangers to human health from other sources such as food and air.
- **Nuisance Organisms:** sensory aesthetic factors such as taste, odor, and color of the drinking water that must be acceptable to a human consumer or else it will reject it, even if the water is completely safe to drink. Organisms which affect such aesthetic qualities of drinking water without making it harmful are called "nuisance organisms."

D. Sanitation and Waste Disposal

The second major component of water indicators takes issues of sanitation into consideration. Safe drinking water indicators measure concerns of safety and quality whereas sanitation indicators measure problems of distributing safe water while focusing on the opportunity for equal access and the presence of reliable facilities. Issues of safe drinking water cannot be acknowledged without addressing the inseparable issue of access to sanitation services.

Sanitation services are generally known as infrastructures of sewerage disposal and waste management. Access to reliable toilettes and safe municipal waste management systems are important to maintaining public health, as many diseases are contracted from open sewage pits and garbage scattered in public places. Dysentery, which is generally contracted from unsanitary conditions and/or lack of hygiene, is the second leading cause of infant mortality worldwide, yet also one of the easiest diseases to prevent with the presence of proper sanitation facilities. Also of equal importance when contemplating issues of sanitation is promoting hygiene education and awareness. Water and sanitation related diseases are as much dependent on behavioral practices of households as is the quantity and quality of water used. [20]

Education on the positive effects of proper hygiene practices and access to private sanitation facilities can have a huge impact. The concern that the sanitation facilities be private is of special concern to women, who often are forced to relieve themselves in unclean areas for the sake of privacy if clean toilettes are not available within the immediate area of their homes. Also, women are generally the primary educators in the home regarding personal hygiene practices.

The United Nations Children's Fund (UNICEF), in its document, Towards Better Programming: A Water Handbook, states that sanitation services, including hygiene education, are now becoming at least as important as water supply

19 These can be viewed online at: http://www.epa.gov/safewater/sdwa/sdwa.html

20 Shyamsundar, Priya. 2002. Poverty Environmental Indicators. Washington, DC: World Bank Economics Series.

in UNICEF's assisted programs around the world. Most sector professionals agree that: (a) isolated water supply interventions are not effective in the prevention of disease, (b) sanitation alone has a larger impact on health than does water alone, and (c) hygiene education, together with sanitation, has more of an impact on the reduction of diarrhea than does water. The UNICEF handbook concludes, *"Water interventions are an important component of public health programmes but only if integrated with hygiene education and sanitation interventions."* [21]

E. Recommended Environmental Health Indicators and Benchmarks for Water Quality and Sanitation

Basis for Selection:

The recommendations on primary environmental health indicators and benchmarks on water quality and sanitation consists of determining the safety of public drinking water supply in three categories: (i) microbial safety standards that have been established by national, regional or local regulatory agencies, which generally consists of establishing the allowable level of fecal coliform microorganisms, such as E. coli bacteria, present in the public drinking water supply, (ii) chemical safety standard or recommended guidelines that have been issued by regulatory agencies on a large number of toxic substances, such as metal ions and organic chemical compounds that are hazardous to human health, where the choice of specific chemical safety standards as an indicator will vary from region to region, and (iii) nuisance guidelines, such as a level of turbidity, odor and other surrogate measurements of degraded water quality. As an important measure of adequate amount of potable and safe drinking water available in a region, the per capita consumption of water by residential households in a community is a recommended indicator or benchmark. Finally, a primary indicator of the impact of unsafe drinking water on vulnerable members in a community can be developed by obtaining data on morbidity and mortality rates of infant diarrheal diseases in a region, where bacterially contaminated drinking water sources are still one of the main causes of childhood illnesses and deaths in many developing countries.

Among secondary water quality and sanitation indicators and benchmarks, the determination of percentage of population that are served piped water, including community pumps and publicly accessible taps can serve as an indirect measure of the availability of potable and safe drinking water in a developing region. Similarly determination of percent of population in a region served with primary and secondary wastewater treatment is an environmental health indicator of adequate sanitation services in a community. In many urban areas of developing regions, another indicator of water quality and sanitation is the percent of population who have actual access to household sewerage or toilette services, since a large fraction of the low-income families live in shanty towns and in poorly served urban slums. In rural areas, a recommended secondary water quality and sanitation indicator is determining the percentage of population who has properly installed latrines, septic tanks and sewage drainage systems in the community.

For the development of tertiary water quality and sanitation indicators and benchmarks, determining the ratio of impervious ground cover to drainage area in an urban watershed environment is recommended. In addition, the determination of the extent of polluted aquifers and groundwater sources of drinking water in a region, and the percent use of recycled wastewater may serve as a tertiary water quality and sanitation indicator or benchmark in a community.

Summary of Recommended Indicators and Benchmarks:

(i) Primary Indicators

- Safety of Public Drinking Water Supply—Microbial Safety Standards (Coliform Organisms)
- Safety of Public Drinking Water Supply—Chemical Safety Standards (Toxic Substances)
- Safety of Public Drinking Water Supply—Nuisance Guidelines (Turbidity, Odor)
- Per Capita Daily Consumption of Drinking Water (Residential Use)
- Child's Morbidity Rate via Ingestion of Contaminated Water (Diarrheal-related)
- Child's Mortality Rate via Ingestion of Contaminated Water (Diarrheal-related)

21 UNICEF (1999) *Towards better programming: A water handbook*. http://www.unicef.org/wes/files/Wat_e.pdf

(ii) Secondary Indicators

- Percent of Population with Access to Piped Water, Pumps, Public Taps, etc
- Percent of Primary/Secondary Wastewater Treatment in a Region
- (Urban) Percent of Population with Access to Sewerage (Toilette) services
- (Rural) Percent of Population with Access to Latrines, Drainage, Septic Tanks, etc.

(iii) Tertiary Indicators

- (Urban) Ratio of Impervious Ground Cover: Natural Ground and Watersheds
- Extent of Polluted Aquifers and Groundwater Sources (Site-Specific)
- Percent Use of Treated Wastewater (if and how it is recycled)

(iv) Modifying Factors

- Population Density
- Rate of Urban Growth
- Geographic Location and Climate Type
- Education on proper hygiene

Chapter VII: Vector-borne Diseases

A. Overview

A disease vector is an organism, such as a mosquito, tick, or leech, which carries disease parasites from one host (person carrying disease) to another. Vectors carrying parasitic diseases have been in existence for centuries. In fact, recently uncovered archeological evidence provides evidence of malaria's impact on civilization since the time of the ancient Egyptians. Today, human activities contributing to changes in the natural environment have led to a resurgence of this and other vector-borne disease on a worldwide scale.

Vector-borne disease species vary considerably in feeding, mating, and incubation habits. For instance, some mosquitoes are active only during the day, and rely on vision and movement to locate their next meal. Other mosquitoes are known to be night-active mosquitoes, and tend to rely on odor to navigate, although such odor preferences vary from species to species. Different mosquito breeds are able to coexist by concentrating on different hosts; by broadening their preferences in host consumption when necessary; and by being active during other times of the day. Some mosquitoes can read the bacterial signals in the water where they lay their larvae to tell whether the pool is temporary or permanent—a crucial determinant regarding the eggs' fate. One type of female, An. funestus, only lays eggs in highly vegetated areas that make them difficult to capture. Thus, whenever a shadow crosses over the larvae, they can dive to the bottom of the pool and remain hidden there for up to thirty minutes![22] Yet one factor shared by all mosquitoes alike is their production of larvae. Larvae development generally lasts only one to two weeks, and hatching usually occurs in less than a minute. However, the most important common requirement for most larvae to survive is the availability of water resources.

B. Human Behavior and Transmission of Vector-Borne Diseases

Transmission and proliferation of vector-borne diseases results from changes in human behavior and natural habitat alterations, as much as it does from mutations in the pathogen itself. Examples of human behavior that affect the environment of disease vectors are: (a) mass migration and sudden population movement, (b) international travel and commerce, (c) changes in land use, (d) microbial adaptation and resistance, (e) lack of reliable public infrastructure; and (f) global climate change. [23]

- ***Population migrations.*** Sudden population change due to war, environmental degradation, and other regional conflicts has enabled disease vectors to spread rapidly, with those in flight often being the most affected. Refugee camps in sub-Saharan Africa and the Middle East, for example, possess a particularly high transmission rate of infectious diseases. Rapid unchecked urbanization has provided some disease vectors with access to numerous habitats, such as open sewers and water storage containers, while increases in human population density have resulted in many mosquitoes developing a preference for feeding solely on humans, as their previous food sources of assorted mammalian and bird species became increasingly scarce.
- ***International travel and commerce.*** The combination of today's international trade, air travel and tourism ensures the continual spread of disease vectors. Each day, some two million people are engaged in cross-border movement. Areas such as seaports, airports, and cemeteries are especially vulnerable in this regard. The effects of global trade in food result in un-hygienic food production, handling, and preparation in originating countries that introduce microbial disease pathogens into foreign countries, such as E. coli, and Salmonella.
- ***Land use change.*** Changes in land and water use patterns are major factors contributing to the spread of vector-borne disease. Deforestation has altered the habitats of disease vectors, often forcing them to adapt to urban living conditions while also bringing humans into closer contact with the insects and animals carrying disease. Water management practices, such as dam building, open irrigation canals and flooded rice fields, and open sewer pits, have encouraged the spread of water-breeding vectors by providing them with an area in which to survive and pro-create.

22 Sharakhov, I. V., Serazin, A. C., Grushko, O. G., Dana, A., Lobo, N., Hillenmeyer, M. E., Westerman, R., Romero-Severson, J., Costantini, C., Sagnon, N.'F., Collins, F. H., and Besansky, N. J. (2002) *Inversions and gene order shuffling in Anopheles gambiae and A. funestus*. Science, 298:182-185.

23 *National Intelligence Estimate: The Global Infectious Disease Threat and Its Implications for the United States, National Intelligence Council*. Woodrow Wilson Environmental Change and Security Project Report 6 (2000)

- ***Microbial adaptation and resistance.*** Technological breakthroughs and use of medicinal antibiotics, both in developed and developing countries, where they are used extensively today, has continually resulted in development of microbial drug resistance. The ability of disease microbes to constantly evolve resistance to antibiotics renders them particularly difficult to treat, especially in poorer areas where there is little hope of acquiring recently introduced drug products that have greater efficacy in treating diseases.
- ***Lack of reliable public infrastructure services.*** The dearth of funds for sanitation facilities, effective water management systems, and basic public health care in many developing countries has led to a re-emergence of vaccine preventable deaths, especially apparent in areas vulnerable to war, natural disaster, or economic collapse.
- ***Climate change.*** Disease associated with mosquitoes is likely to expand its geographic reach as more and more regions around the world experience warmer climates and increased rainfall as a result of global climate change.

C. Major Types of Vector-Borne Diseases

Throughout their existence, mosquitoes have evolved numerous traits to ensure the survival of their breed. Those who have been victim to mosquito bites are not unfamiliar with the itch that follows; an effect of mosquitoes' special saliva, which they inject into human, or animal bloodstreams while feeding. The injection of saliva serves two purposes; first to anaesthetize the host against immediate pain or sensations, and second, to disrupt the blood clotting process that allows the parasite to feed on the host. Unfortunately, the injection of the vector's saliva also serves a third purpose: the transmission of disease to the host organism.

(i) Dengue Fever: The mosquito responsible for transmitting the dengue virus, Aedes aegypti, is a small, black and white insect with stripes on its legs and back which generally bites during the early morning and late afternoon hours. The dengue mosquito rests indoors in dark places or outside where it is cool and shaded. The principal vector of the disease tends to breed in human-made containers that collect rainwater, or any other stagnant pool of water. It is estimated that about 50-100 million people worldwide are infected with Dengue-related diseases each year.

The Dengue virus exists mainly in two forms: dengue fever and dengue hemorrhagic fever, the latter being the more deadly. Dengue hemorrhagic fever (DHF) is a life threatening form of dengue fever with at least four different strains. While infection from one vector will create immunity to that specific strain, it will also exacerbate infection and death when exposed to other remaining strains. There is no vaccine or medical treatment for dengue fever. Thus the only way to prevent the disease is by eliminating the chance of human exposure.[24]

Before the Second World War, it was unusual for more than one Dengue strain to exist in the same area, and most individuals were immune to the strain existing in their communities. However, with the onset of war, new strains of DHF were introduced into many areas, causing mass infection and the spread of DHF. Additionally, cities in developing countries experienced a surge of urban growth, which led not only to a decline of cover vegetation where predators of the Dengue mosquitoes thrived, but also provided Aedis agypti with a multitude of breeding spots in form of open water containers in human settlements. In this way Aedes aegypti evolved from an isolated rural tree-hole breeding disease vector into an urban scourge, as a result of significant change in the urban environment of developing regions. [25]

(ii) Malaria: Anopheles gambiae, otherwise known as "mass murderer" to researchers in the field, is the mosquito species responsible for transmitting malaria. Originating in forested areas of Africa, malaria is one of the oldest diseases of humankind, with one of the most numerically intimidating of death tolls. Although today the geographic range of malaria has decreased, being confined mainly to the tropical regions of Africa, Asia and Latin America, about forty percent of the world's population still lives in risk of contracting malaria. Sub-Saharan Africa alone accounts for an estimated ninety percent of the global malaria burden (WHO, 1999). Although the disease is preventable and even curable, at least 300 million people suffer from infection annually, while over 2 million people die as a result from exposure each year; most of them young children.[26]

There are about 380 different species of the Anopheline mosquito, of which 60 are able to transmit four types of the plasmodium parasites that cause the disease. The disease is spread through the feeding habits of the female mosquito,

24 Marten, G. 2001. *Human Ecology: Basic Concepts for Sustainable Development*. London: Earthscan.

25 *Ibid*.

26 See *History of Malaria*: http://www.unicef.org/media/historymalaria.htm

which requires nutrients from the blood in order to reproduce (the males feed only on plants). Malaria will not display the first signs of infection until 7-20 days after the initial bite. Because malaria can share disease symptoms common to other illnesses, such as headache and fever, many patients consequently receive improper treatment initially. If left untreated, the parasite can infect red blood cells, which results in depleting oxygen in brain tissues and other organs of the body. This leads to severe anemia, permanent organ damage, convulsions, coma and death.[27]

Of the four different species of malarial parasite, the most deadly organism is found in tropical regions of Africa, which accounts for the high incidence of malaria in sub-Saharan Africa. The other factor contributing to the incidence of malarial infection in Africa can be traced to the 1955–1969 worldwide campaign to eradicate malaria. This public health campaign, led by the newly formed World Health Organization, encouraged the use of DDT and chloroquine (a relatively inexpensive drug product) to achieve dramatic results in Europe, North America and the Soviet Union, as well as some areas of Asia and Latin America. However, most areas in Africa did not receive the benefits of this initial campaign, since many countries in the region lacked adequate infrastructure and access to medical resources that were vital to the worldwide campaign's success. In the meantime, the disease vector mosquito had acquired insecticide resistance to DDT, while the disease-bearing parasite had similarly developed drug resistance to chloroquine, a relatively inexpensive pharmaceutical product. Since then, the worldwide quest to eradicate malaria has been abandoned, as more developed countries no longer see themselves at risk. [28]

In many ways, the global campaign to eradicate malaria of the 1960s has only succeeded in making present-day malaria far more lethal by increasing vector resistance to pesticide use and treatment. At present, it is re-emerging in areas once thought to have permanently eradicated the deadly disease. Deterioration of healthcare and sanitation infrastructures, increased human migration, climate change, and faulty land use and urban planning has also been responsible for the resurgence of the malarial mosquitoes in recent years. As a response to the growing urgency of malaria spreading worldwide, WHO and other international bodies have launched the Roll Back Malaria campaign in 1997. [29]

(iii) Schistosomiasis: A major water-borne communicable disease caused by parasitic worms that annually infects 200 million people worldwide. Infection occurs upon human contact with certain types of water snails that carry the parasitic worms known as schistosoma. Disease infection is indicated either by the presence of blood in the urine, which leads eventually to bladder cancer or kidney problems, or bloody diarrhea, which leads eventually to serious complications of the liver and spleen. [30]

Human fecal wastes dumped into freshwater sources are the main factor in the proliferation of the disease. This is because the excreta of an infected person contain eggs that hatch on contact with freshwater. Once the eggs are hatched, they release larvae that seek out snail hosts in which to produce parasites. The new parasites produced by the snail host are then excreted into the surrounding water where they can penetrate human skin within a few seconds. People therefore become infected with schistosomiasis by contact with contaminated water through swimming, fishing or irrigation activities, among others. [31] Schistosomiasis prevention can be achieved by drinking properly boiled water, avoiding swimming in contaminated lakes and streams, and by bathing in water heated to 66 degrees C (150 degrees F) for 5 minutes. [32]

D. Vector-Borne Disease Control

It is virtually impossible to completely block transmission to vector-borne disease, yet there are many ways to reduce transmission. Practices aimed at limiting risk to exposure are known as vector control. Vector control policies are aimed at modifying human behavior as well as human environments, with pesticide application used only as a last resort. This is because insecticides, in addition to being environmentally harmful, are very costly. Even when there are adequate funds to support pesticide use, the mosquito will eventually develop resistance to the chemical, often evolving into an even more pernicious vector to control.

