Sustainable Development Indicators for the Arab Region

Guiding Principles and Methodologies

Part 2 Environmental Indicators

January 2011

ESCWA UNEP LAS

Abu Dhabi Global Environmental Data Initiative

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Theme 7: Natural Hazards
Sub-Theme: Vulnerability to Natural Hazards
Indicator 1: Percentage of Population living in Hazard prone Areas

PERCENTAGE OF POPULATION LIVING IN HAZARD PRONE AREAS		
Core indicator	Vulnerability to natural hazards	Natural hazards

1. INDICATOR

(a) Name: Percentage of population living in hazard prone areas.

(b) Brief Definition: The percentage of national population living in areas subject to significant risk of death or damage caused by prominent hazards: cyclones, drought, floods, earthquake, volcanoes and landslides. The indicator maybe calculated separately for each relevant prominent hazard. The risk of death in a disaster caused by natural hazards is a function of physical exposure to a hazardous event and vulnerability to the hazard. The indicator measures the risk at sub-national scale by using historical and other data on hazards and on vulnerability. The sub-national risk levels are then aggregated to arrive at national values.

(c) Unit of Measurement: Percentage.

(d) Placement in the CSD Indicators Set: Natural hazards/ Vulnerability to natural hazards

2. POLICY RELEVANCE

(a) Purpose: To calculate the percentage of population living in disaster prone areas, thus providing a useful estimate of national vulnerability to cyclones, drought, floods, earthquake, volcanoes and landslides, which combines almost the totality of human and economic loss due to disasters caused by vulnerability to natural hazards. This indicator will contribute to a better understanding of the level of vulnerability in a given country, thus encouraging long-term, sustainable risk reduction programs to prevent disasters, which are a major threat to national development.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): There is a recognized high degree of interdependency between sustainable development and vulnerability to natural hazards. High vulnerability means higher exposure to natural catastrophes in the absence of disaster reduction measures. Disasters caused by vulnerability to natural hazards have a strong negative impact on the development process in both industrialized and developing countries. Therefore, the degree of vulnerability to a given natural hazard provides a key measure of social welfare and development in a given country, as well as an indication of the risk (probability) of natural disasters.
The general increase in vulnerability of societies worldwide has caused the social, economic and environmental impact of to natural disasters to become far greater now than ever before. In fact, the overall number of people affected by disasters has been growing by 6 % each year since 1960. This trend is expected to continue primarily because of increased concentration of people

and values in the areas exposed to natural hazards.

(c) International Conventions and Agreements: Under the Hyogo Framework for Actions, countries and other actors work towards a substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries.

(d) International Targets/Recommended Standards: None.

(e) Linkages to Other Indicators: This indicator is linked with many demographic indicators, including population growth rate (total, urban and rural) and percentage of population in coastal areas. It is also linked to most poverty indicators, as poverty is a major determinant of vulnerability. It is directly linked to the indicator on human economic losses due to natural disasters.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts:
The individual vulnerability to hazard is the probability being killed in the event of a hazard. Alternatively, the indicator can be calculated on the basis of the expected economic damage in the event of a hazard.
The mortality risk due to hazards in a geographic area is the product of the probability of a hazard taking place in that area and the average vulnerability to hazards.
An area is defined as hazard prone area if the mortality risk is higher than a certain threshold.
A cyclone is defined as a wind storm with maximum speed of more than 64 knots per hour. The definition includes typhoons and hurricanes.
A drought is a period of deficiency of moisture in the soil such that there is inadequate water required for plants, animals and human beings. It can be further defined as weighted anomaly of standardized precipitation over an extended period (e.g., 3 months).
A flood is a significant rise of water level in a stream, lake, reservoir or coastal region. Only extreme floods are typically counted.
Earthquake is sudden break within the upper layers of the earth, sometimes breaking the surface, resulting in the vibration of the ground, which were strong enough will cause the collapse of buildings and destruction of life and property. Typically, earthquakes >4.5 on the Richter Scale are considered.
Volcano, or volcanic eruption, is the discharge (aerially explosive) of fragmentary ejecta, lava and gases from a volcanic vent.
Landslides are, in general, all varieties of slope movement, under the influence of gravity. More strictly refers to down-slope movement of rock and/or earth masses along one or several slide surfaces. Snow avalanches may also be included under landslides.

(b) Measurement Methods:
For earthquakes, the percentage of population living in seismic risk zones will be obtained by combing population density maps with seismic hazard maps. The most suitable way to express the level of seismic risk is through zoning (very high, high, medium, and low). Richter Scale and Modified Mercalli scale (easily compatible) are recommended as basis for the zoning. Populations living in “very high” and “high” zones are considered to be at risk.
The percentage of population living in flood prone areas will be obtained by combining the area

affected by the 100 year return period flood with population density data.
For other hazards, the risk at a sub-national scale can be measured by using historical and other data on hazards and on vulnerability.

(c) Limitations of the Indicator: The validity of this indicator is limited by the quality and the format of the data used for its calculation. Comparability over time may represent a particular problem for this indicator.

(d) Status of the Methodology: This methodology is being used by a the Disaster Risk indexing project of the UNDP in partnership with UNEP-GRID; the Hotspots indexing project implemented by Columbia University and the World Bank, under the umbrella of the ProVention Consortium and the Americas programme of IDEA in partnership with the InternAmerica Developing Bank. These projects are based on a conceptual framework that includes particular understanding of the factors contributing to human vulnerability and disaster risk. The methodology for seismic risk assessment is widely used through the scientific community, in particular in RADIUS (Risk Assessment Tools for Diagnosis of Urban Areas Against Seismic Disasters), a tool developed to assess earthquake risk in urban areas worldwide.

(e) Alternative Definitions: Not available

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Cyclone prone areas; drought risk map, floods risk map, earthquake risk maps, volcanoes and landslides risk maps (see above); population distribution maps; flood hazard (floodplain) maps; population distribution maps.
http://www.wetlands.agro.nl
(b) National and International Data Availability and Sources: Data availability at the country varies according to countries. At the international level, data on global hazard frequency and risk and their distribution is available through the Hotspot project implemented by the Center for Hazards & Risk Research at Columbia University. Data on global disasters is available in the EM-DAT database, maintained by the Centre for Research on the Epidemiology of Disasters (CRED) in Brussels. http://www.ecn.nl/doc/europe/legislat/bernconv.html
http://edcdaac.usgs.gov/glcc/glcc.html
(c) Data References: For the Hotspot core data set, see http://www.ldeo.columbia.edu/chrr/research/hotspots/http://www.satellus.se
For the EM-DAT database, see http://www.em-dat.net/http://www.fao.org/forestry

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Secretariat for the International Strategy for Disaster Reduction (ISDR), United Nations, Geneva.

http://www.undp.org/bcpr
(b) Other Contributing Organizations: UNDP, UNEP-GRIP, World Bank (ProVention Consortium), Inter American Development Bank**:** ICSU – International Council of Scientific

Unions, WMO, Munich Reinsurance. **Biodiversity Ecosystems** Eurostat. Economy-wide material flow accounts and derived indicators – A methodological guide, 2001.

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(b) Internet sites:

http://www.unisdr.org
http : //www.munichre.com
http://www.geohaz.org/
http://www.ldeo.columbia.edu/chrr/research/hotspots/
http://www.cred.be
http://www.undp.org/bcpr
http://www.undp.org/bcpr/disred/documents/publications/visionsofrisk.pdf#search='Hotspots%20indexing%20project');

Theme 7: Natural hazards
Sub-Theme: Disaster Preparedness and Response
Indicator 2: Human and Economic Loss Due to Disasters

HUMAN AND ECONOMIC LOSS DUE TO DISASTERS		
Core indicator	**Disaster Preparedness and Response**	**Natural hazards**

1. INDICATOR

(a) Name: Human and economic loss due to disasters caused by vulnerability to natural hazards.

(b) Brief Definition: The number of persons deceased, missing, and/or injured as a direct result of a disaster involving natural hazards; and the amount of economic and infrastructure losses incurred as a direct result of the natural disaster.

(c) Unit of Measurement: Number of fatalities; $US.

(d) Placement in the CSD Indicators Set: Natural disaster/Disaster Preparedness and Response.

2. POLICY RELEVANCE

(a) Purpose: To provide estimates of the human and economic impact of disasters in order to measure the trends in population vulnerability and to determine whether a country or province is becoming more or less prone to the effects of disasters.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Disaster involving natural hazards can have devastating short and long-term impacts on the society and the economy of any country, adversely affecting progress towards sustainable development. They cause loss of life, social disruption and affect economic activities. This is particularly true for highly vulnerable, low-income groups. They also cause environmental damage, such as loss of fertile agricultural land, and water contamination. They affect urban settlements and may result in major population displacements.
The general increase in vulnerability of societies worldwide has caused the social, economic and environmental impact of disaster involving natural hazards to become far greater now than ever before. In fact, the overall number of people affected by disasters has been growing by 6% each year since 1960. This trend is expected to continue primarily because of increased concentration of people and values in the areas exposed to natural hazards, such as floods and earthquakes.

(c) International Conventions and Agreements: Based on the experience of the International Decade for Natural Disaster Reduction, the UN General Assembly adopted resolution

A/54/219 which established a permanent mandate for the UN system in the field of disaster reduction, in the framework of the global programme named International Strategy for Disaster Reduction (ISDR).

(d) International Targets/Recommended Standards: None.

(e) Linkages to Other Indicators: This indicator is linked with indicators that are related to issues of vulnerability: % Population Living Below Poverty Line, Floor Area Per Person, Population Growth Rate, Population of Urban Formal and Informal Settlements, Area of Urban Formal and Informal Settlements, and other institutional indicators like National Sustainable Development Strategy.