27 McGinn, Anne Platt. (2003). *Combating Malaria, in State of the World 2003*. Washington, DC: Worldwatch

28 See *History of Malaria* http://www.unicef.org/media/historymalaria.htm

29 See *Roll back to Malaria Partnership* to: http://www.rbm.who.int

30 WHO Infectious Disease Homepage http://www.who.int/ctd/schisto/disease.htm

31 *Ibid.*

32 Ahmed, A. Karim. *op. cit.*

Risk of exposure to vector-borne disease is, in general, directly related to environmental conditions. Environmental management, which includes planning, organization, and modification of environmental factors that accelerate disease transmission, can be an effective means of vector control. Management strategies are often site-specific, depending on what type of habitats the mosquito in question prefers, and should therefore focus on destruction and alteration of natural as well as manmade containers responsible for providing larval habitats that produce the greatest number of mosquitoes in each community.

In order to manage environmental conditions to successfully decrease vector disease incidence, it is crucial to understand the breeding habits of the target mosquito, because it is the reduction in larvae production and not the elimination of individual mosquitoes that will produce the most dramatic effects. Ae. aegypti, for example, breeds primarily in human-made containers in Asia and the Americas, while in Africa it breeds both in synthetic containers as well as natural ones, such as leaves, tree holes, etc. [33]

In 1980, the WHO Expert Committee on Vector Biology and Control defined environmental management as a component of three parts: (a) environmental modification, (b) environmental manipulation, and (c) changes in human habitat or behavior. [34]

(i) Environmental Modification:

Long-lasting physical transformations of disease-bearing vector habitats include:

- **Improvement of Water Supply and Storage:** Having a reliable source of water that does not enable mosquitoes to breed can make a great difference in any community. Water piped to households is preferable to wells, communal standpipes, rooftop catchments and other open delivery systems. Of equal, if not more importance, is how water is stored. If water is stored using tanks, drums, jars, or other similar devices, openings should be sealed using tight fitting lids or screens. It is important that the covered containers be routinely inspected to ensure that they have not deteriorated, while at the same time allow users to withdraw water easily.
- **Solid Waste Management:** Many open containers can be found at the sites of garbage dumps, and thus all vector control policies should promote environmentally sound waste management, especially focusing on such aspects as “reduce, reuse, recycle.” Used tires provide a favorite hatching area for mosquitoes, and thus special efforts should be made to reduce their vector-breeding potential, such as cutting, shredding or chipping them into smaller fragments.
- **Sanitation Systems:** Every effort should be made to ensure that sanitation facilities do not promote an increased population of disease-bearing vectors.

(ii) Environmental Manipulation:

Temporary changes to disease-bearing vector habitat as a result of planned activity to produce conditions unfavorable to vector breeding include:

- **Chemical Application:** Although the use of insecticides for prevention and control of vector borne disease is strongly discouraged, since it ultimately results in vector resistance, in severe cases of malarial proliferation it may be necessary to use them in combination with more preventative and sustainable measures.

(iii) Changes in Human Habitation or Behavior:

Efforts to reduce human/vector pathogen contact through education include:

- **Habitat:** Human beings can make many simple changes in their immediate habitat to discourage disease vector production. For example, fences and fence posts made of hollow stems, such as bamboo, may be cut to the node; containers capable of collecting water outside should be covered or stored upside down; ornamental pools and fountains can be chlorinated or populated with larvivorous fish; rice paddies can be drained intermittently to kill mosquito larvae; roof gutters could be periodically drained; and housing evaluated to make sure there are no unscreened openings where vectors can get indoors. In Indonesia for example, malaria transmission rates were drastically reduced when farmers allowed rice paddies to dry out completely during certain periods. Similarly, in Sri Lanka, the breeding of malaria-

33 See Chapter 5: *Vector Surveillance and Control*. Available online at: http://www.who.int/emc/disease/ebola/Denguepublication/048-59.pdf

34 World Health Organization. 1980. *Environmental management for vector control, in Fourth report of the WHO Expert Committee on Vector Biology and Control*. Geneva: WHO.

transmitting mosquitoes was significantly suppressed in small rivers and irrigation canals by regularly flushing them out. [35]

- **Behavior:** Sleeping under bednets can reduce the number of mosquito bites considerably. On the other hand, it was found in India that women who wear long shawls about their bodies were unwittingly storing disease vectors.

E. Recommended Environmental Health Indicators and Benchmarks for Vector-Borne Diseases

Basis for selection:

The primary recommended environmental health indicators and benchmarks assess the incidence of vector-borne diseases in a selected population and among children below the ages of five. Such environmental health indicators provide an overview or snapshot of the severity of different types of vector-borne diseases in a community, especially among vulnerable young children. In addition, three specific vector-borne diseases are selected for priority concern—dengue fever, malaria and schistosomiasis. Such indicators or benchmarks can be developed by obtaining the morbidity and mortality rates of these vector-borne diseases from official public health records of a selected region.

For secondary indicators, emphasis is placed in determining the amount of public health educational and prevention programs that is available in a community. Also, equally important are indicators that assess the availability of vector-borne disease prevention program, such as the number of household use of bednets, and access to preventative public health facilities in a community.

Among tertiary indicators for vector-borne diseases that needs considerable further development is to link them to significant land use changes in a region, such a deforestation rates and wetland management programs, and other infrastructural factors as agricultural irrigation practices and large dam construction projects.

Note: Although environmental factors such as global warming can have a significant impact on spreading the geographic reach of vector-borne diseases, it is ultimately changes in human behavior influenced through widespread public health educational and prevention programs that will make the greatest contributions in halting transmission of vector-borne diseases, since mosquitoes and other parasitic organisms already exist in tropical regions and have proven capable of adapting to new habitats at higher latitudes.

Summary of Recommended Indicators and Benchmarks:

(i) Primary Indicators

- Percent of Population with Vector-Borne Diseases
- Percent of Children below five years with Vector-Borne Diseases
- Dengue Fever: Morbidity and Mortality Rates
- Malaria: Morbidity and Mortality Rates
- Schistosomiasis: Morbidity and Mortality Rates

(ii) Secondary Indicators

- Educational Indicators: e.g., Number of Public Health Educational Programs
- Prevention Indicators: e.g., Number of Programs to Limit Potential Breeding Habitats
- Percent of Household with Bednets in a Region
- Percent of Population with Access to Preventive Public Health Facilities

(iii) Tertiary Indicators

- Land Use Changes: Deforestation Rates, Wetland Management, Irrigation Practices, Dam Constructions.

(iv) Modifying Factors

- Population Density: Rate of Urban Growth
- Climate Type: Rainfall Patterns, Temperature Ranges

35 UNEP, UNICEF, WHO. 2002. *Children in the New Millenium: Environmental Impact on Health*. New York: United Nations Environment Program (UNEP), United Nations Children's Fund (UNICEF), World Health Organization (WHO).

Chapter VIII: Food Security and Safety

A. Overview

Having secure access to safe, affordable, and nutritious food is one of the most fundamental requirements of survival of a community, and thus constitutes a basic human right. It is the responsibility of governmental institutions to ensure that all people have access to adequate food. The right to food consists of two primary aspects: first, ensuring all inhabitants have enough food to meet their basic daily needs, commonly referred to as food security; and second, ensuring that all inhabitants are protected from harmful and unsafe food, referred to as food safety.

B. Food Security: Causes of Food Scarcity

Food security can be defined as access to ample and nutritious food at all times which provides enough nourishment for an active and healthy life. [36] Food security is primarily an issue of distribution. Today some 800 million of the world's population—about 200 million of them young children—suffer from hunger and chronic malnutrition. [37] In many developing regions, it is estimated that over half of all child mortality is caused by malnutrition. [38] The cycle of hunger and infection that leads to vulnerable immune systems is often responsible for this. In these instances, even if children are adequately fed they may not be able to absorb nutrients adequately due to water-borne diseases like diarrhea and other parasitic infections such as hookworm, roundworm, and whipworm. In this way, issues of food security like malnutrition are inseparable from water safety and sanitation concerns.

In the past, when more food was needed, more land was simply cleared away to allow the development of new farming areas. In many areas throughout the world today, this is no longer an option. A large majority of the world's most suitable agricultural land is already in use, and even if remaining forests, wetlands or grasslands were converted to farmland, the net gain from the marginal quality of these cleared areas would not match the productive loss of such natural ecosystems.

Food insecurity is a problem not so much of the quantity of food available but of its patterns of distribution – there is sufficient food available to feed to world's population, it is simply not distributed among those that need it most. Lack of food can generally be related to combination of three factors: (a) lack of adequate resources; (b) lack of proper land management strategies; and (c) lack of adequate distribution. While lack of adequate resources and lack of proper land management are problems confronted locally, lack of adequate distribution is most commonly experienced at the global scale.

(i) Lack of Resources: Lack of adequate resources essential for agriculture is a problem experienced by more and more communities. Many areas simply are not endowed with the natural resources necessary to farm successfully, with minimal availability of arable land and/or water. Some areas have used resources they originally possessed to the point of near depletion. In the case of water use, this is especially true – water availability is one of the single, most important factors associated with food security issues. If an area has no water, it will have no food. Yet it is also difficult for most areas of the world to acquire water from outside sources. Many regions of the world have resorted to farming in areas where nature never intended the use of a plow or a cultivator. For instance, mountainous farm plots, besides having characteristically rocky, infertile soils, are often prone to mass amounts of severe erosion once trees and shrubberies are removed that formerly provided soil stabilization in hilly areas. Air pollutants, such as acid aerosols and photochemical oxidants, can also adversely affect crop yields, in addition to other atmospheric factors related to local weather and climate variability.

(ii) Poor Management Strategies: Land and irrigation water in agricultural regions are often managed in highly unsustainable manners with a focus on short term production, which inevitably leads to dangerously low crop yields in the long run. Throughout the 1960s and 70s, the easiest and fastest way to increase crop yields was by increasing irrigation and through excessive use of pesticides and fertilizers. Yet such procedures have already been practiced to exhaustion, leaving many areas drained of nutrients and unable produce a healthy crop yield. Faulty water management can lead to waterlogged soils, depriving crops of much needed oxygen that results in salinization, as well as soil erosion. About two-thirds of soil erosion is caused by water washing away fertile topsoil; the remaining

36 Please refer to: http://www.childstats.gov/ac2000/ccontxt.asp

37 WRI, UNEP, UNDP, World Bank. 1998-99. *World Resources: A Guide to the Global Environment, Environmental Change and Human Health*. New York: World Resources Institute (WRI), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), and World Bank.

38 Bartlett, Hart, Satterthwaite, de la Barra, and Missair. 1999. *Cities for Children: Children's Rights, Poverty, and Urban Management*. London: Earthscan Publications Ltd.

one third is attributed to wind erosion. [39] Farmland can also be degraded in other ways, such as through mechanical tilling, repeated cropping without sufficient fallow periods, and the replacement of nutrients with manure or fertilizer, which actually ends up depleting soil nutrients. Meanwhile, the over-application of pesticides kills beneficial organisms, not to mention being toxic to humans and other biological species.

(iii) Distributional Inequities: More commonly, food scarcity results not from limited food supply, but from lack of access to the available food supply, and often is a logistical or market-driven problem of inequitable food distribution. The International Fund for Agricultural Development (IFAD) observes in its mission statement that the causes of food insecurity and famine were "…not so much from failures in production, but structural problems relating to poverty and the fact that a majority of the developing world's poor population was concentrated in rural areas." [40] Global markets and increasingly internationalized systems of trade render the food distribution problem much more complex. The present global market is dominated by a few large national economies, which makes it difficult for smaller developing nations to compete in already highly specialized markets. Thus, developing countries' requirements to integrate into the global economy is acquired by devoting their arable lands to high-value export products, (i.e. "cash crops"), rather than cultivating basic food crops needed for local populations. [41] In addition, many cash crops, such as cotton and tobacco, require large amounts of water. Moreover, such agricultural uses, using large quantities of synthetic fertilizers and pesticides, significantly degrade the environment, while providing no nutritious food value to the general public.

Quite often, national governments involved in such export trade practices find that they lack sufficient capital to import basic food crops to feed their own people. Thus, it is possible for a net surplus of food to exist on a global scale while millions of people at the regional or local scale may experience famine-like conditions, unable to obtain basic foodstuffs. Such "market failure" in food commodities occurs when little or no food is available within a market system to feed hungry people in dire need. For example, food may be produced for export-market only or is out of the price range of most poor people in rural areas. Thus, food access should be examined at the market-level, i.e. access to land and food, and not simply in terms of crop failure or increasing population because all agricultural activities (except subsistence agriculture) occur through an exchange of cash or labor. Large-scale famines can no longer be seen as lack of food but the result of complex interaction of societal forces pitted against the need to conserve natural resources and to maintain a clean and sustainable environment. Thus, during times of agricultural crisis, no social or economic basis exists to expect market-driven systems to provide sufficient food for people—if people can't afford to pay for food, the current market system will not be able to provide it, no matter how dire the circumstances. [42]

Health Impacts of Pesticides and Agricultural Chemicals [43]

Although there are many different pesticide products available in today's marketplace, their major uses generally fall under the following categories: insecticides, rodenticides, herbicides, fungicides and antimicrobials that are employed to control insects, rodents, weeds, fungi, and bacteria/viruses, respectively. Other minor categories of uses include chemical agents that control algae, mites, nematodes, insect eggs, or those that disrupt insect mating behavior (pheromones), or inhibit insect or plant growth. Chemical substances that are active ingredients of pesticide products are divided into the following categories: (a) organo-chlorine compounds, such as DDT, aldrin, endrin, and lindane, which have relatively low acute toxicity, but are often found to be cancer-causing substances that bioaccumulate in the environment (as persistent organic pollutants), (b) organophosphate compounds, such as malathion, parathion, methylparathion, which generally possess high acute toxicity as nerve agents (as chemical inhibitors of nerve transmissions), but do not appear to pose cancer risks and are much more biodegradable, (c) carbamate compounds, such as carbaryl, carbofuran, thiodicarb, which generally have high acute toxicity and may pose cancer risks, but do not as a rule bioaccumulate in the environment, (d) metal-based compounds, such as arsenic, copper, zinc, mercury, lead oxides and their salts, that have the acute and chronic toxicological profiles associated with heavy metals.

39 WRI, UNEP, UNDP, World Bank. 1998-99. *World Resources: A Guide to the Global Environment, Environmental Change and Human Health*. New York: World Resources Institute (WRI), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), and World Bank.

40 Please refer to International Fund for Agricultural Development's missions statement: http://www.ifad.org/sf/mission.htm

41 International Institute for Sustainable Development http://iisd1.iisd.ca/pcdf/1996/81quizon.htm

42 Vogel, C. and J. Smith, 2002. *Politics of Scarcity. South African Journal of Science* 98: 7-8 p.315

43 Excerpted from: Ahmed, A. Karim. *op. cit.*

At present, large volumes of chemical pesticides are produced and sold globally for agricultural production, forest management and household use. It is estimated that worldwide industrial sales of pesticides were about $33 billion in 1996, while the export of pesticide products from developed to developing countries continues to increase substantially each year. However, the volume of discarded and obsolete pesticide products in many developing regions has skyrocketed in recent years. These include such non-biodegradable organo-chlorine pesticides (such as aldrin, dieldrin, DDT, endrin, HCH, lindane) and the acutely toxic organophosphate pesticides (such as malathion and parathion). The UN's Food and Agriculture Organization has likened the current situation to a "time bomb" and has urgently called upon industry and governments to increase the pace of clean-up of contaminated storage sites. Several hundred thousand metric tons of banned or unwanted pesticides are now stockpiled in waste storage sites around the world awaiting proper treatment and disposal.

Throughout the 1970s and 1980s, while industrialized countries in North America and Europe began to impose stricter controls on their domestic production, use and disposal of toxic substances, pesticides and hazardous wastes, there was a dramatic increase in the export of banned and severely restricted products from developed to developing regions of the world. This led the international community to adopt a series of agreements and conventions that provided voluntary guidelines and regulatory procedures to control the global shipment of toxic substances and hazardous wastes. In 1995, the International Code of Conduct on the Distribution and Use of Pesticides was adopted by the Food and Agriculture Organization (FAO), followed in 1987 by the enactment of the London Guidelines for the Exchange of Information on Chemicals in International Trade by the United Nations Environment Programme (UNEP).

In 1989, an international regulatory procedure, called the Prior Informed Consent (PIC) was adopted to help control the importation of banned or severely restricted products into developing countries, to be jointly implemented by UNEP and FAO. Under PIC, officials in importing countries are required to be informed by the exporter about the toxicological characteristics and regulatory status of potentially hazardous chemicals before shipment of the product to their region. In 1998, the Rotterdam Convention was adopted, extending the PIC regulatory procedure to hazardous pesticide products on the list of toxic substances requiring prior informed consent. The Rotterdam Convention provides legally binding assurances that all shipments of dangerous chemicals and pesticides be subject to authorization by importing countries, including provisions for obtaining adequate product labeling and toxicological information on imported goods

In recent years, a considerable amount of regulatory attention in developed countries has been placed in preventing and controlling health risks associated with carcinogenic or mutagenic (i.e., genetic or developmental) impacts of toxic substances, since their chronic effects are not immediately manifested because of their long latency periods or over a multi-generational time frame. This includes assessing health risks from trace amounts of cancer-causing substances found in air, water, soil, food and other consumer products. Thus, regulatory agencies in many developed countries have established fairly stringent health safety standards for potentially carcinogenic substances. Many of these toxic chemicals are persistent organic pollutants (POPs), such as those found in a number of widely used pesticides and chlorinated hydrocarbons. The major characteristic of POPs is their long-term chemical stability, i.e., they do not break down to form less toxic chemical substances in the environment. Moreover, POPs as a class of compounds do not readily dissolve in water. Thus, they tend to bioconcentrate in the food chain, especially in the fatty tissues of fish and livestocks, posing serious health risks to human populations. Under the recently signed international agreement, the Stockholm Convention on Persistent Organic Pollutants (POPs Treaty), which was adopted in December 2000 in Johannesburg, the following 12 chemicals are to be phased out and eliminated: polychlorinated biphenyls (PCBs), dioxins and furans, aldrin, dieldrin, DDT, endrin, chlordane, hexachlorobenzene, mirex, toxaphene and heptaclor.