This indicator would have greater significance if correlated to indicators of vulnerability to specific hazards such as earthquakes and floods, which account for the majority of loss due to natural disasters, especially in developing countries and if related to the number of people leaving in high-risk areas.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: There is a recognized high degree of interdependency between sustainable development and vulnerability to natural hazards. High vulnerability means higher exposure to natural catastrophes in the absence of disaster risk reduction measures. Disasters caused by vulnerability to natural hazards have a strong negative impact on the development process in both industrialized and developing countries. Therefore, the degree of vulnerability to a given natural hazard provides a key measure of social welfare and development in a given country, as well as an indication of the risk (probability) of a disaster.

For the purpose of this indicator, the following definitions have been used:

Disaster involving natural hazards is the consequence of the impact of a natural hazard on a socio-economic system with a given degree of vulnerability, which overwhelms local capacity to respond to the emergency and has disruptive consequences on human, social and economic parameters.

Natural hazards comprise phenomena such as earthquakes; volcanic activity; landslides; tsunamis; tropical cyclones and other severe storms; tornadoes and high winds; river floods and coastal flooding; wildfires and associated haze; drought; infestations.

Vulnerability to hazards is a function of human activities. It describes the degree to which a socio-economic system is susceptible to the impact of natural and other related hazards. Vulnerability also depends on aspects such as hazard awareness, the characteristics of human settlements and infrastructure, public policy and administration, and organized abilities in all fields of disaster management. At present, poverty is one major cause of vulnerability in many parts of the world.

(b) Measurement Methods: The measurement methods proposed are based on the criteria used by the Centre for Research on the Epidemiology of Disaster (CRED). The data elements included here have been selected and modified according to the requirements of the sustainable development indicator methodology sheets. Overall, these data should be collected and validated at the country level by a public authority using these standard criteria and methods. Each element is presented first in a concise description, followed by comments and the proposed recording procedure.

i) Onset Date: This establishes the date when the disaster situation occurred. This date is well defined for all sudden-impact disasters. For disaster situations which develop gradually overtime (for example, drought) scientific (meteorology and seismology institutes) and governmental (civil defense authorities) sources.

ii) Declaration Date: The date when the first call for external assistance concerning the disaster is issued. This call for external assistance mentioned here is defined according to the definition of a disaster situation stated above. This date is available for all disaster situations to be included for the indicator. Only the date of the first appeal for external assistance is recorded.

iii) Disaster Type: This describes the disaster according to a pre-defined classification scheme. Disaster types should include all types of natural disasters, for example, earthquakes, cyclones, floods, volcanic eruptions, drought, and storms. Disasters may be further described as sudden onset, such as earthquakes and floods, and long-term, such as drought. Two or more disasters may be related, or other disaster types may occur as a consequence of a primary event. For example, a cyclone may generate a flood or landslide; or an earthquake may cause a gas line to rupture.

iv) Country: This defines the country in which the disaster occurred. Every disaster record will be by country. Autonomous regions, not yet recognized as countries, will not be used. The same disaster may affect more than one country, and here separate records are maintained.

v) Fatalities: This includes persons confirmed dead and persons missing and presumed dead. Official figures are used whenever available. The figure is updated as missing persons are confirmed to be dead.

vi) Estimated Amount of Damage: This represents the value of all damages and economic losses directly related to the occurrence of the given disaster. The economic impact of a disaster usually consists of direct (for example, damage to infrastructure, crops, housing) and indirect (for example, loss of revenues, unemployment, market destabilization) consequences on the local economy. Although several institutions have developed methodologies to quantify these losses in their specific domain, no standard procedure to determine a global figure for the economic impact exists. Three different figures are recorded from sources which have a well-defined methodology for the assessment of economic impacts, including the World Bank and other international lending agencies; the host government; and, especially in the case of complex emergency situations, the total budget requirements listed in the consolidated appeals launched by UN agencies and other major non-government organizations.

(c) Limitations of the Indicator: The validity of this indicator is limited by the quality and the format of the data used for its calculation. Comparability over time may represent a particular problem for this indicator.

(d) Status of the Methodology: The methodology is in widespread use on both developed and developing countries although it is not standardized.

(e) Alternative Definitions: If the indicator has to reflect changing risk, the measurement should be losses per unit of time per capita. This is not possible without further development of the indicator methodology.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: As described in 4.b.

(b) National and International Data Availability and Sources: Data above is normally available within each country or easily obtainable; other sources are international scientific associations; insurance companies (Munich Re, Swiss Re), national geological survey agencies; space agencies and satellite service providers; the UN system and the ISDR framework. Internationally, some data is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) in Brussels, which compiles and validates data from diverse sources

(c) Data References: EM-DAT database, maintained by CRED, see http://www.em-dat.net/ .

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Secretariat for the International Strategy for Disaster Reduction (ISDR), United Nations, Geneva.

(b) Other Contributing Organizations: The Centre for Research on the Epidemiology of Disasters, Faculty of Medicine, University of Louvain, Belgium. The following organizations were consulted over the development and subsequent review of this indicator methodology sheet: World Food Programme, United Nations Environment Programme, Pan American Health Organization, International Federation of the Red Cross and Red Crescent Societies, and US Agency for International Development, ICSU – International Council of Scientific Unions, Munich Reinsurance Company.

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(b) Internet sites:
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http://www.geohaz.org/
http://www.ldeo.columbia.edu/chrr/research/hotspots/
http://www.cred.be
http://www.undp.org/bcpr
http://www.undp.org/bcpr/disred/documents/publications/visionsofrisk.pdf#search='Hotspots%20indexing%20project');

Theme 8: Atmosphere

SUB THEME/ ISSUE	Indicators
Climate Change Air Quality	Emissions of Greenhouse Gases
	Ambient Concentration of Air Pollutants in Urban Areas
Ozone Layer Depletion	Consumption of Ozone Depleting Substances

Theme 8: Atmosphere
Sub-Theme: Climate Change
Indicator 1: Emissions of Greenhouse Gases

EMISSIONS OF GREENHOUSE GASES		
Core indicator	**Climate Change**	**Atmosphere**

1. INDICATOR

(a) Name: Emissions of Greenhouse Gases (GHG).

(b) Brief Definition: Anthropogenic emissions, less removal by sinks, of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6). .

(c) Unit of Measurement: Annual GHG emissions in gigagrams (Gg). Emissions of CH_4, N_2O, HFCs, PFCs and SF_6 can be converted to CO_2 equivalents using the so-called global warming potentials (GWPs) provided in assessments of the Intergovernmental Panel on Climate Change.

(d) Placement in the CSD Indicator Set: Atmosphere/Climate Change.

2. POLICY RELEVANCE

(a) Purpose: This indicator measures the emissions of the six main GHGs which have a direct impact on climate change, less the removal of the main GHG CO_2 through sequestration as a result of land-use change and forestry activities.

(b) Relevance to Sustainable/ Unsustainable Development (theme/sub-theme): For about a thousand years before the industrial revolution, the amount of greenhouse gases in the atmosphere remained relatively constant. Since then, the concentration of various greenhouse gases has increased. The amount of carbon dioxide, for example, has increased by more than 30% since pre-industrial times and is currently increasing at an unprecedented rate of about 0.4% per year, mainly due to the combustion of fossil fuels and deforestation. The concentrations of methane and nitrous oxide are increasing as well due to agricultural, industrial and other activities. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) do not occur naturally in the atmosphere but have been introduced by human activities. They are strong greenhouse gases and have long atmospheric lifetimes.
Since the late nineteenth century, the mean global temperature has increased by 0.4-0.8°C and the sea level has risen by 10 to 15cm. A doubling of the CO_2 concentration in the atmosphere is believed to cause an increase in the global mean temperature of 1.5 to 4.5°C. To appreciate the magnitude of this temperature increase, it should be compared with the global mean temperature difference of perhaps 5 to 6°C from the middle of the last ice age to the present interglacial period.

(c) International Conventions and Agreements: The United Nations Framework Convention on Climate Change entered into force in March 1994 and as of 11 April 2007 has received 191 instruments of ratification or accession. The Kyoto Protocol to the Convention was adopted in December 1997 and entered into force on 16 February 2005. As of 6 June 2007, the Kyoto Protocol has received 174 instruments of ratifications, accessions, approvals or acceptances.

(d) International Targets/Recommended Standards: The Climate Change Convention includes a commitment by developed country Parties (Annex I Parties), including economies in transition, to aim to return emissions of CO_2 and other GHGs not controlled by the Montreal Protocol to their 1990 levels by 2000. This was achieved: in 2000, GHG emissions from Annex I Parties were about 6 per cent below the 1990 level. The Kyoto Protocol sets individual emission reduction targets for Annex I Parties (developed countries, including countries with economies in transition), which should lead to an overall reduction in GHG emissions from developed countries by at least 5 per cent below the 1990 level in the first commitment period 2008 to 2012.

(e) Linkages to Other Indicators: This indicator is linked to many other socio-economic and environmental indicators, including GDP growth rate, energy consumption, environmental protection expenditures, and expenditures on air pollution abatement.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Greenhouse gases contribute in varying degrees to global warming depending on their heat absorptive capacity and their lifetime in the atmosphere. The global warming potential (GWP) describes the cumulative effect of a gas over a time horizon (usually 100 years) compared to that of CO_2. For example, according to the IPCC Second Assessment Report, 1995, the global warming potential of CH_4 (methane) is 21, meaning that the global warming impact of one kg of CH_4 is 21 times higher than that of one kg of CO_2.

(b) Measurement Methods: In some cases, GHG emissions can be measured directly at the source. More commonly, emissions are estimated from data on emission sources, for example oil sales data or cattle numbers, using an emission factor for each source.