More recently, another class of toxic substances, known as endocrine disrupters, has been brought to the attention of regulatory agencies in developed countries for its potentially severe long-term impact on both animals and human populations. These toxic substances contain organo-chlorine pesticides, polychlorinated biphenyls, dioxins and furans, and a number of plant-based and synthetic estrogens. By interfering with the endocrine system, these estrogen-mimicking compounds have been associated with developmental disorders and reproductive failures in wildlife animal and fish species, stunting their normal growth and their ability to produce healthy offspring. While the toxicological impact of endocrine disruptors on human populations has not been thoroughly determined, preliminary studies have shown significant declines in the male sperm production in the past few decades. In addition, some researchers believe that recent increases in breast, testicular and prostate cancer, along with increased behavioral disorders in children in many developed countries, may be associated with long-term, chronic exposure to endocrine disruptors, which are found in

trace amounts in many fresh water sources and food products. At present, a number of multilateral agencies (for example. WHO, Organization for Economic Cooperation and Development (OECD)), and national regulatory agencies (including U.S. Environmental Protection Agency, the U.S. Department of Agriculture, and Environment Canada) have embarked on a concerted effort to assess the potentially serious harmful effects of endocrine disruptors on human populations.

C. Food Safety Guidelines

The enormous volume of the world food trade is valued at between US$300 billion and $400 billion. A common concern of many national governments is that food imported from other countries should be safe and not jeopardize the health of consumers or pose a threat to the health and safety of their animal and plant populations. Reliable access to nutritious food can mean nothing if the food itself is unsuitable for consumption or dangerous to human health. It is generally assumed that most causes of food safety are a result of environmental contaminants or chemical residues found on the food, such as pesticides and other synthetic agents. In many regions of the world, however, the impacts of improper food handling and lack of hygiene, which results in harmful bacteria and other microbial agents such as protozoa, parasites, viruses, and fungi or their toxins, that is the most frequent cause behind food borne diseases. Other factors affecting food safety include antibiotic resistance to certain pathogens; the use of genetically modified organism (GMO) that could potentially transfer human allergens and lead to antibiotic resistance; and organically-raised foods that contain no chemical preservatives and may be more perishable. [44]

International legal instruments, such as a set of codes, have been developed for protecting the health of consumers against food-borne hazards. The Codex Alimentarius is the international food guideline that has been in place since 1963 to ensure food safety worldwide. Jointly administered by the FAO and WHO, the Codex's mission is to provide internationally accepted, scientifically based food safety guidelines in order to maintain and protect public health. The Codex Alimentarius serves as the basis for many national food standards around the world, since it has set global standards for pesticide and veterinary drug residues, additives, food imports, inspections, and food sampling methods, among other items. [45] The Codex guidelines are considered scientifically justified and is accepted as the benchmarks against which national measures and regulations are generally taken. [46]

D. Recommended Environmental Health Indicators and Benchmarks for Food Security and Safety

Basis for Selection:

For primary environmental health indicators, emphasis is placed on determining the extent of malnourished individuals in the general population and among young children in a community, such as the incidence of caloric and protein deficiencies, and the incidence of nutritionally insufficient intake of essential minerals and vitamins. As an important corollary to these primary indicators and benchmarks, efforts should be made to assess the availability in a community with high incidence of malnutrition of key low-cost mineral and vitamin supplements, which may differ from region to region due to geographical factors, such as iodine deficient soil, and other socio-economic considerations. Another important environmental health indicator is the determination of the percent of food commodities, such as raw fruits and vegetables that have detectable levels of toxic pesticide residues or have bacterial and/or fungal contamination.

Among the secondary environmental health indicators recommended are developing a quantitative inventory of the types and amounts (per hectare) of acutely or chronically toxic pesticides used in food production in a farming community, including determining the per capita use of highly toxic pesticides, such as chlorinated hydrocarbons, organic phosphates and carbamates, in a given agricultural region. These secondary indicators and benchmarks provide an indirect measure of potential health-related problems in many agricultural areas of developing regions, such as those linked to acute poisonings and accidental deaths in adults and young children, enhanced rates of teenage suicides (from self-induced abuse) and other chronic diseases, such as increased incidence of developmental diseases, respiratory disorders and different forms of cancer. A more direct measure of agricultural chemical impacts on the health and welfare of infants and young children is determining the prevalence of blue-baby syndrome in a

44 FAO Food Quality and Safety http://www.fao.org

45 Guidelines can be found at: http://www.codexalimentarius.net/standard_list.asp

46 *Understanding the Codex Alimentarius* http://www.fao.org/docrep/w9114e/W9114e01.htm#TopOfPage

farming community, which is caused by ingesting contaminated drinking water that results from excessive nitrate (e.g., animal manure) and commercial fertilizer runoffs into surface and groundwater sources.

Finally, it is important to determine the extent of sustainable agricultural practices that are being carried out in a region. For these purposes, tertiary indicators and benchmarks should be developed that assesses the percent of food crops grown in a farming community that do not use pesticides, synthetic fertilizers or other types of agricultural chemicals. Another environmental health indicator or benchmark would be determining the percent of farmers that use integrated pest management (IPM) techniques on their land, in which pesticides and other agricultural chemicals are only used as a last resort, while biological means of control and non-chemical methods are the principal mode of suppressing harmful insect and weed populations.

Summary of Recommended Indicators and Benchmarks:

(i) Primary Indicators

- Incidence of Malnutrition in Population/Children: Calorie/Protein Deficiencies
- Incidence of Malnutrition in Population/Children: Essential Mineral/Other Nutrient Deficiencies
- Incidence of Malnutrition in Population/Children: Vitamin Deficiencies
- Percent of Population with Access to Key Low-Cost Mineral and Vitamin Supplements
- Percent of Food Products with Detectable Levels of Toxic Pesticide Residues
- Percent of Bacterial and Fugally Infected Food Products

(ii) Secondary Indicators

- Types and Amounts of Acutely/Chronically Toxic Pesticides Used on Farm Land Under Cultivation—
- Per Capita Use of Highly Toxic Pesticides in Agricultural Production in a Region—Chlorinated Hydrocarbons, Organophosphates and Carbamates
- Nitrate and Commercial Fertilizer Contamination in Drinking Water: Incidence of Blue-Baby Syndrome in a Region

(iii) Tertiary Indicators

Implementation of Sustainable Agricultural Methods:

- Percent of Crops Not Using Chemical Pesticides
- Percent of Crops Not Using Synthetic Fertilizers
- Percent of Crops Using Integrated Pest Management (IPM)

(iii) Modifying Factors

- Geographic Location
- Climate Type: Rainfall Patterns and Temperature

Appendices

Appendix I: Environmental Protection and Public Health—Major International Documents[47]

Brundtland Commission Report

As a matter of fundamental human right, the importance of environmental protection and public health in the context of sustainable development was first clearly enunciated in the 1987 Brundtland Commission Report ("Our Common Future"). It defined the concept of sustainable development as follows: "Humanity has the ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."

The Brundtland Commission also included a set of General Principles, Rights and Responsibilities for achieving environmental protection and sustainable development. Its broad first principle of human rights was presented as follows: "All human beings have the fundamental right to an environment adequate for their health and well-being."

Agenda 21, Rio Declaration and the World Summit on Sustainable Development

Since the initial publication of the Brundtland Commission Report, global population has increased from 5.0 billion in 1987 to over 6.2 billion in mid-2002, with current estimates of 9 billion people living on earth in 2050. This unprecedented population growth has placed an immense strain on human communities and natural ecosystems around the world. This is especially true in developing countries, where many of its inhabitants continue to reside in abject poverty, where they lack life's basic needs and amenities, such as adequate shelter and food, clean drinking water, unpolluted air, proper sanitation facilities or access to primary health care.

At the United Nations Conference on Environment and Development (UNCED, also known as the "Earth Summit") held in Rio de Janeiro in June 1992, some 178 countries adopted Agenda 21, the centerpiece report of UNCED, which enunciated a detailed road map for achieving a more ecologically sound and economically sustainable future. In its preamble, Agenda 21 stated that "integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own, but together we can—in a global partnership for sustainable development."

In the Rio Declaration on Environment and Development, which was also adopted at the 1992 UNCED meeting, representatives from developed and developing countries recognized the right to a clean and healthy environment as an overarching human entitlement: "Principle 1: Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."

In addition, the Rio Declaration explicitly affirmed the rights of indigenous communities in managing their environment in order to preserve their "identity, culture and interests and their effective participation in the achievement of sustainable development" (*Article 22*), and for the protection of the "environment and natural resources of people under oppression, domination and occupation" (*Article 23*).

The UN's World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in August-September, 2002, stated in its Plan of Implementation (in Paragraph 5) that "Peace, security, stability and respect for human rights and fundamental freedoms, including the right to development, as well as respect for cultural diversity, are essential for achieving sustainable development and ensuring that sustainable development benefits all."

I-B. Environmental Protection and Public Health: Major International Treaties and Conventions

- During the past decade, the international community has adopted a series of agreements and conventions that provide regulatory procedures and guidelines to control the global export and shipment of toxic substances and hazardous wastes. In 1995, the International Code of Conduct on the Distribution and Use of Pesticides was adopted by the Food and Agriculture Organization (FAO),

47 Excerpted from: Ahmed, A. Karim. *op. cit.*

followed in 1987 by the enactment of the London Guidelines for the Exchange of Information on Chemicals in International Trade by the United Nations Environment Programme (UNEP).

- In 1989, an international agreement, known as Prior Informed Consent (PIC) (later extended by the Rotterdam Convention in 1998) was adopted to help control the importation of banned or severely restricted products into developing countries. Under PIC, officials in importing countries must be informed by the exporter about the toxicological characteristics and regulatory status of potentially hazardous chemicals before shipment of the product to their region.
- Discarded agricultural chemicals, unused toxic pesticides and hazardous wastes are generally recognized as requiring legal restrictions or regulatory oversight in their international shipments or transfers. Over one hundred countries have banned or severely restricted the import of hazardous materials. However, some developing countries, especially in Asia and Africa, have found an economic niche in importing hazardous wastes from developed nations. The Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal offers a system by which to regulate transport and disposal of such wastes, but also encourages waste minimization and the implementation of sound environmental management policy.
- A class of toxic chemicals, known as persistent organic pollutants (POPs), is made up of long-lasting, non-biodegradable organic compounds that bioconcentrate in the food chain, posing serious health risks to human populations. The international community recently signed a landmark agreement, the Stockholm Convention on Persistent Organic Pollutants (POPs Treaty), which was adopted with considerable worldwide publicity in December 2000 in Johannesburg. Under the POPs Treaty, the following chemicals are to be globally phased out: polychlorinated biphenyls (PCBs), dioxins and furans, aldrin, dieldrin, DDT, endrin, chlordane, hexachlorobenzene, mirex, toxaphene and heptachlor.
- Global climate change exacerbated by anthropogenic activity may bring about severe weather events and drastic changes in land-use patterns in many regions of the world, leading to a number of significant environmental and public health impacts. The impact of global warming on human communities has several short-term and long-term local and regional environmental consequences. Based on these concerns, the international community drafted the Kyoto Protocol to the United Nations Framework Convention on Climate Change in 1998. The Kyoto Protocol calls on ratifying states to reduce atmospheric emissions of greenhouse gases linked to global warming through nationally based emission-reductions program and the creation of international mechanisms for trading emission credits and for providing technical assistance to developing countries.
- In the mid-1980s, the growing worldwide consensus between research scientists and policy makers that earth's protective stratospheric ozone was being depleted led to the adoption of the landmark Montreal Protocol on Substances that Deplete the Ozone Layer in 1987, along with a number of modifying amendments in the 1990s. The Montreal Protocol has led to a worldwide phase out of stratospheric ozone-depleting substances, including chlorofluorocarbons (CFCs) and other halocarbon compounds.
- Global concerns about the rapid rate of loss and extinction of biological species led to the adoption of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in March 1973. The international agreement required the listing of "all species threatened with extinction which are or may be affected by trade. Trade in specimens of these species must be subject to particularly strict regulation in order not to endanger further their survival and must only be authorized in exceptional circumstances."
- To preserve and equitably share the genetic resource base of earth's biological diversity, the international community signed the Convention on Biodiversity at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. This international agreement on biodiversity describes its main objectives as: ". . . the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies . . ."

Appendix II: Atmospheric Pollutants and Air Quality Standards [48]

Air pollution was recognized as a major public health problem in the 1940s and 1950s when large numbers of individuals in industrial or urban centers in North America and Europe became seriously ill or died from exposure to a variety of toxic air pollutants that were emitted from manufacturing and domestic sources. In 1948, a severe air pollution episode occurred in a small steel mill town of Donora, Pennsylvania (on the outskirts of Pittsburgh), which resulted in acute respiratory illnesses among a large fraction of the population and in the deaths of scores of inhabitants. In 1952, an estimated 4,000 deaths were attributed to the dense "killer fog" that blanketed London, England for several days, most of it caused by emissions from numerous commercial and residential fossil fuel combustion sources within the city.

Since these well-publicized air pollution episodes, many developed countries have adopted stringent air quality standards to safeguard the public from the most commonly occurring and widespread airborne pollutants. These include sulfur dioxide, nitrogen dioxide, particulate matter, carbon monoxide, ground-level ozone (photochemical oxidants) and lead. In the United States, under its air quality regulatory framework, these commonly found airborne gaseous substances and particles are collectively known as "criteria air pollutants", to distinguish them from other atmospheric pollutants that are found in specific industrial or urban locations. Other non-criteria or "toxic air pollutants", which are present at high concentration levels in specific regions, consist of heavy metals (cadmium, chromium, mercury, etc) volatile organic compounds (VOCs, such as benzene, methylene chloride, perchloroethylene, etc) and other toxic airborne substances (asbestos, pesticide vapors, etc.).

Criteria Air Pollutants

As mentioned above, the class of air pollutants known as "criteria air pollutants", which are ubiquitous and commonly found in the atmosphere in almost all regions of the globe, are airborne substances that have adverse acute and/or chronic impacts on human health. The emission sources, physical-chemical characteristics and human health effects of each of the criteria air pollutants are discussed below.

Sulfur Dioxide

As one of the most common and ubiquitous air pollutants that originate from industrial, commercial and residential sources, sulfur dioxide (SO2) is formed by the combustion of fossil fuels that have high sulfur content, such as certain grades of oil and coal. Sulfur dioxide can be further oxidized to sulfur trioxide (SO3), which rapidly reacts with atmospheric water vapor to form airborne sulfuric acid (H2SO4). The formation of sulfuric acid results in the secondary formation of acid aerosols, which is the main cause of acid precipitation (such as acid rain or acid snow) in certain parts of the industrialized world, especially in northeastern United States and Canada and in northern continental Europe and the Scandinavian countries.

Health effects associated with sulfur dioxide exposure include interference with normal breathing, alteration of pulmonary defense mechanisms and the aggravation of existing cardiovascular diseases. These health effects are more pronounced in young children and the elderly, and in those individuals who suffer from asthma, chronic bronchitis and emphysema. Short term exposure to high levels of sulfur dioxide in a population may lead to increased hospitalization and excess incidence of deaths from a variety of respiratory and cardiovascular diseases. Since sulfur dioxide is often secondarily oxidized to acid aerosols, it is difficult at times to separate its overall health effects from those associated with exposure to fine particulate matter that contain hydrated aerosol particles.

While in recent years the concentration of sulfur dioxide has declined in North America and Western Europe, it still remains high in Eastern Europe and in many urban and industrialized centers of Asia and Latin America. For instance, in a number of industrial centers and major cities of India and China, the ambient (i.e., the surrounding atmosphere's) annual average concentration levels of sulfur dioxide are two- to six-fold above the WHO's SO2 air quality guidelines of 50 micrograms per cubic meter. The United States Environmental Protection Agency (USEPA) has established a national ambient air quality standard for sulfur dioxide at an annual arithmetic mean of 80 microgram per cubic meter, along with short term air quality standards for 24-hour and 3-hour averages (365 and 1,300 micrograms per cubic meter, respectively.)

48 Excerpted from: Ahmed, A. Karim. *op. cit.*

Particulate Matter

Traditionally, particulate matter as a criteria air pollutant was considered as a dispersed mixture of: (a) the heavier, coarse-sized solid or liquid particles that are derived mainly from naturally occurring sources, such as wind-blown dust, sea sprays, plant particles, etc., and (b) the lighter, fine particulate fraction, which is principally a product of human activity, such as industrial processing and fossil fuel combustion. Generally speaking, fine particles have aerodynamic diameters less than 2.5 micrometers in size (approximately, 1/30th the size of a human hair) and remain in the atmosphere for relatively long periods of time and are transported over long distances, while airborne solid matter or liquid droplets above 5 to 10 micrometers in diameter quickly settle out by gravitational sedimentation near the emission source.