(c) Limitations of the Indicator: This indicator shows the net amount of GHGs entering the atmosphere for each reporting country each year. It does not show how much the climate will be affected by the increased accumulation of GHGs or the consequent effect of climate change on countries. Data for developed countries, including economies in transition, are more complete and easier available than data for developing countries.

(d) Status of the Methodology: Developed country Parties to the Convention have been reporting GHG data, beginning with 1990 data, since 1994. The IPCC has published two sets of guidelines on methodologies for the estimation of GHG inventories and further elaborated this with guidance on good practice in 2000 and guidance for land use, land-use change and forestry in 2003.

(e) Alternative Definitions/Indicators: GHG emissions can alternatively be measured on a gross instead of net basis in which case no account is taken of removal by sinks. There are a number of other gases that indirectly produce GHGs and these could also be included in the scope of the definition. The GWP potential can be calculated over different time horizons, such as 20 years or 500 years.

In addition to the six main greenhouse gases included in this indicator, chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and other ozone-depleting gases also contribute to the global warming and could be monitored. However, the global warming potentials of ozone-depleting greenhouse gases are highly uncertain, since they depend on the depletion of ozone, itself a greenhouse gas. CFCs and HCFCs are included in the indicator "Consumption of ozone-depleting substances". One could also monitor indirect greenhouse gases such as nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs). Although these gases themselves are not greenhouse gases, they affect atmospheric chemistry, leading to an increase in tropospheric ozone, which is a greenhouse gas. However, no global warming potentials are provided for indirect greenhouse gases.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Greenhouse gas emissions data.

(b) National and International Data Availability and Sources: National communications from Parties to the Climate Change Convention, including both developed and developing countries, are available. In addition, developed countries submit their detailed GHG inventories to the UNFCCC secretariat annually. At the international level, the UNFCCC Secretariat supports a database with GHG data based on annual data inventory submissions from developed countries and periodic submissions of national communications from developing countries.

(c) Data References:
GHG data section at the UNFCCC website (http://unfccc.int/ghg_emissions_data/items/3800.php)
National greenhouse gas inventory data for the period 1990-2004 and status of reporting. UNFCCC document FCCC/SBI/2006/26 (available at http://unfccc.int/resource/docs/2006/sbi/eng/26.pdf)
National submissions of GHG inventories of Annex I Parties under the Climate Change Convention (available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3734.php

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). The contact point is the
Executive Secretary, Secretariat, UNFCCC, fax no. (49-228) 815-1999.

(b) Other Contributing Organizations: The Intergovernmental Panel on Climate Change (IPCC) develops methodological guidance for GHG emissions estimates. The International

Energy Agency (IEA) supports a comprehensive database on CO_2 emissions from fuel combustion, including the data on CO_2–related indicator.

6. REFERENCES

(a) Readings:

National greenhouse gas inventory data for the period 1990-2004 and status of reporting. UNFCCC document FCCC/SBI/2006/26 (available at http://unfccc.int/resource/docs/2006/sbi/eng/26.pdf)

UNFCCC reports on technical reviews of GHG inventories of developed countries (http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/3723.php).

UNFCCC reports on in-depth reviews of national communications of individual countries (available at http://unfccc.int/national_reports/annex_i_natcom/idr_reports/items/2711.php).

(b) Internet sites:

unfccc.int (UNFCCC)
http://www.un.org/climatechange/ (Gateway to the UN System's Work on Climate Change)
www.iea.org (IEA)
www.ipcc.ch (IPCC)
www.ipcc.nggip.iges.or.jp (IPCC technical support)

Theme 8: Atmosphere
Sub-Theme: Air Quality
Indicator 2: Ambient Concentration of Air Pollutants in Urban Areas

AMBIENT CONCENTRATION OF AIR POLLUTANTS IN URBAN AREAS		
Core indicator	**Air Quality**	**Atmosphere**

1. INDICATOR

(a) Name: Ambient concentration of air pollutants in urban areas.

(b) Brief Definition: Ambient air pollution concentrations of ozone, particulate matter ($PM_{10,}$ and $PM_{2,5}$, if those are not available: SPM, black smoke), sulfur dioxide, nitrogen dioxide, lead. Additional: carbon monoxide, volatile organic compounds including benzene (VOCs). The priority is collection of the indicator in large cities (over 1 million population).

(c) Unit of Measurement: $\mu g/m^3$, ppm or ppb, as appropriate;

(d) Placement in the CSD Indicator Set: Atmosphere/Air Quality.

2. POLICY RELEVANCE

(a) Purpose: The indicator provides a measure of the state of the environment in terms of air quality and is an indirect measure of population exposure to air pollution of health concern in urban areas.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): An increasing percentage of the world's population lives in urban areas. High population density and the concentration of industry exert great pressures on local environments. Air pollution, from households, industry power stations and transportation (motor vehicles), is often a major problem. As a result, the greatest potential for human exposure to ambient air pollution and subsequent health problems occurs in urban areas. Improving air quality is a significant aspect of promoting sustainable human settlements.
The indicator may be used to monitor trends in air pollution as a basis for prioritizing policy actions; to map levels of air pollution in order to identify hotspots or areas in need of special attention; to help assess the number of people exposed to excess levels of air pollution; to monitor levels of compliance with air quality standards; to assess the effects of air quality policies; and to help investigate associations between air pollution and health effects.

(c) International Conventions and Agreements: None.

(d) International Targets/Recommended Standards: World Health Organization (WHO) air quality guidelines exist for all the pollutants of this indicator. Many countries have established their own air quality standards for many of these pollutants.

(e) Linkages to Other Indicators: This indicator is closely linked to others which relate to causes, effects, and societal responses. These include, for example, the indicators on population growth rate, rate of growth of urban population, percent of population in urban areas, annual energy consumption per capita, emissions of sulfur oxides and nitrogen oxides, life expectancy at birth, total national health care as a percent of Gross National Product, share of consumption of renewable energy resources, environmental protection expenditures as a percent of Gross Domestic Product, expenditure on air pollution abatement, childhood morbidity due to acute respiratory illness, childhood mortality due to acute respiratory illness, capability for air quality management, and availability of lead-free gasoline.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The indicator may be designed and constructed in a number of ways. Where monitored data are available, it is usefully expressed in terms of mean annual or percentile concentrations of air pollutants with known health effects – e.g., ozone, carbon monoxide, particulate matter ($PM_{10,}$ $PM_{2,5}$, SPM), black smoke, sulfur dioxide, nitrogen dioxide, volatile organic compounds including benzene (VOCs) and lead – in the outdoor air in urban areas.
Where monitoring data are unavailable, estimates of pollution levels may be made using air pollution models. Dispersion models, however, depend on the availability of emission data; where these are not available, surveys may be conducted using rapid source inventory techniques. Because of the potential errors in the models or in the input data, results from dispersion models should ideally be validated against monitored data.

(b) Measurement Methods: Suitable air monitors must fulfill several requirements, such as detection limits, interferences, time resolution, easy operation and of course, cost. There are several good references in the literature or available at agencies on air monitoring and analysis from where information can be obtained. It is important, however, to refer to the published scientific literature for the most appropriate and recent air monitoring methods.
A number of models are available for estimation of ambient concentration of air pollutants. Most of them are founded on the Gaussian air dispersion model.

(c) Limitations of the Indicator: Measurement limitations relate to detection limits, interferences, time resolution, easy operation, and cost. Evaluation of the accuracy of model results is critical before relying on model output for decision-making.

(d) Status of the Methodology: The methodology is widely used in many developed and developing countries.

(e) Alternative Definitions: None.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Data must be time and spatially representative concentrations such as, for example, mean annual concentrations (mean concentrations of the pollutant of concern, averaged over all hours, or days, of the year) or percentile concentration (concentration of the pollutant of concern exceeded in 100-X% of hours/days, where X is the percentile as defined by the relevant standards). In addition, information must be available on site location and type (e.g., industrial, transport oriented or residential area).

(b) National and International Data Availability and Sources: Data on ambient air pollution concentrations is often routinely collected by national or local monitoring networks. Data is often also collected for research purposes by universities and research institutes. In addition, industry collects many data.

(c) Data References: Data on ambient air pollution can be obtained from national and local monitoring networks. Sometimes, data is available from universities, research institutes and industry. In addition, a growing volume of data can be obtained from international sources such as the European Environmental Agency.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the World Health Organization (WHO). The contact point is the Director, Department for the Protection of the Human Environment; fax no. (41 22) 791 4159.

(b) Other Contributing Organizations: The United Nations Environment Programme.

6. REFERENCES

(a) Readings:

WHO (2000) Air Quality Guidelines for Europe, Second Edition. WHO Regional Publications, European Series, No. 91

WHO (2000) Human Exposure Assessment, Environmental Health Criteria Document 214, Programme of Chemical Safety.

WHO (2000) Decision-Making in Environmental Health: From Evidence to Action, edited by C. Corvalan, D. Briggs and G. Zielhuis, E & FN Spon, London, New York.

WHO (1999) Monitoring Ambient Air Quality for Health Impact Assessment, WHO Regional Publications, European Series, No. 85.

WHO (1999) Environmental Health Indicators: Framework and Methodologies. Prepared by D. Briggs, Occupational and Environmental Health.

WHO (2006) WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005. Summary of risk assessment. http://www.who.int/phe/air/aqg2006execsum.pdf

Schwela & Zali (eds. 1999) Urban Traffic Pollution. Edited by D. Schwela and O. Zali, E & FN Spon, London, New York.

UNEP/WHO (1992) Urban Air Pollution in Megacities of the World, Blackwell Publishers, Oxford, UK.

UNEP/WHO (1994) Global Environmental Monitoring System (GEMS/Air), Methodology Review Handbook Series. Volumes 2, 3, and 4.