Fine particles constitute the most respirable and harmful fraction of atmospheric particulate matter, since they are small enough to evade the respiratory system's clearance mechanism for removing coarser particles, allowing them to penetrate and deposit into the deeper (alveolar) regions of the lung. Fine particles consist of a variety of toxic vapors, liquids and gases that are either absorbed on solid particulate surfaces or are embedded in liquid aerosols. Thus, they contain a mixture of heavy metal ions, hazardous organic vapors and acid aerosols, with the relative proportions of these chemical substances varying from region to region. For instance, in areas that are downwind from electric power generating plants and metallic ore processing operations, atmospheric fine particles generally contains a higher proportion of sulfuric and nitric acids, formed by the secondary oxidation and hydration of sulfur dioxide and nitrogen dioxide.

A large body of scientific studies has shown the linkage between fine particulate matter exposure and a variety of respiratory diseases, including shortness of breath, bronchitis, asthma and premature deaths. Young children, who breathe 50% more air per body weight than an adult, are especially vulnerable to the environmental impacts of particulate matter. Several acute and chronic respiratory illnesses, including childhood asthma, have been attributed to exposure to fine particles. High levels of atmospheric fine particles also seriously affect the elderly, particularly those with immune system deficiencies or those who have underlying respiratory or cardiovascular diseases.

Until ten or fifteen years ago, most countries only used a total suspended particle (TSP) air quality standard to regulate the levels of atmospheric particulate matter. Unfortunately, the use of TSP to monitor the level of atmospheric fine particles had been demonstrated to be misleading, especially in regions of the world where there were high levels of naturally occurring coarser particles, such as windblown dust or sea sprays. In recent years, a number of regulatory agencies have moved to adopt new health-based air quality standards on particulate matter. For example, the U.S. Environmental Protection Agency in 1987 revoked its TSP standard and enacted instead a PM10 national ambient air quality standard (at an annual arithmetic mean of 50 micrograms per cubic meter), which required specific monitoring of particulate matter below 10 micrometers in diameter.

In 1997, to provide additional protection of the general population, the USEPA proposed a fine particulate matter national ambient air quality standard of PM2.5 (at an annual arithmetic mean of 15 micrograms per cubic meter), whereby the air monitoring of fine particles below 2.5 micrometer was required. This is based on recognition by the public health community that current particulate matter standards (TSP or PM10) are not sufficiently protective of human health. Moreover, the USEPA has issued a short-term PM10 air quality standard (at a 24-hour average of 150 micrograms per cubic meter) and proposed a short-term PM2.5 air quality standard (at a 24-hour average of 65 micrograms per cubic meter). At present, both WHO and the European Commission are reviewing the replacement of TSP air quality guidelines by establishing a health-based fine particle guideline and recommending a monitoring system of using PM10 and/or PM2.5 as appropriate public health yardsticks.

Nitrogen Dioxide

Nitrogen dioxide (NO2) is a gaseous compound, which is an oxidation by-product of naturally occurring atmospheric nitrogen and oxygen, formed during high temperature combustion processes. Thus, it is a result of a variety of industrial, commercial and residential activities, such as production of steam in electric power generating and manufacturing plants and the use of gasoline products in internal combustion engines of motor vehicles. Since nitrogen dioxide is a dark colored gas, its presence at high levels in the atmosphere is often noted in industrial and urban areas by the familiar brown haze that tends to hover over the region. During the combustion process, nitrogen dioxide is initially formed from its precursor compound, nitrogen oxide (NO), and therefore it is often found in a mixture of various oxidized states of the compound, known collectively as nitrogen oxides (NOx). Further chemical oxidation and hydration of nitrogen oxide compounds produces atmospheric nitric acid (HNO3), which is a major

aerosolized component (droplets of air/liquid mixtures) of particulate matter that form acid precipitation in a number of regions of the world.

The environmental impact of nitrogen dioxide on human health may be viewed both directly and indirectly. At relatively high concentrations, nitrogen dioxide causes direct acute effects on respiratory tracts and mucous membranes of both adults and children, such as nose, throat and eye irritations. However, its main long-term health impacts are largely indirect, since it participates in the formation of ground level photochemical smog by reacting with volatile organic compounds, and in the formation of highly corrosive nitric acid, which then becomes part of the fine particulate fraction in the atmosphere. At present, the WHO health-based air quality guideline for nitrogen dioxide is 40 micrograms per cubic meter (annual average), while the USEPA has established an annual (arithmetic mean) average of 100 micrograms per cubic meter as its national ambient air quality standard for nitrogen dioxide.

Ozone (Photochemical Oxidants)

As a gaseous substance, ozone (O3) contains three atoms of oxygen (arranged in an unstable, ring structure) and is a highly reactive chemical compound found in the atmospheric smog of many regions of the world. In the stratosphere (a region some 10 to 30 miles above the earth's surface), ozone is found as a naturally occurring substance that forms a protective layer against the sun's harmful ultraviolet radiation. However, in the lower atmosphere at the earth's surface, ozone—along with other photochemical oxidants—are a product of a number of anthropogenic activities. They are formed by photochemical oxidation (i.e., atmospheric chemical reactions that are catalyzed by sunlight) of a variety of airborne compounds, such as: (a) hydrocarbon gases that are emitted from power plants, oil refineries, chemical plants, motor vehicles, etc, and (b) nitrogen oxides that are produced from similar industrial and residential sources. While there are many different kinds of reactive chemical substances found in smog, ozone is generally chosen as a surrogate measure of the levels of photochemical oxidants in the lower atmosphere.

At a general rule, atmospheric ozone levels reach their highest concentration during daytime hours and during the summer months when sunlight is at its brightest. High levels of ambient ozone concentration in a community have been correlated with increased incidence of respiratory illnesses and elevated hospital admission rates. Short-term exposure to elevated levels of ozone causes upper respiratory tract irritation and uncomfortable chest distress that may last for several hours. Increased ozone levels may interfere with overall lung function, especially among athletes and those who work outdoors. High levels of ozone may increase the incidence of asthma in a population and may make individuals more susceptible to a variety of allergens, such as exposure to dust mites, cockroaches, pets, fungus, pollen, etc. Other health impacts of ozone include long-term damage to lung linings and the aggravation of other lung diseases, such as chronic bronchitis and emphysema. It is believed that repeated short-term exposure to elevated levels of ozone and other photochemical oxidants may lead to permanent health damage, especially among young children whose lungs are still not fully developed.

At present, the WHO air quality guideline on ozone is 120 micrograms per cubic meter for an 8-hour exposure period. The USEPA has adopted 1-hour average at 235 micrograms per cubic meter (0.12 ppm) as its national ambient air quality standard for ozone. In recent years, the U.S. EPA has also proposed an 8-hour average of 157 micrograms per cubic meter (0.08 ppm) as an additional national ambient air quality standard for ozone.

Carbon Monoxide

Carbon monoxide (CO) is a highly toxic, colorless and odorless gas. It is principally formed as an incomplete combustion product of carbon-based sources (gasoline and diesel fuels) used in motor vehicles. In many urban environments, as much as 95% of carbon monoxide present in the atmosphere comes from motor vehicle exhausts. Thus, its atmospheric concentration levels are especially high in heavily used roadways and during morning and evening rush hours. Other significant emission sources of carbon monoxide are the boilers and incinerators employed in industrial and fuel combustion processes.

Over the years, the health impacts of carbon monoxide have been well characterized. Carbon monoxide enters the bloodstream through inhalation and reduces the amount of oxygen that is delivered to organs and tissues of the body. Physiologically, carbon monoxide binds to hemoglobin (Hb), an oxygen-binding protein found in the bloodstream, by displacing oxygen to form carboxyhemoglobin (Hb-CO). Thus, carbon monoxide decreases the ability of hemoglobin to carry fresh, inhaled oxygen to other parts of the body. Exposure to elevated levels of carbon monoxide may therefore affect capacity to work, impair manual dexterity, reduce learning ability and cause visual impairment.

In addition, acute health effects of carbon monoxide exposure at even moderate amounts may be serious to individuals with underlying cardiovascular diseases.

WHO has recommended several health-based short-term air quality guidelines for carbon monoxide – at 10, 30, 60 and 100 milligrams per cubic meter for 8-hour, 1-hour, 30-minute and 15 minute averages, respectively. On the other hand, the U.S.EPA has only two short term national ambient air quality standards for carbon monoxide: 10 and 40 milligrams per cubic meter for 8-hour and 1-hour averages.

Lead

Lead is a naturally occurring metallic substance that has been incorporated into a variety of handicrafts, water pipings, ceramic glazes, household paints and other manufactured products over two or three thousand years. However, its toxic effects on human populations have only been recognized fully in the past 50 to 100 years. Today, lead is present in many old housing structures and contaminated industrial sites, and it continues to be used in many consumer products, such as paints and ceramic glazes. The main source of lead in the atmosphere is exhaust from motor vehicles that employ lead compounds as an antiknock additive in gasoline products. While in recent years lead additives in gasoline have been phased out in many developed countries in North America and Western Europe, it is still being used in many Eastern European countries and in most developing regions of the world.

The health effect of lead has been well documented in both adults and children. Its impacts are especially severe on young children, since it is a neuro-toxic agent that impairs the normal development of the central nervous system. At relatively low exposure levels, lead has been shown to affect the cognitive skills of children – a 10 micrograms per deciliter increase in blood lead level caused a decline of about 2.5 IQ points in lead-exposed children. Chronic lead exposure may also result in decreased growth, hyperactivity and impaired hearing in children. Short-term high levels of lead exposure may cause permanent brain damage in children and on occasion result in death. At present, in many regions of the developing world, blood lead levels in children below five years old continue to exceed 10 micrograms per deciliter, which is the health advisory guideline established by the U.S. Centers for Disease Control and Prevention (USCDC) for safeguarding children from long-term ill effects of lead exposure.

The current WHO health-based air quality guideline for lead is an annual average of 0.5 microgram per cubic meter. The USEPA has adopted a national ambient air quality standard for lead of 1.5 microgram per cubic meter averaged quarterly each year.

Toxic Air Pollutants

Toxic air pollutants are a large and diverse class of hazardous airborne substances that range from heavy metals, volatile organic compounds, and other atmospheric suspended substances, including a number of insecticide and herbicide vapors, inorganic mineral fibers and radionuclides.

Heavy Metals

While a number of toxic heavy metals are found in the atmosphere, their airborne concentration levels vary markedly from region to region. Airborne heavy metals consist of arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc. Heavy metals are emitted into the atmosphere ore smelters, ferrous and non-ferrous industries, coal-fired power plants, metal foundries and a variety of manufacturing facilities. Each heavy metal—and their various compounds—has different physical and chemical properties and thus possesses diverse toxicological characteristics. For instance, both mercury and lead are well known neurotoxic agents, while arsenic, beryllium and chromium VI are potent carcinogens. Exposure to airborne cadmium has been associated with kidney disorders, chronic bronchitis, emphysema and lung cancer. Nickel fumes cause eye and skin irritation and can lead to pneumonia-like symptoms, while chronic exposure to nickel is associated with nasal, throat and lung cancer. On the other hand, low concentration levels of copper, selenium and zinc have important nutritional value to animals and humans, but at higher exposure levels they can exhibit quite toxic effects. Therefore, it is not possible to generalize about the health effects of heavy metals as a group, since their risk profiles are assessed on an individual basis in order to determine their specific toxic impact on human populations.

Volatile Organic Compounds

This group of toxic air pollutants constitutes a vast number of organic chemical substances that range from highly volatile solvents (such as benzene, methylene chloride, perchloroethylene, etc.) to complex polyaromatic compounds (multiple-cyclic organic chemicals, such as dioxins and furans). The chief emission sources of these volatile organic compounds (VOCs) are petroleum refineries, coke ovens, chemical manufacturing and processing plants, motor vehicle exhausts, municipal and hazardous waste incinerators and a number of industrial facilities and commercial outlets, such as tanning factories, dry cleaning establishments and gasoline stations. Short-term exposure to high levels of VOCs may cause headaches, dizziness, nausea and abdominal distress, while long-term chronic exposure may lead to an array of neurological diseases, reproductive failures, developmental abnormalities, genetic damage and cancers.

Other Air Toxics

A number of insecticides and herbicides used in agriculture, forests and domestic settings can remain airborne for considerable periods of time and thus adversely affect animal and human populations that live in proximity to commercial and residential spraying. At present, in many developed countries, a number of non-biological degradable pesticides (such as DDT, aldrin, dieldrin, chlordane, etc) have been phased out for their long-term chronic impact on human populations, while under a new international treaty (the recently signed Persistent Organic Pollutants (POPs) Treaty) a worldwide campaign has been launched to discard the remaining stockpiles of POPs and rapidly phase out the commercial and residential use of these toxic substances.

Another common hazardous airborne substance is asbestos fiber, whose microscopically small aerodynamic diameter allows it to penetrate deeply into the alveolar region of human lungs. In the past, asbestos was used extensively in many commercial and residential applications, mainly as an acoustical and thermal insulator (in floor and ceiling tiles, cement pipes, etc.) and as a fire proofing material in building structures. Over time, asbestos fibers in these buildings became frayed and loose, thus allowing them to become airborne in both the interior and exterior of human dwellings. Chronic exposure to airborne asbestos fibers has been conclusively linked in many occupational health studies to a variety of diseases, including asbestosis (a debilitating respiratory disease), mesothelioma (abdominal carcinoma) and lung cancer .

Finally, certain biologically harmful radionuclides (such as Iodine-131, Cesium-137, Polonium-210, Strontium-90, etc) are released into the atmosphere in trace amounts from nuclear power plants and uranium processing facilities, and in considerably higher amounts during above ground nuclear weapons testing. On the other hand, the radionuclide gas, radon (which is a potential carcinogen) is present in the interior air of buildings and residences in certain geographical regions where it occurs naturally at high concentrations in the underlying soil substratum.

Indoor Air Pollution

Developing Regions

In recent years, there has been a growing recognition that in addition to deteriorating outdoor air quality in many parts of the world, indoor air pollution is a major public health problem, especially in rural populated areas of developing regions. A significant factor here is the almost exclusive reliance of rural populations on traditional forms of energy sources, such as biomass fuels that produce high levels of harmful air pollutants in indoor environments, e.g., gaseous fumes, smoke and fine particulate matter emitted from cooking stoves and other heat producing devices. It is estimated that currently 2 billion people around the world use biomass fuels (such as firewood, dung and crop residues), and other fossil fuel products (such as low grade coal and charcoal), to cook their meals and heat their homes. Recent studies have shown that in developing countries such as India and China, indoor air pollution poses a major risk factor on their national burden of disease. For example, using conservative assumptions of use patterns in the rural sector of India, it was determined that between 400,000 and 550,000 premature deaths annually may be attributed to the use of biomass fuels. Employing the World Bank's disability-adjusted lost life-year (DALY) approach, between 4 and 6 percent of India's burden of disease is linked to the use of biomass fuels in the country. Earlier studies had shown that particulate matter concentration levels (monitored as PM10) of over 2,000 micrograms per cubic meter (averaged over a 24-hour period) were measured in indoor dwellings among the rural population, with short-term PM10 levels rising considerably higher during cooking periods. This should be compared to the annual average atmospheric concentration levels of PM10 ranging between 90 and 600 micrograms

per cubic meter (with a population mean of 200 micrograms per cubic meter) in the outdoor air of many Indian cities and urban areas.

In addition to the use of traditional biomass fuels, coal is still widely used in many regions of Eastern Europe, China and South Africa. While coal products are easier to obtain, transport and store, they are a considerably less clean source of fuel than firewood. For the past twenty years, a number of national and international programs have been initiated to introduce clean fuels and cooking stoves around the world. Since the early 1980s, China has embarked on a major national effort to introduce improved cooking stoves to over 175 million rural households. A similar effort in India, under the aegis of National Programme on Improved Chulhas (cooking stoves), has led to distribution of 30 million improved stoves. Unfortunately, in a follow-up survey, it was found that less than one-third of such stoves were still in use in India. It now appears that many former recipients in rural areas remained unconvinced of the stove's overall energy efficiency and its ability to produce less smoke. The greater success of this approach in China may be attributed to superior program design and implementation, such as better education and training, less bureaucratic interference, with more user involvement in the construction of stoves for convenience, attractiveness and longevity.

Developed Regions

Indoor air pollution has also been recognized as an environmental health problem in many developed countries. Myriad air pollution sources reside in the interiors of buildings and residential homes, including gas-, coal-, wood- and kerosene-based stoves (buildup of carbon monoxide and nitrogen dioxide), building materials (asbestos floor and ceiling tiles), furnishings (volatile chemicals used in carpeting, drapes, upholstery), furniture and paneling (urea-formaldehyde resins used in pressed wood), household products (toxic chemicals used in cleaners, paints, solvents, insect sprays), household allergens (dust mites, molds, mildew, pet and insect residues), humidifiers (use of ultrasonic and impeller units), central heating and cooling systems, second-hand tobacco smoke, and radon gas seepage in residential basements. With buildings and homes now being built with more tightly sealed interiors, acute and chronic exposure to these indoor air pollutants has increased in recent years. This factor coupled with inadequate ventilating systems in the workplace and residential homes has enhanced the potential for serious respiratory illness for adults and children. Practical solutions to these problems include eliminating (where possible) the sources of indoor air pollutants, increasing the dwelling's air exchange rate with the outdoors (opening windows, unblocking air supply vents), cleaning humidifiers and ventilation systems, and installing air-cleaning devices.

A number of physical symptoms and diseases have been associated with indoor air pollution in the working environment of office buildings in developed countries. These include serious illnesses such as asthma, hypersensitivity pneumonitis, humidifier fever and Legionnaire's disease. More often, individuals working or residing in poorly maintained or inadequately ventilated buildings may not manifest any specific pattern of disease, but suffer from a variety of physical symptoms, collectively labeled as the "sick building syndrome". Such persons may experience a variety of different symptoms: headaches; dizziness; nausea; dryness or burning sensation in their eyes, nose or throat; a general sense of lethargy or fatigue; frequent sneezing; stuffy or runny nose; irritability; and forgetfulness. Frequently, these symptoms may affect workers when they enter a building and then dissipates when they leave the premises. WHO has estimated that as many as 30% of new or remodeled buildings today may have occupants who suffer from physical symptoms associated with poor indoor air quality.

Appendix III: Bacterial and Chemical Contaminants in Water—Drinking Water Standards [49]

Infectious and Vector-Borne Diseases

Microbial Diseases in Developing Regions

According to WHO and the US Centers for Disease Control and Prevention (CDC), over 2 billion people, mostly living in developing countries, are at elevated risk to water-related bacterial diseases. While there are many illnesses in this category, the major water-borne diseases include acute dehydrating diarrhea (cholera), abdominal illness (typhoid fever), bacterial enteritis (salmonellosis), acute diarrhea (dysentery) and chronic diarrhea (Brainerd diarrhea). One of the main modes of transmission of these diseases is from drinking bacterially infested water from poorly maintained municipal distribution systems. This happens either as a result of lack of chlorination at the drinking water source or through cross-contamination of the disinfectant-treated piped water by underground sewage wastes. Another mode of microbial infections from water sources occurs through occasional phytoplankton blooms. Such a bloom episode, in which pathogenic bacteria survive and spread widely, was associated with a major cholera outbreak in Bangladesh in 1994.

Proper means to address these water-related environmental health problems in developing regions requires simple point-of-use disinfection methods and availability of clean storage vessels. At present this may be achieved relatively inexpensively in many rural areas by the use sodium hypochlorite as a disinfectant, which is produced from salt water by means of simple electrolytic devices. However, the widespread use of sanitary latrines in rural areas, along with the introduction of sewage treatment systems in urban areas of developing regions, is necessary if long-term solutions to water pollution problems are to be achieved.

Cryptosporidiosis and Giardiasis

In many regions of the world, including the United States, a common water-related diarrheal disease that has been recognized as a major public health problem is cryptosporidiosis, which is caused by a microscopic parasite (Cryptosporidium). This parasite is generally found in drinking water, swimming pools and recreational streams that are contaminated by human fecal wastes. Since Cryptosporidium has a strong protective outer shell, it survives outside the human body for long periods of time, thus making it difficult to destroy by using conventional disinfectants such as chlorine. Additionally, this highly contagious disease can be transmitted by raw, uncooked food or by oral contact of bacterially contaminated objects by young children. For these reasons, thorough washing of hands with soap and water after using the toilet (or changing diapers) and before eating a meal is highly recommended. Furthermore, the importance of restricting the use of inside recreational waters (pools, jacuzzis, hot tubs) and outdoor streams by individuals who have been recently been infected with this bacterial disease needs to be widely communicated to the general public.

Another increasingly common water related diarrheal disease around the world, including the United States, is giardiasis, which is caused by a one-celled microscopic parasite (Giardia). Similar to the spread of cryptosporidium in the environment, giardia is transmitted by discharges of fecal wastes into water, food, soil and other surfaces. Therefore the preventative hygienic measures that are recommended to lower the overall incidence of cryptosporidiosis apply to giardiasis as well.

Malaria

One of the most serious vector-borne diseases in the world today is malaria. It occurs in many warm, tropical regions of the world, such as Central and South America, Hispaniola, the sub-Saharan region of Africa (where the largest annual incidences are reported), the Indian subcontinent, Southeast Asia, the Middle East and Oceania. Malaria is a water-related disease, since it is caused by four subspecies of microscopic parasites (Plasmodium) carried by female Anopheles mosquitoes that breed their larvae in stagnant pools and water storage reservoirs in warm climates. Each year, 300 to 500 million people contract malaria worldwide, of which some 1.5 to 2.7 million people die from the disease. The overwhelming majority (90%) of fatal cases are children below the age of 5 years. Since the 1970s,

49 Excerpted from: Ahmed, A. Karim. *ob. cit.*

there has been a resurgence of malaria in many regions of the world, partially due to the rapid formation of parasites that are resistant to malaria preventing drugs, such as chloroquine and other quinoline products. In addition, significant increases in the incidence of malaria in recent years have been caused by the construction of dams, intensified irrigation systems and other water-related projects, accounting for a large number of new mosquito breeding sites in many developing regions.

In general, prevention and control of malarial diseases is quite complex and multifaceted. Though relatively expensive, the use of wire screens in houses and other buildings is an effective way to keep infectious mosquitoes out of indoor premises. The use of mosquito fish in small ponds and water tanks for reducing larval populations has met with success in some communities. Insect repellent treatments of home walls, bednets, mats and coils are also recommended in severely affected areas. It should be noted, however, that in many regions of the world, some strains of mosquitoes have become highly resistant to frequently used insecticides, such as DDT and pyrethroids. For travelers who plan to visit areas of the world where malarial diseases are endemic, it is important to take antimalarial prescription drug (whose non-resistant properties have been well established) in advance (generally 4–6 weeks before traveling) and to maintain a strict dosage regimen. Moreover, use of insect repellents is advisable, along with wearing clothing that covers the body and sleeping under mosquito bednets treated with insecticides.

Schistosomiasis and Trachoma

It is estimated that 200 million people worldwide are infected with schistosomiasis, with another 2 billion people in some 74 countries at elevated risk from this debilitating water-borne disease. Schistosomiasis (sometimes known as bilharzia) is caused by parasitic worms (Schistosoma) when human beings come into contact with certain types of snails that harbor these parasites in contaminated fresh water. The main factor in the proliferation of this disease is dumping human fecal wastes to fresh water sources. While 20 million people suffer from severe consequences of this disease, the World Health Organization states that better latrines and sanitation facilities could significantly reduce the incidence of schistosomiasis by as much as 77%. Prevention of schistosomiasis can be achieved by avoiding swimming or wading in contaminated streams and lakes, by drinking properly boiled water, and bathing or showering in water heated to 66 degrees C (150 degrees F) for 5 minutes.

Improved water sanitation and hygienic conditions could also reduce the worldwide incidence of trachoma, a serious chronic eye disease, which is caused by an infectious bacterial agent (Chlamydia trachomatis). This disease is spread by person-to-person contacts and by insect vectors such as houseflies. The infection begins by irritation of the cornea (trichiasis), which increases the risk of ulceration of the cornea, resulting in reduced vision and blindness. At present, it is estimated that 500 million people are at risk to this disease, while 146 million people are threatened with irreversible blindness. The World Health Organization estimates that trachoma results in 6 million cases of blindness each year, and that the prevalence of this disease in children is 10–40% in some African countries. Recently, WHO initiated a global campaign to eliminate trachoma, which consists of a combined strategy of: (1) monitoring and conducting surveillance for the disease, (2) improving community water supplies and introducing sanitation facilities, (3) encouraging individual hygiene programs, (4) prescribing the use of antimicrobial drugs, and (5) eye surgery to correct the onset of trichiasis.

Naturally Occurring Water Contaminants

Arsenic

An environmental health problem of enormous proportion has arisen in a number of regions of the world where naturally occurring arsenic found in subsoil layers has contaminated underground drinking water sources. The most severe cases of arsenic poisoning have occurred in Bangladesh, where it is estimated that between 35 and 77 million people (in a country of 125 million people) were exposed to this toxic chemical substance by ingesting drinking water from underground aquifers. Today, 97% of the population in Bangladesh drinks water drawn from underground aquifers. These underground drinking water sources were tapped through installation of tube wells under an extensive World Bank assisted program during the 1980s when it was recognized by local authorities that surface water sources in the country had become too contaminated for human consumption. At present, in many rural areas of the country arsenic is found in drinking water above WHO's recommended level of 10 parts per billion (ppb). To confront this public health crisis, a combination of remediation, clinical and educational programs have been undertaken by the national government and by a number of international agencies. Three types of action programs have been identified to address this problem: (1) enabling people in the community to have access to

arsenic-free drinking water, (2) providing financial assistance and medical treatment to those suffering from arsenic poisoning, and (3) conducting an extensive study of underground water sources to understand the overall hydro-geological nature of the problem.

Toxicological studies show that ingestion of arsenic may lead to thickening of the skin, nervous system disorders, digestive problems, diabetes, liver disease, and cancer. Treatment for arsenic poisoning range from changes in dietary habits (e.g., eating more high sulfur-containing foods, such as eggs, onions and garlic, and those food products with high fiber content) to medical treatments (oral ingestion of charcoal tablets or intravenous injection of metal binding agents). Other countries of the world where arsenic in drinking water from underground sources (and in some cases from surface mine tailings and agricultural runoffs) has also been identified as an environmental health risk include Argentina, Chile, China, India, Mexico, Thailand and the United States.

Fluoride

In several regions of the world, unsafe levels of naturally occurring fluoride, which is present abundantly in the earth's crust, are found in drinking water. Excessive level of fluoride ingestion causes a chronic disease known as fluorosis, which is a serious bone disease that discolors teeth (dental fluorosis), and causes stiffness of joints and other skeletal deformations. According to UNICEF, fluorosis is endemic in at least 25 countries across the globe, whereas WHO estimates that in China alone some 30 million people suffer from chronic fluorosis. In 1993, fluorosis was reported to be endemic in 15 out of 32 states in India and an estimated 5 million people in Mexico were affected by high levels of fluoride from exposure to underground drinking water. In areas of the world where high levels of fluoride occur in groundwater, surface water sources need to be developed that are free of bacterial and chemical contaminants. Another approach is to remove fluoride from groundwater sources by employing either flocculation (solid precipitation) or adsorption (chemical binding) treatment procedures. Currently, in many developed countries, fluoride is added intentionally in drinking water—at a presumed safe concentration level of around 1 part per million (ppm)—as a preventative measure against dental decay. However, WHO has recommended that in warmer climates, fluoride in drinking water be kept below the 1 ppm concentration level, since individuals in hot weather ingests greater quantities of water daily than those living in more temperature regions.

Water-Related Toxic Substances and Hazardous Wastes

Increasingly, many surface and underground drinking water sources around the world have become severely polluted by a variety of toxic chemical substances and hazardous wastes. These sources of water contamination include manufacturing, refinery and municipal effluent discharges, leachates from landfills and hazardous waste sites, agricultural runoffs, mining operations, and other commercial and recreational activities. Among the more common toxic substances found in drinking water are (i) heavy metals, (ii) toxic organic compounds, (iii) pesticides and fertilizers, and (iv) disinfection by-products. [50]

The major identifiable or "point" sources of heavy metal contamination of waterways are from the mining, metal smelting, electroplating and chemical manufacturing industries, whereas "non-point" sources of heavy metals are mainly from agricultural runoffs (containing mineral fertilizers, sewage sludge and certain types of pesticides) and from urban/suburban runoffs, along with atmospheric fallout linked to road traffic and emissions from power plants and waste incinerators. Major sources of toxic organic compounds in surface and ground water are from chemical, pharmaceutical, synthetic polymer (plastic/rubber) and fossil fuel refining industries, while most pesticide contamination of drinking water originates from agricultural and domestic uses.

Disinfectant by-products are formed in waterways and reservoirs when chlorine—used as a bactericidal agent in many water treatment plants—chemically reacts with naturally occurring organic compounds (e.g., soil-bearing humic acids) to form a number of halogenated organic compounds, such as chloroform and bromoform. In addition, agricultural runoff of nitrogen fertilizers in many rural areas of the world contaminates rivers, lakes and underground aquifers leading to excessive levels of dissolved nitrates in drinking water that may cause "blue baby syndrome", an acute and serious life-threatening disease among infants and young children.

The presence of toxic chemical substances and hazardous waste materials in drinking water pose a large spectrum of human health risks to the general population. They range from simple ailments such as short-term skin rashes, nose and eye irritation, gastrointestinal distress, numbness in fingers and toes, to a variety of serious acute and

50 Examples of heavy metals in water resources consist of such chemical substances as beryllium, cadmium, chromium, lead, mercury, nickel; toxic organic compounds such as benzene, dichloroethylene, dioxin, ethylene dibromide, MTBE, phthalates, PCBs, toluene, xylenes; pesticides such as alachlor, atrazine, DDT, dalapron, hexachlorobenzene, lindane, permethrin, 2,4-D; and disinfection by-products such as bromates, chlorophenols, chloroform, bromoform, halogenated acetic acids and acetonitriles (For more explanatory information on these chemical substances, see Section III-B).

chronic diseases. For instance, a number of heavy metals cause long-term liver and kidney damage, nervous system disorders, loss of fingernails and hair, blood pressure changes and circulatory problems. Many persistent organic pollutants (POPs) found in drinking water, such as aromatic and halogenated hydrocarbons, cause developmental and nervous system disorders, reproductive difficulties, liver and kidney problems, several types of cardiovascular disorders, increased risks of childhood and adult cancer and potential genetic damage to future generations. The chief characteristic of POPs is their long-lasting presence in the environment, where they can exert their adverse toxicological effects on human and animal populations for many years or even decades.

The human health risks associated with ingesting heavy metal and toxic organic substances in drinking water over a prolonged period of time often occurs at relatively low concentration levels, generally in the range of parts per million (ppm) or below. For these reasons, prevention and/or removal of trace amounts of these water-borne contaminants in drinking water sources is considered a matter of high priority by regulatory agencies in many industrialized and rapidly developing countries. In addition to prohibiting or severely restricting the discharge of toxic effluents and hazardous wastes into surface and ground water sources, a number of technological solutions may be employed to remove chemical contaminants in drinking water. These include the use of activated charcoal filters (and other chemical adsoption devices) at the water tap to remove persistent organic pollutants and disinfectant by-products in homes and office buildings.

In some areas of developed countries, such as the United States and Canada, where ground water has been severely polluted with heavy metals or toxic organic compounds, an entire aquifer that serves a community may have to undergo extensive remediation, such as by pumping out and treating the underground contaminated drinking water source. At present, the treatment technologies to remove drinking water contaminants employ a variety of approaches, including chemical adsorption technique, biological degradation, air stripping of volatile compounds and metallic precipitation. However, such a remediation procedure would be prohibitively expensive and difficult to carry out in less developed regions of the world, and is not recommended as the method of first choice in most cases.

Water Resources and Drinking Water Standards

At present, drinking water is not available at sufficient amounts needed for daily human consumption in many regions of the world for the simple reason that the global supply of freshwater is unevenly distributed. For instance, some arid and semi-arid regions on the earth's surface receive only about 2% of the global flow of fresh water, while they account for 40% of the total landmass of the world. On the other hand, some major river basins may carry enormous quantities of fresh water, such as the Amazon River (accounting for 16% of the global water run-off) or the Congo River basin, which accounts for one-third of all fresh water flow on the African continent. For these reasons, in many regions of the world more than half the population, especially those living in rural areas, obtain their drinking water supplies from shallow well waters and underground aquifers.

In addition to providing drinking water that is free from pathogenic microbial contaminants that cause water-borne infectious diseases, special steps must be taken to keep toxic substances (such as industrial chemicals, urban/suburban storm water effluents and agricultural runoffs) from polluting downstream water resources. These measures include protecting watersheds and aquatic recharge areas from a variety of human activities, such as dumping of human wastes, mining operations, manufacturing discharges and excessive use of agricultural fertilizers and pesticides. Groundwater sources of drinking water must be protected from surface drainage and flooding, with rainwater recharge areas kept free of garbage and toxic waste disposals, agricultural husbandry and land clearance activities.

An important factor in achieving clean water supplies for the community is the development of health-based water quality standards and indicators that should be accompanied by frequent monitoring to ensure compliance with safe drinking water guidelines and regulations. WHO has issued Guidelines for Drinking Water Quality, a set of recommendations whose primary goal is to safeguard human health and which were intended for the development of national water quality standards. Its health-based guidelines for chemical substances are divided as follows: (i) inorganic compounds (including heavy metals and anions), (ii) organic compounds, (iii) pesticides, and (iv) disinfectants/disinfectant by-products. The WHO guidelines provide recommended maximum acceptable concentration levels for each water-borne contaminant in order to ensure the safety of drinking water sources. However, these guidelines are not envisioned to be a mandatory limit, since the water quality guidelines are to be viewed "in the context of local or national environmental, social, economic and cultural conditions."

Under the U. S. Safe Drinking Water Act, the United States Environmental Protection Agency (USEPA) has issued legally enforceable drinking water standards known as National Primary Drinking Water Regulations (NPDWRs), which are divided into the following broad categories: (i) microorganisms (including bacteria and viruses), (ii)

disinfectants/disinfectant by-products, (iii) inorganic chemicals (including heavy metals and anions), (iv) organic chemicals (including pesticides), and (v) radionuclides (including alpha and beta particles). In addition, the USEPA has published non-enforceable guidelines—the National Secondary Drinking Water Regulations (NSDWRs)—on a number of physical/chemical factors and chemical substances that cause cosmetic or aesthetic effects in drinking water. These include items such as corrosivity, odor, color, foaming agents, pH (acidity), total dissolved solids and the non-health impacts of a number of metal cations and anions (aluminum, chloride, copper, fluoride, iron, manganese, silver, sulfate and zinc). However, each state in the U. S. has the regulatory discretion to adopt the federal NSDWRs as enforceable drinking water standards.