(b) Internet sites:

http://www.who.int/phe/en/
http://www.euro.who.int/air
http://www.unep.org

Theme 8: Atmosphere
Sub-Theme: Ozone Layer Depletion
Indicator 3: Consumption of Ozone Depleting Substances

CONSUMPTION OF OZONE DEPLETING SUBSTANCES		
Core indicator	Ozone Layer Depletion	Atmosphere

1. INDICATOR

(a) Name: Consumption of Ozone Depleting Substances (ODSs).

(b) Brief Definition: This indicator will show the consumption trends for ODSs controlled under the Montreal Protocol on Substance that Deplete the Ozone Layer, thereby allowing inference of the amounts of Ozone Depleting Substances being eliminated as a result of the protocol.

(c) Unit of Measurement: ODP Tonnes, which is defined as the Metric Tonnes of ODSs weighted by their Ozone Depletion Potential (ODP).

(d) Placement in the CSD Indicator Set: Atmosphere/Ozone layer depletion.

2. POLICY RELEVANCE

(a) Purpose: This indicator depicts the progress towards the phase out the ODSs by the countries which have ratified the Montreal Protocol on Substances that Deplete the Ozone Layer and its Amendments of London (1990), Copenhagen (1992), Montreal (1997) and Beijing (1999).

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The phase-out of ODSs, and their substitution by less harmful substances or new processes, will lead to the recovery of the ozone layer. Stratospheric ozone absorbs most of the biologically damaging ultraviolet radiation (UV-B). Without the filtering action of the ozone layer, more UV-B radiation can penetrate the atmosphere to have adverse effects on human health, animals, plants, micro-organisms, marine life, materials, biogeochemical cycles, and air quality.

(c) International Conventions and Agreements: The Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer and the London, Copenhagen, Montreal and Beijing Amendments to the Protocol.

(d) International Targets/Recommended Standards: The international target under the agreements listed in 2 (c) is the gradual (but ultimately complete) phase-out of use/consumption of ODSs.
The indicator is also used to measure progress towards the Millennium Development Goal Nr. 7 (Ensure environmental sustainability) and the associated target "Integrate the principles of

sustainable development into country policies and programmes and reverse the loss of environmental resources".

(e) Linkages to Other Indicators: This indicator has links to other environmental and institutional indicators, such as number of chemicals banned or restricted and ratification of international agreements. It has significant implications to human health and natural resources.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: **Ozone Depleting Substance** (ODS) means any organic substance containing chlorine or bromine, which destroys the stratospheric ozone layer. **Controlled substance** means a substance in Annex A, Annex B, Annex C or Annex E of the Montreal Protocol, whether existing alone or in a mixture. It includes the isomers of any such substance, except as specified in the relevant Annex, but excludes any controlled substance or mixture which is in a manufactured product other than a container used for the transportation or storage of that substance. **Production** means the amount of listed, controlled substances produced, minus the amount destroyed by technologies to be approved by the Parties to the Montreal Protocol and minus the amount entirely used as feedstock in the manufacture of other chemicals. The amount recycled and reused is not to be considered as "production". **Consumption** is the sum of production plus imports minus exports of controlled substances. We are addressing apparent consumption. **Weighted tonnes of ODSs** means the amount of ODSs in tonnes multiplied by their ozone depleting potential. **Ozone depleting potential** (ODP) is a relative index of the ability of a substance to cause ozone depletion. The reference level of 1 is assigned as an index to CFC-11 and CFC-12. If a product has an ODP of 0.5, a given weight of the product in the atmosphere would, in time, deplete half the ozone that the same weight of CFC-11 or CFC-12 would deplete. ODPs are calculated from mathematical models which take into account factors such as the stability of the product, the rate of diffusion, the quantity of depleting atoms per molecule, and the effect of ultraviolet light and other radiation on the molecules.

(b) Measurement Methods: Weighted Tonnes of ODSs for production are the sum of national annual production (in tonnes) of each controlled substance (as reported to the Ozone Secretariat in accordance with Article 7 of the Montreal Protocol) multiplied by the ozone depleting potential of that substance (as listed in Annexes A, B, C and E of the Montreal Protocol, whose text can be found in the Handbook for the International Treaties for the Protection of the Ozone Layer, 2003 [NB: A new edition is coming out in 2006]). It can be found at: http://ozone.unep.org/ , http://www.unep.ch/ozone or http://www.unep.org/ozone . Weighted Tonnes of Ozone Depleting Substances for consumption are obtained through a similar calculation using national annual consumption values (in tonnes).

(c) Limitations of the Indicator: Availability and accuracy of data and timely reporting will determine the country's ability to use the indicator. The indicator by itself does not reveal much about current trends in the deterioration of the ozone layer because of delays in ecosystem response.

(d) Status of the Methodology: For more information, please consult the Reports of the Secretariat on information provided by the Parties in accordance with Article 7 of the Montreal

Protocol or the Home Page at: http://ozone.unep.org/ , http://www.unep.ch/ozone or http://www.unep.org/ozone .