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http://bradfor.ac.uk/acad/sbtwc/btwc/int_inst/health_convs/WHO-CONSTITUTION.pdf

Table A: Benchmarks and Indicators organized by Issue and Score

Summary of Acronyms used in table: EPA - Environmental Protection Agency; WHO - World Health, Organization; PAHO - Pan American Health Orgranization; UN FCAGDI - UN Friends of the Chair advisory group on Development Indicators; UNICEF - United Nations Children's Fund; UNDP - United Nation's Development Program; OECD - Organization for Economic Cooperation Resources Institute; IISD - International Institute for Sustainable Development

Indicator	Type	Selection Score	Reference Organization and Source	Date
Access to Resources and Coverage				
% of children under 12 months immunized for measles	Action	3.5	World Bank	2001
% of children under five who have access to a health facility able to provide IMCI	State	3.5	World Bank	2001
% of health facilities with all essential equipment, materials, and drugs for IMCI	State	3.5	World Bank	2001
% of health facilities with at least 60 % of workers who manage children trained in IMCI	State	3.5	World Bank	2001
% of pregnant women receiving antenatal care at least once	Action	3.5	World Bank	2001
BCG Vaccination coverage	Action	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Diphtheria, Pertussis and Tetanus Vaccination (DPT3) coverage	Action	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators http://www.paho.org/English/SHA/cdatlas.htm	1995 - 1996
Involvement of NGOs and private providers in the IMCI strategy	State	3.5	World Bank	2001
Measles Vaccination coverage	Action	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
One-year-old fully immunized against tuberculosis and measles (%) 1995-1998	Exposure	3.5	UNDP	2000
Oral Polio vaccination (OPV 3) coverage	Action	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Tetanus Toxoid Vaccination coverage	Action	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
% of children under 5 who slept under an insecticide treated bednet the previous night (malaria risk areas)	Action	2.5	World Bank; http://wbln0018.worldbank.org/HDNet/hddocs.nsf/c840b59b6982d2498525670c004def60/45f1ac457b0990b985256a42005d5ef1?OpenDocument	2001
% of children with fever in last two weeks, who received appropriate antimalarial treatment (in malaria risk areas)	Action	2.5	World Bank; http://wbln0018.worldbank.org/HDNet/hddocs.nsf/c840b59b6982d2498525670c004def60/45f1ac457b0990b985256a42005d5ef1?OpenDocument	2001
% of districts that have achieved 80% coverage	Action	2.5	World Bank	2001
% of infants aged 6-9 months who are receiving breastmilk and complementary food	State	2.5	World Bank	2001
% of infants under 6 months of age exclusively breastfed	State	2.5	World Bank; http://wbln0018.worldbank.org/HDNet/hddocs.nsf/c840b59b6982d2498525670c004def60/45f1ac457b0990b985256a42005d5ef1?OpenDocument	2001

% of target group immunized against each selected disease	Action	2.5	World Bank	2001
1 year old children DPT	Exposure	2.5	UNICEF	2001
1 year old children measles	Exposure	2.5	UNICEF	2001
1 year old children Polio	Exposure	2.5	UNICEF	2001
1 year old children TB	Exposure	2.5	UNICEF	2001
Caretaker knows at least two signs for seeking care	Exposure	2.5	World Bank	2001
Immunization coverage in under one year old: DPT3, OPV3, BCG, measles (%)	Action	2.5	PAHO; Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Population with access to services of drinking water	Effect/ Action	2.5	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Population with access to services of sewerage	Effect/ Action	2.5	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Pregnant women tetanus	Exposure	2.5	UNICEF	2001
% of administrative units reporting regularly on case detection and treatment	State	2	World Bank	2001
% of detected TB cases among DOTS strategy	State	2	World Bank	2001
% of drug administrative units reporting stock-outs of TB drugs within a year	State	2	World Bank	2001
% of health facilities able to confirm malaria diagnosis according to national	State	2	World Bank	2001
% of health facilities with a regular supply of 1st, 2nd, and 3rd line	State	2	World Bank	2001
% of patients with uncomplicated malaria getting correct treatment in	Action	2	World Bank; http://wbln0018.worldbank.org/HDNet/hddocs.nsf/c840b59b6982d2498525670c004def60/7ff1f1dd996a	2001
% of population at risk with access to correct case management (in high transmission areas, % of children <5 with access to IMCI)	Exposure	2	World Bank	2001
% of smear-positive cases among all detected cases (over 50% in high burden countries)	State	2	World Bank	2001
Existence of central TB unit, national TB control guidelines, and resources for core functions (training supervision, drugs)	State	2	World Bank; http://wbln0018.worldbank.org/HDNet/hddocs.nsf/c840b59b6982d2498525670c004def60/e6f37926d7a37b6f85256a160065e397?OpenDocument#section8	2001
Use of Oral Rehydration Therapy (ORT)	Action	2	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
% of community level agents (CHWs, drug vendors, traditional healers) able	State	1	World Bank	2001
Oral rehydration therapy use rate (%) 1995-1998	Action	1	UNDP	2000
Acute Respiratory Infection (ARI)	Effect		World Bank	2000 - 2001
Diarrhea prevalence and treatment	Action		World Bank	2000 - 2001
Immunization rate	State		World Bank	2000 - 2001

Percentage of health facilities reporting no disruption of stock of anti-malarial drugs (as specified by national health policy) for more than one week during the previous 3 months			World Bank	2002
Prevalence of ARI/CRI	Impact Indicator		World Bank	2002
Prevalence of chronic lung disease (COPD)			World Bank	2002
Proportion of households having at least one treated bednet	Intermediate Indicator		World Bank	2002
Air Quality				
Capacity of SOx and NOx abatement equipment of stationary sources	Action	3.5	OECD	2001
Car fleet equipped with catalytic converters	Action	3.5	OECD Environment Directorate http://www.oecd.org/pdf/M00019000/M00019613.pdf	2001
Carbon dioxide emissions	Pressure	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=121&indedit=Go	2001
Carbon monoxide concentrations	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=378&indedit=Go	2001
Carbon monoxide concentrations	State	3.5	OECD; Advanced air quality indicators and reporting Methodological study and assessment ENV/EPOC/PPC(99)9FINAL/	1999
Consumption of Ozone depleting substances		3.5	UN Statistic Division	1995
Consumption of Ozone layer depletion substances	Pressure	3.5	UN Dept. of Economic and Social Affairs; Division for Sustainable Development, Indicators for Sustainable Development: Framework and Methodologies, DESA/DSD/2001/3	2001
Emission of green house gases	Pressure	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=157&indedit=Go	2001
Emissions of CO2, CH4, Methane, Ozone depleting substances (CFC, halons)	Pressure	3.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/a65f2cf5452aedf5852567360072fdaf?OpenDocument	1998
Emissions of CO2, SO2, NOx		3.5	EPA	1995
Emissions of Greenhouse Gases	Pressure	3.5	UN Dept. of Economic and Social Affairs	2001
Ground level UV-B radiation	State	3.5	OECD	2001
Index of acidifying substances (Emissions of NOx and SOx)	Action	3.5	OECD	2001
Index of apparent Ozone depleting substances (ODS)	Pressures	3.5	OECD	2001
Index of greenhouse gas emissions (CO2, CH4, N2O, PFC, HFC, SF6 emissions)	Pressure	3.5	OECD Environment Directorate http://www.oecd.org/pdf/M00019000/M00019613.pdf	2001
Lead concentrations	State	3.5	OECD	1999
Lead concentrations	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=380&indedit=Go	2001
Nitrogen dioxide (micrograms per cubic meter) year 1999	State	3.5	World Bank	2001
Nitrogen dioxide concentrations	State	3.5	OECD	1999
NOx concentrations	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=379&indedit=Go	2001

Ozone concentrations	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=377&indedit=Go	2001
Ozone concentrations	State	3.5	OECD	1999
Sources of indoor air pollution	State	3.5	WHO/SDE/OEH/99.10 www.who.org	1999
SPM concentration	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=376&indedit=Go	2001
Sulfur dioxide (micrograms per cubic meter) year 1998	State	3.5	World Bank	2001
Sulfur dioxide concentrations	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=375&indedit=Go	2001
Sulfur dioxide concentrations	Pressure	3.5	OECD	1999
Ambient concentration of air pollutants in urban areas	State	3	UN Dept. of Economic and Social Affairs	2001
Ambient concentrations of air pollutants in urban areas	Impact and effect	3	WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Ambient concentrations of CO2, SO2, NOxO3 and TSP in urban areas	Action	3	UN Statistic Division	1995
Availability of lead-free gasoline	State	3	WHO/SDE/OEH/99.10 www.who.org	1999
Average monthly ambient concentrations in capital/town of: NOx (ppb), Sox (ppb), Lead compounds (ppb), Benzene (ppm)	Action	3	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/825eca792859be3985256736007256cd?OpenDocument	1998
Capability for air quality management	Pressure	3	WHO/SDE/OEH/99.10 www.who.org	1999
Suspended particulate in capital city (annual mean)	State	3	World Bank; Environmental Economics and Indicators http://wbln0018.worldbank.org/environment/EEI.nsf/3dc00e2e4624023585256713005a1d4a/97ea1d6b968ab2e1852567360077fcf4?OpenDocument	1998
Suspended particulate in capital city (micrograms/m3)	State	3	World Bank	2001
Atmospheric concentrations of GHG, global mean temperature	State	2.5	OECD	2001
Air quality index	Impact and effect	2.5	UN Statistic Division	1995
Ambient concentration of air pollutants in urban areas	State	2.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=159&indedit=Go	2001
Atmospheric concentrations of ODS	State	2.5	OECD Environment Directorate http://www.oecd.org/pdf/M00019000/M00019613.pdf	2001
Average monthly level of airborne particles	State	2.5	World Bank	1998
Childhood mortality due to acute Respiratory illness	Effect	2.5	WHO/SDE/OEH/99.10 www.who.org	1999
Exceedance of critical loads of pH: concentration in acid precipitation	State	2.5	OECD	2001
Particulate matter concentrations	State	2.5	OECD; Advanced air quality indicators and reporting Methodological study and assessment ENV/EPOC/PPC(99)9FINAL/	1999
Urban air emissions (urban traffic density and car ownership)	Pressures	2.5	OECD	2001
Population exposure to air pollution (concentration of air pollutants)	State	1.5	OECD	2001

Stratospheric ozone levels	Action	1.5	OECD	2001
Total suspended particulates (micrograms per cubic meter) year 1995	State	1.5	World Bank	2001
Generation of municipal, industrial, hazardous and nuclear waste	Pressures	0.5	OECD	2001
[X] x= CO2, CH4, N2O, CCI4, CH3CCI3, CCI3F, CCI2F2, C2CI3F3			WRI; http://earthtrends.wri.org/pdf_library/data_tables/ac3n_2000.pdf	2000 - 2001
Availability of ventilation in cooking area	Intermediate Indicator		World Bank	2002
CFC recovery rate	Action		OECD	2001
Children sleeping in cooking area			World Bank	2002
Economic, fiscal, regulatory instruments	Action		OECD	2001
Indoor air pollution	Exposure		World Bank	2002
Percentage of children living in areas in which air quality standards are exceeded			EPA; http://www.epa.gov/children/indicators/ACE_Report.pdf	1990-1998
Percentage of children living in counties where at least one hazardous air pollutant concentration was greater that a health benchmark in 1990			EPA	1990
Percentage of children's days with good, moderate, or unhealthy air quality			EPA	1990-1998
Percentage of homes with children under 7 where someone smokes regularly			EPA; http://www.epa.gov/children/indicators/ACE_Report.pdf	1994-1990
Percentage of households using clean fuel/improved stoves			World Bank	2002
Urban air pollution	Exposure		World Bank	2002
WHO standards			UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=247&indedit=Go	2001
Demographics				
Population Growth rate	Driving Force	2.5	UN Statistic Division	1995
Literate population%		2	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Annual Population growth rate%	Driving Force	1.5	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Population density	Pressure	1.5	UN Statistic Division	1995
Population growth rate	Driving Force	1.5	UN Statistic Division	1995
Crude birth rate (1000pop)	Pressure	1	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	2000
Total Population (thousands)	Driving Force	1	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	2000
Urban/rural migration rate	Pressure	1	UN Statistic Division	1995
Annual deaths average (thousands)	Effect	0.5	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Crude death rate (1000pop)	Effect	0.5	PAHO; http://www.paho.org/english/sha/beindexe.htm	2000
Rural population density (per sq. km. of arable land)	Driving Force	0.5	World Bank	2001
Total fertility rate per woman	Pressure	0.5	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Total population (thousands) 1998	Driving Force	0.5	UNDP Human Development Report http://www.undp.org/hdr2000/english/book/back2.pdf	2000
Annual births average (thousands)	Driving Force	0	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000

City population (thousands) year 2000	Driving Force	0	World Bank; http://www.worldbank.org/data/wdi2001/pdfs/tab3_13.pdf	2001
Crude birth rate (1000pop)	Driving Force	0	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Total Population (thousands)	Driving Force	0	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4 http://www.paho.org/english/sha/beindexe.htm	2000
Urban Population (%)	Driving Force	0	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Adult literacy rate (% age 15 and above) 1998			UNDP	2000
Population of Urban formal and informal settlements			UN Dept. of Economic and Social Affairs; Division for Sustainable Development, Indicators for Sustainable Development: Framework and Methodologies, DESA/DSD/2001/3	2001
Environmental and Related Socio-Economic Indicators				
Area of population in marginal settlements	Impact and effect	3.5	UN Statistic Division	1995
Carbon Dioxide emissions (1996): - total (millions of metric tons) - share of world total (%) - per capita (metric tons)	Pressure	3.5	UNDP	2000
CO2 emissions per capita (mt)	State	3.5	World Bank	2001
Effects on: water and air quality, land use and soil quality, toxic contamination	State	3.5	OECD Environment Directorate http://www.oecd.org/pdf/M00019000/M00019613.pdf	2001
Emissions of carbon dioxide (Kg/cap.) (kg/USD GDP) % of change (1990-1998)	Pressure	3.5	OECD	1999
Emissions of nitrogen oxides (Kg/cap.) (kg/USD GDP) % of change (1990-late1990s)	Pressure	3.5	OECD	1999
Emissions of sulfur oxides (Kg/cap.) (kg/USD GDP) % of change (1990-late1990s)	Pressure	3.5	OECD	1999
Road-transport related air emissions and emission intensities	Pressure	3.5	OECD	1999
Sulfur dioxide emissions per capita (kilograms) 1995-97	Pressure	3.5	UNDP	2000
Total CO2 emissions, industrial (1000 kt)	State	3.5	World Bank	2001
Trends in CO2 emissions from transport	Pressure	3.5	OECD	1999
CO2 per unit of GDP (Kg/87$GDP)	State	3	World Bank	2001
% of population with sanitary services	Impact and effect	2.5	UN Statistic Division	1995
Industry shares of emissions of organic water pollutants	Pressure	2.5	World Bank; http://www.worldbank.org/data/wdi2001/pdfs/tab3_6.pdf	2001
Motor vehicles in use per 1000 habitants	Pressure	2.5	UN Statistic Division	1995
Transport related air emissions and emission intensities	Pressure	2.5	OECD	1999
Area affected by salinization and water logging	Impact and effect	2	UN Statistic Division; http://www.un.org/Depts/unsd/enviro/longlist.html	1995
CO2 emissions per unit of GDP (Kg/PP$ GDP)	State	2	World Bank	2001
Depletion of mineral resources (% of proven reserves)	Impact and effect	2	UN Statistic Division	1995
Extraction of other mineral resources	Pressure	2	UN Statistic Division	1995

Annual fresh water withdrawals (as % of water resources & per capita) 1987-97	Pressure	1.5	UNDP; Human Development Report http://www.undp.org/hdr2000/english/book/back2.pdf	2000
Annual internal renewable water resources (cubic meters per capita) 2000	State	1.5	UNDP	2000
Average annual rate of deforestation (%) 1980-90/1990-95	Pressure	1.5	UNDP	2000
Energy efficiency & intensity	Action	1.5	OECD	2001
Industrial waste (kg/USD GDP)	Pressure	1.5	OECD	1999
Lifetime of proven reserves	Impact and effect	1.5	UN Statistic Division	1995
Municipal waste (Kg/cap.)	Pressure	1.5	OECD	1999
Nuclear waste (t./Mtoe of TPES)	pressure	1.5	OECD	1999
Printing and writing paper consumed (kilograms per capita) 1997	Pressure	1.5	UNDP	2000
Waste minimization (recycling rates)	Action	1.5	OECD	2001
Annual energy consumption per capita	Pressure	1	UN Statistic Division	1995
Annual energy consumption per capita	Pressure	1	UN Dept. of Economic and Social Affairs	2001
Intensity of material use	Pressure	1	UN Dept. of Economic and Social Affairs; Division for Sustainable Development, Indicators for Sustainable Development: Framework and Methodologies, DESA/DSD/2001/3	2001
Capital accumulation (environmentally adjusted)	Action	0	UN Statistic Division	1995
% of population in urban areas	Driving Force		UN Statistic Division; http://www.un.org/Depts/unsd/enviro/longlist.html	1995
Annual roundwood production	Pressure		UN Statistic Division	1995
cement manufacturing, 1996			WRI	2000 - 2001
CO2 emitted per million Int$ (PPP) of GDP (metric tons), 1990, 1996			WRI	2000 - 2001
Consumption of road fuels: intensities and structure by type of fuel	Pressure		OECD	1999
Deforestation rate	Impact and effect		UN Statistic Division	1995
Environmental protection expenditure as % of GDP	Action		UN Statistic Division; http://www.un.org/Depts/unsd/enviro/longlist.html	1995
Final energy consumption by transport intensities and structure by mode	Pressure		OECD; Indicators for the integration of environmental concerns into transport policies ENV/EPOC/SE(98)1FINAL/	1999
Freshwater resources per capita (cubic meters) 1999	State		World Bank	2000
Fuelwood consumption per capita	Pressure		UN Statistic Division	1995
Gas flaring, 1996			WRI	2000 - 2001
Gaseous fuels, 1996			WRI	2000 - 2001
Industrial CO2 emissions (Kt) & (metric tons per capita) (1997)	State		World Bank; http://devdata.worldbank.org/external/dgcomp.asp?rmdk=110&w=0&SMDK=473883	2000
Intensity of energy use	Pressure		UN Dept. of Economic and Social Affairs	2001
Liquid fuels, 1996			WRI	2000 - 2001
Organic water pollutant (BOD) emissions (kg per day) (1998)	Pressure		World Bank	2000

Per capita CO2 emissions (kg), 1996			WRI	2000 - 2001
Population expose to leq>65dB (A) (million inh.)	Exposure		OECD	1999
Reforestation rate	Action		UN Statistic Division	1995
Share of consumption of renewable energy resources			UN Dept. of Economic and Social Affairs	2001
Shelter index	Impact and effect		UN Statistic Division	1995
Solid fuels, 1996			WRI	2000 - 2001
Food Safety				
Monitoring chemical hazards in food	Action	3	WHO/SDE/OEH/99.10 www.who.org	1999
Food production index (1989-91=100) 1998		2.5	UNDP	2000
Daily per capita supplies of calories 1970/1990	State	1.5	UNDP	2000
Daily per capita supply of fat: total (grams)1997, change (%) 1970-97	State	0.5	UNDP	2000
Daily per capita supply of protein total (grams)1997, change (%) 1970-1997	State	0.5	UNDP	2000
Food consumption (as % of total household consumption) 1997	Pressure	0.5	UNDP	2000
Food-borne illness	Effect	0.5	WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Daily per capita supply of calories 1997	State		UNDP	2000
Food aid in cereals (thousands of metric tons) 1998	State		UNDP	2000
Number of impaired waters	State		EPA	1998
Nutrient export	State		EPA; http://www.epa.gov/iwi/national/canindex.html	1987
Percentage of fruits, vegetables, grains, dairy, and processed foods with detectable pesticide residues	State		EPA; http://www.epa.gov/children/indicators/ACE_Report.pdf	1990 - 1994
Risk of water Nitrate Contamination	State		EPA	1970 - 1995
Soil permeability	State		EPA	1998
Hazardous/Toxic Substances				
Level in children	Exposure	3.5	WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Nuclear waste generated (metric tons of heavy metal) 1991-97	Pressure	3.5	UNDP	2000
Hazardous waste generated (1,000 metric tons) 1991-97	Pressure	2.5	UNDP	2000
Municipal waste generated (kilograms per person) 1997	Pressure	2.5	UNDP	2000
Contaminated land management	Action	2	WHO/SDE/OEH/99.10 www.who.org	1999
Mortality due to poisoning	Effect	2	WHO/SDE/OEH/99.10 www.who.org	1999
No. of cases per year of chemical induced acute poisonings	Exposure	2	World Bank	1998
Generation of hazardous waste (m3)	Pressure	1.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/089dea9ca460da3c8525673600756de2?OpenDocument	1998

Import/export of hazardous wastes (ha)	Exposure	1.5	World Bank	1998
No. of chemicals banned or severely restricted (since 90/ between 80's and 90's)	Action	1.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/089dea9ca460da3c8525673600756de2?OpenDocument	1998
Area of land contaminated by toxic waste	Impact and effect	1	UN Statistic Division	1995
Volume of toxic chemicals imported (tons/yr)	Exposure	1	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/089dea9ca460da3c8525673600756de2?OpenDocument	1998
Annual frequency of monitoring activities for heavy metals in the biophysical environment	Action	0.5	World Bank	1998
Agroindustrial waste	Exposure		World Bank	2002
No. of storage sites for hazardous wastes (ha)	Action		World Bank	1998
Health				
Immunization against infectious childhood diseases	Exposure	4.5	UN Dept. of Economic and Social Affairs	2001
Annual no. of births (thousands), 1999	Driving Force	3.5	UNICEF	2001
Contraceptive prevalence rate	Effect	3.5	UN Dept. of Economic and Social Affairs	2001
Infant mortality rate	Effect	3.5	WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Mortality rates from malignant neoplasms (100.000 pop, total, male, female est../ adj.)	Effect	3.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Percentage of Newborns with Low Birth Weight	Effect	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
% of urban population expose to concentrations of SO2, particulates, ozone, CO and Pb	Impact and effect	3	UN Statistic Division	1995
AIDS annual incidence rate (1.000.000pop)	Effect	2.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Crude birth rate (per 1,000 people)	Driving Force	2.5	World Bank	2001
Immunization, DPT (% of children under 12 months) (1999/1998)	Action	2.5	World Bank; http://devdata.worldbank.org/external/dgcomp.asp?W=0&RMDK=110&smdk=500012	2000
Immunization, measles (% of children under 12 months) (1999/1998)	Action	2.5	World Bank	2000
Life expectancy	Effect	2.5	WHO/SDE/OEH/99.10 www.who.org	1999
Life expectancy at birth (years)	Driving Force	2.5	Population Division and Statistics Division of the United Nations Secretariat World Population Prospects: The 2000 Revision, Volume I http://www.un.org/Dept/unsd/social/health.htm	2000

Malnutrition prevalence, weight for age (% of children under 5)	Effect	2.5	World Bank; http://devdata.worldbank.org/external/dgcomp.asp?W=0&RMDK=110&smdk=500012	2000
Mortality rates from diseases of the circulatory system (100.000 pop, total, male, female, est./ adj.)	Effect	2.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Mortality rates from external causes (100.000 pop, total, male, female, est./ adj.)	Effect	2.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Reduction in vaccine-preventable deaths		2.5	World Bank; http://wbln0018.worldbank.org/HDNet/hddocs.nsf/c840b59b6982d2498525670c004def60/86eca35fe033893285256a42005e0dc6/$FILE/AAG%20Immuniz%20rev%2011_01.pdf	2001
Life expectancy at birth (years)	Pressure	2	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Annual no. of under 5 deaths (thousands), 1999	Effect	1.5	UNICEF	2001
Child malnutrition: prevalence of underweight under 5s	Effect	1.5	OECD	1999
Children Status	Effect	1.5	UN Dept. of Economic and Social Affairs	2001
Cholera reported cases	Effect	1.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Dengue confirmed cases	Effect	1.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Infant Mortality Rate	Effect	1.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators http://www.paho.org/English/SHA/cdatlas.htm	1995 - 1996
Infant mortality rate	Effect	1.5	OECD	1999
Infant mortality rate	Impact and effect	1.5	UN Statistic Division	1995
Infant mortality rate (per 1,000 live births) 1997/1998	Effect	1.5	UNDP	2000
Infant mortality rate (per 1,000 live births) 1998	Effect	1.5	UNDP	2000
Infant Mortality rate (under 1) 1960/1999	Effect	1.5	UNICEF	2001
Infant mortality,1998 (deaths/1000 live births)	Effect	1.5	OECD	1999
Infants with low birth-weight % 1990-1997	Effect	1.5	UNDP	2000
Life expectancy at birth (years) 1970-75, 1995-2000		1.5	UNDP; Human Development Report http://www.undp.org/hdr2000/english/book/back2.pdf	2000
Malaria cases (per 100,000 people) 1997	Exposure	1.5	UNDP	2000
Malaria reported cases	Effect	1.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Malaria risk areas population (%)	Exposure	1.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Maternal mortality ratio	Effect	1.5	OECD	1999
Maternal mortality ratio reported (per 100,000 live births) 1990-98	Effect	1.5	UNDP Human Development Report http://www.undp.org/hdr2000/english/book/back2.pdf	2000
Mortality rate under 5 years old	Effect	1.5	UN Dept. of Economic and Social Affairs	2001
Mortality rate, under-5 (per 1,000 live births) (1999/1999)	Effect	1.5	World Bank	2000
People living with HIV/AIDS, total number (age 0-49), adult rate (% people 15-49) 1997	Exposure	1.5	UNDP	2000
People not expected to survive to age 60 % 1995-2000	Effect	1.5	UNDP	2000
Pregnant women with anemia (%) 1971-1991	Effect	1.5	UNDP	2000
Total fertility rate	Driving Force	1.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators http://www.paho.org/English/SHA/cdatlas.htm	1995 - 1996

Total population (thousands), 1999	Driving Force	1.5	UNICEF	2001
Tuberculosis cases (per 100,000 people) 1997	Exposure	1.5	UNDP	2000
Under 5 mortality rate	Effect	1.5	OECD	1999
Under 5 mortality rate 1960/1999	Effect	1.5	UNICEF; The state of the World's Children 2001 http://www.unicef.org/sowc01/tables/#	2001
Under five mortality rate (per 1,000 live births) 1970/1998	Effect	1.5	UNDP	2000
Under five years Mortality Rate	Effect	1.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Under-5 mortality rate (per 1000 birth)	Effect	1.5	World Bank; Environmental Economics and Indicators http://wbln0018.worldbank.org/environment/EEI.nsf/3dc00e2e4624023585256713005a1d4a/97ea1d6b968ab2e1852567360077fcf4?OpenDocument	2001
Under-5 mortality rate (per 1000 live births)	Effect	1.5	World Bank	2001
Child mortality rate (male/female)	Driving Force	1	United Nations Secretariat	2000
Infant mortality (1000 live births)	Effect	1	Epidemiological Bulletin/ PAHO, Vol. 21, No. 4	2000
Infant mortality rate (2000-2005, male/female)	Driving Force	1	United Nations Secretariat	2000
Reported cases of Dengue	Effect	1	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Reported Cases of Cholera	Effect	1	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Reported cases of Malaria	Effect	1	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Calorie supply per capita	Driving Force	0.5	UN Statistic Division	1995
Crude death rate (per 1,000 people)	Effect	0.5	World Bank; http://www.worldbank.org/data/wdi2001/pdfs/tab2_1.pdf	2001
Female life expectancy at birth, 1998 (years)	Driving Force	0.5	OECD; Environmental data information, statistics http://www.oecd.org/pdf/M00019000/M00019568.pdf	1999
Incidence of environmental related diseases	Impact and effect	0.5	UN Statistic Division	1995
Life expectancy at birth (years) 1995-2000		0.5	UNDP	2000
Life expectancy at birth (years), 1999	State	0.5	UNICEF	2001
Measles incidence (registered deaths/ confirmed cases)	Exposure	0.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Tuberculosis incidence rate (100.000 pop, total/BK+)	Exposure	0.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
% of children stunted	Effect		World Bank	2000 - 2001
% of children underweight	Effect		World Bank	2000 - 2001
% of mothers with low body mass index (BMI)	Effect		World Bank	2000 - 2001
Asthma hospitalization rate for children 0-14			EPA	1987-1998

Average concentrations of lead in blood for children 5 and under			EPA	1976 - 1994
Cancer incidence and mortality for children under 20			EPA	1975 - 1995
Cancer incidence for children under 20 by type			EPA	1973 - 1996
Cigarette consumption per adult Annual average, index (1984-86=100) 1993-97	Action		UNDP	2000
E.Coli/100 ml of water consumed by residents by source			World Bank	2002
Infant mortality rate	Effect		World Bank; http://www.worldbank.org/poverty/health/data/index.htm	2000 - 2001
Infant mortality rate (Per 1,000 live births) (1980, 1990)	Effect		World Bank	2000 - 2001
Infant mortality rate (per 1000 live births) 1995-00			WRI; http://earthtrends.wri.org/pdf_library/data_tables/hd2n_2000.pdf	2000 - 2001
Infant mortality, deaths per 1,000 live births	Effect		OECD Health data tables http://www.oecd.org/oecd/pages/home/displaygener	2001
Life expectancy at birth	Driving Force		OECD	1999
Life expectancy at birth			UN Dept. of Economic and Social Affairs	2001
Life expectancy in years	Driving Force		OECD Health data tables http://www.oecd.org/oecd/pages/home/displaygeneral/0,3380,EN-statistics-194-5-no-no-no-194,FF.html	2001
Malaria API (1000pop)			Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Maternal mortality ratio (Per 100,000 live births) 1990-98	Effect		World Bank; http://www.worldbank.org/poverty/wdrpoverty/report/tab7.pdf	2000 - 2001
Percentage of child caregivers and food prepares with appropriate hand washing	Exposure		http://lnweb18.worldbank.org/ESSD/essdext.nsf/44DocByUnid/6AFA9F01440581D085256B8A004C6	2002
Percentage of children aged 1-5 with concentrations of lead in blood greater than 10 ug/dl			EPA; http://www.epa.gov/children/indicators/ACE_Report.pdf	1992 - 1994
Percentage of children under 18 with asthma, 1997-98			EPA	1997 - 1998
Percentage of children under 18 with asthma and chronic bronchitis			EPA	1990 - 1996
Prevalence of Diarrhea	Impact Indicator		World Bank	2002
Total fertility rate 1995-2000	Driving Force		UNDP	2000
Under five mortality rate (per 1,000 live births) 1998	Effect		UNDP	2000
Under five mortality rate (per 1000 live births), 1997			WRI	2000 - 2001
Under-5 mortality rate	Effect		World Bank	2000 - 2001
Infrastructure				
Access improved water source (%total pop)	Exposure	3.5	World Bank	2001
Carbon dioxide emissions	Pressure	3.5	OECD	1999
Generation of hazardous waste	Pressure/Exposure	3.5	UN Statistic Division	1995
Municipal waste disposal	Exposure	3.5	UN Statistic Division	1995
Percentage population with Sewerage and Excreta Disposal Services - Urban	Pressure	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996

Percentage population with Sewerage and Excreta Disposal Services - Rural	Pressure	3.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Population served (%) 1992-97: - by municipal waste services - by public sanitation services	Action	3.5	UNDP; Human Development Report http://www.undp.org/hdr2000/english/book/back2.pdf	2000
% of population with access to primary health care facilities	Exposure	3	UN Dept. of Economic and Social Affairs	2001
% of population with adequate sewage disposal facilities	Exposure	3	UN Dept. of Economic and Social Affairs	2001
Population with access to safe drinking water	Exposure	3	UN Dept. of Economic and Social Affairs	2001
Waste recycling (as % of apparent consumption) - paper and cardboard - glass 1992-97	Action	3	UNDP	2000
Access improved water source rural (% rural pop)	Exposure	2.5	World Bank	2001
Access improved water source urban (%urban pop)	Exposure	2.5	World Bank	2001
National population expose to noise levels from various sources (air, road and rail traffic, neighborhood noise) Leq< 65db(A), Leq.dB (A)-	Exposure	2.5	OECD; Towards a more sustainable household consumption patterns indicators to measure progress ENV/EPOC/SE(98)FINAL/	1999
No. of enforcement actions	Action	2.5	World Bank	1998
No. of polluted permits negotiated	Action	2.5	World Bank	1998
No. of water monitoring stations	State	2.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/1539ea8d91c2f07a852567360073e591?OpenDocument	1998
Percentage population with drinking water supply services - Urban	Pressure	2.5	PAHO;http://www.paho.org/English/SHA/cdatlas.htm	1995 - 1996
Percentage population with drinking water supply services - Rural	Pressure	2.5	PAHO; Health Situation and Inequities in the Region of the Americas: Atlas of Basic Indicators www.paho.org	1995 - 1996
Regular and accurate monitoring of water quality (frequency and yes/no)	Action	2.5	World Bank	1998
Rehabilitated sewer network (yes/no and coverage)	Exposure	2.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/529c855aeb59725b8525673600740f32?OpenDocument	1998
Rehabilitated waste water treatment plant (yes/no)	Exposure	2.5	World Bank	1998
Wastewater treated	Action	2.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=248&indedit=Go	2001
% of water collected	Action	2	World Bank	1998
% of water treated	Action	2	World Bank	1998
No. of waste water treatment plants	Action	2	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/529c855aeb59725b8525673600740f32?OpenDocument	1998
Active NGOs (No.)	Action	1.5	World Bank	1998
Countries with effective processes for sustainable development	Action	1.5	OECD	1999
Developed plan/strategies (yes/no)	Action	1.5	World Bank	1998
Energy efficiency: GDP per Unit of energy use	Pressure	1.5	OECD	1999

Existence of environmental laws and agencies (yes/no)	Action	1.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/b10a70a52ee2a6e78525673600709bb4?OpenDocument	1998
Generation of household waste	Pressure	1.5	OECD	1999
Imports and exports of hazardous waste	Exposure	1.5	UN Statistic Division	1995
Population with [sustainable] access to safe water		1.5	OECD	1999
Public waste water treatment (% of population served)	Exposure	1.5	OECD Environmental data compedium http://www.oecd.org/pdf/M00019556.pdf	1999
Share of environmental expenses of the total government budget (%)	Action	1.5	World Bank	1998
Waste recycling and reuse	Action	1.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?188cid=&indedit=Go	2001
Waste recycling rates	Action	1.5	OECD	1999
Distance traveled per capita by mode of transport		0.5	UN Dept. of Economic and Social Affairs	2001
Generation of hazardous waste	Pressure	0.5	UN Dept. of Economic and Social Affairs	2001
Generation of hazardous waste	Pressure/Exposure	0.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=186&indedit=Go	2001
Generation of Industrial and Municipal solid waste	Pressure	0.5	UN Dept. of Economic and Social Affairs	2001
Solid waste disposal	Pressure/Exposure	0.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=249&indedit=Go	2001
Waste recycling and reuse	Action	0.5	UN Dept. of Economic and Social Affairs	2001
Access to improved water source (% of population with access) (1982-85, 1990-96)	Action		World Bank; http://www.worldbank.org/poverty/wdrpoverty/report/tab7.pdf	2000 - 2001
Access to safe water (private or public)	Exposure		World Bank	2002
Access to sanitation (% of population with access) (1982-85, 1990-62)	State		World Bank	2000 - 2001
Access to sanitation (private or public)	Exposure		World Bank	2002
Control of corruption	Action		World Bank	2001
Disposal practices of children's feces	Exposure		World Bank	2002
Government effectiveness	Action		World Bank; http://www.worldbank.org/wbi/governance/govdata2001.htm	2001
Hours/day of available piped water	State		World Bank	2002
Improved water source, rural (% of rural population with access)	Action		World Bank	2000
Improved water source, urban (% of urban population with access)	Action		World Bank	2000
Installed monitoring and laboratory equipment (yes/no)			World Bank	1998
Installed new waste water treatment plant (yes/no)			World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/529c855aeb59725b8525673600740f32?OpenDocument	1998
Population without access to safe drinking water (%) 1990-98			UNDP	2000
Quantity of water used per capita per day	Pressure		World Bank	2002

Rate of growth of urban population	Driving Force		UN Statistic Division	1995
Regulatory quality	Action		World Bank	2001
Rule of law	Action		World Bank	2001
Signatory to the Kyoto Protocol, 1999 (Y,N)			WRI;http://earthtrends.wri.org/pdf_library/data_tables/ac1n_2000.pdf	2000 - 2001
Time taken/ distance involved in collecting water	State		World Bank	2002
Land Management				
Gross agricultural green house gas emissions	Pressure	3.5	OECD	2001
major protected areas (as a % of national territory) 1999	State	3.5	UNDP	
Pest management: - use of non-chemical pest control methods - use of integrated pest management	Action	2.5	OECD	2001
Agriculture withdrawal (%total freshwater withdrawal)	Pressure	2	World Bank; The little green data book http://wbln0018.worldbank.org/enviro…/c1d2d6efaae48d7f85256a3f0059f054?OpenDocument	2001
Fertilizer consumption 100 grams//ha arable land)	Pressure	2	World Bank; The little green data book http://wbln0018.worldbank.org/enviro…/c1d2d6efaae48d7f85256a3f0059f054?OpenDocument	2001
Irrigation and water management	Action	2	OECD	2001
Nutrient management	Action	2	OECD	2001
Soil and land management	Action	2	OECD; Environmental indicators for agriculture Volume 3: Methods and results http://www.oecd.org/htm/M00009000/M00009667.htm	2001
Whole farm management/ organic management	Action	2	OECD; Environmental indicators for agriculture Volume 3: Methods and results http://www.oecd.org/htm/M00009000/M00009667.htm	2001
Forest area as a % of National Surface [land] area	State	1.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=123&indedit=Go	2001
Land affected by desertification	Exposure	1.5	UN Dept. of Economic and Social Affairs	2001
Pesticide use (t/km2 of arable land)	Pressure	1.5	OECD	1999
Use of agricultural pesticides	Pressure	1.5	UN Dept. of Economic and Social Affairs	2001
Use of agricultural pesticides	Pressure/Exposure	1.5	UN Statistic Division	1995
Use of agricultural pesticides		1.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=123&indedit=Go	2001
Use of fertilizers	Pressure	1.5	UN Dept. of Economic and Social Affairs	2001
Use of fertilizers	Pressure/Exposure	1.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=123&indedit=Go	2001
Area affected by soil erosion	Impact and effect	1	UN Statistic Division	1995
Land affected by desertification	Impact and effect	1	UN Statistic Division	1995
Arable and permanet crop land areas	State		UN Dept. of Economic and Social Affairs	2001
Area of Urban formal and informal settlements	Pressure		UN Dept. of Economic and Social Affairs	2001
Average Annual Fertilizer use (Kg per hectare of cropland) 1985-87,97			WRI; http://earthtrends.wri.org/pdf_library/data_tables/af2n_2000.pdf	2000 - 2001
Land use change			UN Statistic Division	1995
Nitrogenous fertilizer use (t/km2 of arable land)	Pressure		OECD Environmental data compedium http://www.oecd.org/pdf/M00019556.pdf	1999
Nutrient use: - nitrogen balance; - nitrogen efficiency			OECD	2001

Pesticide use (Kg per hectare of cropland) 1996			WRI;http://earthtrends.wri.org/pdf_library/data_tables/af2n_2000.pdf	2000 - 2001
Pesticide use and risks	Pressure		OECD	2001
Soil quality			OECD	2001
Use of fertilizers			UN Statistic Division	1995
Water use: intensity, efficiency, water stress	Pressure		OECD	2001
Marine Water Resources				
Discharges of oil into coastal waters	Pressure	3	UN Statistic Division; http://www.un.org/Depts/unsd/enviro/longlist.html	1995
Industrial, agricultural and municipal discharges directly into marine water bodies	Pressure	2	UN Statistic Division	1995
% of total population living in coastal zones	Pressure	1	UN Dept. of Economic and Social Affairs	2001
Deviation in stock from maximum sustainable yield of marine species	Impact and effect		UN Statistic Division	1995
Loading of N and P in coastal waters	Impact and effect		UN Statistic Division	1995
Sanitation				
Diarrhea - mortality in children	Effect	4.5	WHO/SDE/OEH/99.10 www.who.org	1999
Diarrhea - morbidity in children	Effect	4.5	WHO/SDE/OEH/99.10 www.who.org	1999
% of children under 12 months fully immunized for measles	Action	3.5	World Bank	2001
% of children under 12 months fully immunized for DPT	Action	3.5	World Bank	2001
Access to sanitation rural (% rural population)	Exposure	3	World Bank	2001
Access to sanitation urban (% urban population)	Exposure	3	World Bank	2001
% of children sick in last two weeks who were offered increased fluids and same amount or more food	Action	2.5	World Bank	2001
Access to basic sanitation	Exposure	2.5	WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Immunization coverage rates	State	2.5	World Bank	2001
% of population using adequate sanitation facilities, 1999, total, urban, rural	Pressure	1.5	UNICEF	2001
Access to sanitary means of excreta disposal: % of population who use toilet or pit latrine	Action	1.5	World Bank	2001
Access to sanitation in Urban areas (%)	Exposure	0.5	World Bank Environmental Economics and Indicators; http://wbln0018.worldbank.org/environment/EEI.nsf/3dc00e2e46240235852567130005a1d4a/97ea1d6b968ab2e1852567360077fcf4?OpenDocument	2001
% of population with improved sanitation facilities (total, urban, rural)	Exposure		United Nations Secretariat	2000
Social Equality Issues				
Population connected to waste water treatment plants		3.5	OECD	1999
Ratio of Average Female wage to Male wage	Effect	3.5	UN Dept. of Economic and Social Affairs; Division for Sustainable Development, Indicators for Sustainable Development: Framework and Methodologies, DESA/DSD/2001/3	2001

Unemployment rate	Driving Force	3.5	UN Dept. of Economic and Social Affairs	2001
Air emissions from residential energy use(as a share of total emissions in % and related intensities in Kg per capita and per GDP)	Pressure	2.5	OECD; Towards a more sustainable household consumption patterns indicators to measure progress ENV/EPOC/SE(98)FINAL/	1999
General mortality rates (all causes, 100.000 pop, male/female, est./adj.)	Effect	2.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Mortality rates from communicable diseases (100.000 pop, total, male, female, est./ adj.)	Effect	2.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
% of Population living below Poverty Line	Driving Force/ State	1.5	UN Dept. of Economic and Social Affairs; Division for Sustainable Development, Indicators for Sustainable Development: Framework and Methodologies, DESA/DSD/2001/3	2001
Floor area per person	State	1.5	UN Dept. of Economic and Social Affairs	2001
National health expenditure as a % of GDP	Driving Force	1.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Population below poverty line (%)	Driving Force	1.5	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Incidence of extreme poverty: Population below $1 per day	Effect	0.5	OECD Core set of indicators; http://www.oecd.org/dac/indicators/htm/list.htm	1999
Inequality: poorest fifth's share of National consumption	Effect	0.5	OECD	1999
Poverty (% pop.<50% medium income)	Effect	0.5	OECD	1999
Waste water discharges by household		0.5	OECD	1999
Birth attended by trained personnel	Exposure	0	Epidemiological Bulletin/ PAHO, Vol. 20, No. 3	1999
Gini Index of Income Inequality			UN Dept. of Economic and Social Affairs	2001
Household water consumption			OECD	1999
Male and female life expectancy at birth, 1975-80, 1995-00			WRI	2000 - 2001
Persons per room per housing			World Bank	2002
Political stability/ no violence	Action		World Bank	2001
Population with access to safe water (rural, urban, total) 1990-1997			WRI	2000 - 2001
Population with access to sanitation (rural, urban, total) 1990-1998			WRI; http://earthtrends.wri.org/pdf_library/data_tables/hd3n_2000.pdf	2000 - 2001
Poverty gap ratio: incidence times depth of poverty	Effect		OECD	1999
Residential energy consumption			OECD	1999
Total final energy consumption			OECD; Towards a more sustainable household consumption patterns indicators to measure progress ENV/EPOC/SE(98)FINAL/	1999
Voice and accountability	Action		http://www.worldbank.org/wbi/governance/govdata2001.htm	2001
Water abstraction for public supply (intensity per capita and as a % of total abstractions)			OECD	1999
Socio-Economic Indicators				
GDP per Capita	Driving Force	2.5	UN Dept. of Economic and Social Affairs; Division for Sustainable Development, Indicators for Sustainable Development: Framework and Methodologies, DESA/DSD/2001/3	2001
Production and consumption patterns	Impact and effect	1.5	UN Statistic Division	1995
Real GDP per capita growth rate	Driving Force	1.5	UN Statistic Division; http://www.un.org/Depts/unsd/enviro/longlist.html	1995

GDP per capita, 2000 (1000 USD/cap.)	Driving Force	0.5	OECD	1999
GNP per capita (US$), 1999	Driving Force	0.5	UNICEF; The state of the World's Children 2001 http://www.unicef.org/sowc01/tables/#	2001
GNP total (US$ millions) per capita (US$) 1998	Driving Force		UNDP	2000
Vulnerability				
Human settlements vulnerable to natural disasters	Exposure	3.5	UN Statistic Division	1995
Refugees by country of origin (thousands) 1998	Pressure	3.5	UNDP	2000
Frequency of natural disasters	State	2.5	UN Statistic Division	1995
Water Issues				
Acidification of fresh water bodies	Impact and effect	3.5	UN Statistic Division	1995
BOD and COD in fresh water bodies	Impact and effect	3.5	UN Statistic Division	1995
Concentration of fecal coliform in freshwater	State	3.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=172&indedit=Go	2001
Concentrations of fecal coliform in fresh water bodies	Impact and effect	3.5	UN Statistic Division	1995
Concentrations of lead, cadmium, mercury and pesticides in fresh water bodies	Impact and effect	3.5	UN Statistic Division	1995
Discharge of COD	Pressure	3.5	World Bank	1998
Discharges of BOD (ton/yr)	Pressure	3.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/1539ea8d91c2f07a852567360073e591?OpenDocument	1998
Frequency, duration and extent of water shortages	State	3.5	OECD	2001
Fresh water resources per capita (mt)	State	3.5	World Bank	2001
Mortality due to vector borne disease	Effect	3.5	WHO/SDE/OEH/99.10 www.who.org	1999
Regular and accurate monitoring of water quality (frequency and yes/no)	Action	3.5	World Bank	1998
Adequacy of vector control and management disease	Action	3	WHO/SDE/OEH/99.10 www.who.org	1999
Industrial, agricultural and municipal discharges directly into the fresh water bodies	Pressure	3	UN Statistic Division	1995
Access to an improved water resource: urban and rural % of population	Exposure	2.5	World Bank	2001
Annual freshwater used as a % of internal resources	Pressure	2.5	World Bank	1998
BOD in water Bodies	State	2.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=171&indedit=Go	2001
Fresh water resources	State	2.5	World Bank; http://www.worldbank.org/data/wdi2001/pdfs/tab3_5.pdf	2001
Total fresh water withdrawal (% total water resources)	Pressure	2.5	World Bank	2001
Water prices and user charges for sewage treatment	Action	2.5	OECD	2001
Outbreak of water-borne diseases	Effect	2	WHO/SDE/OEH/99.10 www.who.org	1999

% of population using improved drinking water sources, 1999, total, urban, rural	Pressure	1.5	UNICEF	2001
Access to safe drinking water [use of safe drinking water]	Exposure	1.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=314&indedit=Go	2001
Access to safe drinking water: % of population who use any of the following for drinking: piped water, public tap, borehole/pump, protected well or spring, rainwater.	Action	1.5	World Bank	2001
Annual freshwater withdrawals	Pressure	1.5	World Bank	2001
Discharges of fecal coliform counts	Pressure	1.5	World Bank; http://wbln0018.worldbank.org/environment/EEI.nsf/0d16be276f5c1f04852567310056ce9c/1539ea8d91c2f07a852567360073e591?OpenDocument	1998
Emission of organic water pollutants: Kg per day and Kg per day/per worker	Pressure	1.5	World Bank; http://www.worldbank.org/data/wdi2001/pdfs/tab3_6.pdf	2001
Heavy metals concentrations	State	1.5	World Bank	1998
Intensity of use of water resources (abstractions/available resources)	Pressures	1.5	OECD	2001
Population at risk from vector-borne disease	Exposure	1.5	WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Water consumption	Pressure	1.5	UN FCAGDI; http://esa.un.org/unsd/indicatorfoc/indsearchpage.asp?cid=245&indedit=Go	2001
Water quality index by fresh water bodies	Impact and effect	1.5	UN Statistic Division	1995
Water quality risk and state indicators	Exposure	1.5	OECD; Environmental indicators for agriculture Volume 3: Methods and results http://www.oecd.org/htm/M00009000/M00009667.htm	2001
Water withdrawal (% of gross annual availability)	Presure	1.5	OECD	1999
Annual withdrawals of ground and surface water	Pressure	1	UN Statistic Division	1995
BOD in water bodies	Exposure	1	UN Dept. of Economic and Social Affairs	2001
Concentration of Faecal Coliform in Freshwater	Exposure	1	UN Dept. of Economic and Social Affairs	2001
Annual withdrawals of ground and surface water as a % of total available water	Pressure	0	UN Dept. of Economic and Social Affairs	2001
% of population with access to improved drinking water resources (total, urban, rural)	Exposure		United Nations Secretariat; World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), Global Water Supply and Sanitation Assessment 2000 Report http://www.un.org/Depts/unsd/social/watsan.htm	2000
Access to improved water source (% of population urban& rural with access) (1996)	Action		World Bank	2000 - 2001
Access to safe and reliable supplies of drinking water	Exposure/Action		WHO/SDE/OEH/99.10 http://www.who.int/environmental_information/Information_resources/documents/Indicators/EHIndicators.pdf	1999
Annual freshwater withdrawals	Pressure		World Bank	2000 - 2001
Connections to piped water supply	Exposure/Action		WHO/SDE/OEH/99.10 www.who.org	1999

Domestic consumption of water per capita	Pressure		UN Statistic Division	1995
Freshwater resources per capita (cubic meters) 1998	State		World Bank; http://www.worldbank.org/poverty/wdrpoverty/report/tab9.pdf	2000 - 2001
Industrial, agricultural water use per GDP	Pressure		UN Statistic Division	1995
Intensity of water quality monitoring	Action		WHO/SDE/OEH/99.10 www.who.org	1999
Percentage of children living in areas served by public water systems in which the nitrate/nitrite drinking water standard was exceeded			EPA	1993 - 1998
Percentage of children living in areas served by public water systems that exceeded a drinking water standard or violated treatment requirements			EPA	1993 - 1998
Percentage of children living in areas with major violations of drinking water monitoring and reporting requirements			EPA	1993 - 1998
Vector diseases	Exposure		World Bank	2002
Water supply and sanitation	State		World Bank; http://lnweb18.worldbank.org/ESSD/essdext.nsf/44DocByUnid/6AFA9F01440581D085256B8A004C6D4F?Opendocument	2002
General Collections of Indicators				
Compendium of SD Indicator Initiatives			IISD Compendium of SD Indicator Initiatives; http://iisd.ca/measure/compindex.asp	2000
Environmental Protection Agency Indicators			EPA; Environment and Health workshop, National Academies	2002
Environmental Trends			Worldwatch Institute; http://www.worldwatch.org/pubs/vs/vs98/index.htm	1998

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