(e) Alternative Definitions/Indicators: An alternative indicator could focus on emissions of ODSs. However, such information is not available, hence the use of the consumption data as a proxy for indicating possible levels of emissions since most of the usage of ODSs is ultimately emitted to the atmosphere. Another possible indicator is the concentration levels of ODSs in the atmosphere.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Data on production, imports and exports of controlled substances by the Parties to the Montreal Protocol.

(b) National and International Data Availability and Sources: The data are available for most countries, on a national level, on a regular annual basis, as part of their reporting obligations under the Montreal Protocol. The data are more centrally available at the international level from the Ozone Secretariat in Nairobi and from the Multilateral Fund Secretariat in Montreal (as Parties to the Protocol report to these Secretariats). The data sources are the Ozone Secretariat and the national government ministry responsible for reporting under the Montreal Protocol.

(c) Data References: UNEP, Production and Consumption of Ozone Depleting Substances, 1986-2004, United Nations Environment Programme, pp. 41, 2005. Web site: http://ozone.unep.org/ , http://www.unep.ch/ozone or http://www.unep.org/ozone .
Data on this indicator is also included in the MDG database, see http://mdgs.un.org/

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the United Nations Environment Programme (UNEP)/Ozone Secretariat. The contact point is the Executive Secretary of the Ozone Secretariat, fax no. (254-2) 762-4691/2/3.
(b) **Other Contributing Organizations:** Other organizations interested in the further development of this indicator would include: The Multilateral Fund Secretariat, the Global Environment Facility (GEF) Secretariat, United Nations Development Programme (UNDP), UNEP Division of Technology, Industry & Economics (UNEP DTIE), United Nations Industrial and Development Organization (UNIDO), the World Bank, the Technology and Economic Assessment Panel to the Montreal Protocol, the Parties to the Montreal Protocol, the Organization for Economic Co-operation and Development (OECD), and members associated with the Alternative Fluorocarbon Environmental Acceptability Study (AFEAS).

6. REFERENCES

(a) Readings:
Ozone Secretariat, UNEP, Handbook for the International Treaties for the Protection of the Ozone Layer (Sixth Edition), pp.398, 2003. (ISBN: 92- 807-2316-2).

UNEP, Synthesis of the Reports of the Scientific, Environmental Effects and Technology and Economic Assessment Panels of the Montreal Protocol. A Decade of Assessments for Decision Makers Regarding the Protection of the Ozone Layer: 1989-1998, United Nations Environment Programme, pp. 161, 1999. (ISBN: 92-807- 1733-2).
UNEP, Reports of the Technology and Economic Assessment Panel of the Montreal Protocol.
Reporting of Data by the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer.

(b) Internet sites:
http://ozone.unep.org/
http://www.unep.ch/ozone
http://www.unep.org/ozone
http://www.unmfs.org
http://www.uneptie.org/ozonaction.html
http://www.undp.org/seed/eap/montreal/index.htm
http://www.unido.org
http://www-esd.worldbank.org/mp

THEME 9: Land/ Agriculture

SUB THEME/ ISSUE	Indicators
Land Use	Land Use Change
Land Degradation - Desertification	Land Affected by Desertification/Degradation
	Vegetation Cover/Composition
Agriculture	Arable and Permanent Crop Land Area
	Use of Fertilizers
	Use of Agricultural Pesticides

Theme 9: Agriculture/ Land
Sub-Theme: Land Use
Indicator 1: Land Use Change

LAND USE CHANGE		
Core indicator	Land use and status	Land

1. INDICATOR

(a) Name: Land use change.

(b) Brief definition: Change with time of the distribution of land uses within a country.

(c) Unit of Measurement: Proportion of change of each category of land use to another land use per unit of time.

(d) Placement in the CSD Indicator Set: Land/Land use and status.

2. POLICY RELEVANCE

(a) Purpose: The purpose of this indicator is to highlight changes in the productive or protective uses of the land resource to facilitate sustainable land use planning and policy development.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub theme): Information on land use change is critical for integrated and sustainable land use planning. Such information is useful in identifying opportunities to protect land uses or promote future allocation aimed at providing the greatest sustainable benefits for people. Changes in arable and permanent crop land and wooded areas give important information about a country's endowment in agricultural and forest resources, both from an economic and an environmental perspective. Economically, changes in land use will, for example, result in changes in the volume of produce available and influence employment opportunities. From an environmental point of view, unsustainable land use is an important factor in land degradation, may pose a threat to ecosystems, and lead to natural habitat loss and landscape changes. Changes which lead, for example, to inappropriate farming and grazing practices, or to environmentally insensitive construction or mining activities are significant from a sustainability viewpoint. This indicator acts as a synoptic measure for the myriad of more specific environmental and natural resource changes significant to sustainable development.

(c) International Conventions and Agreements: Not available.

(d) International Targets/Recommended Standards: Generally, international targets for this indicator do not exist. However, certain minimal contiguous limits or proportions of total land area have been established for certain need or desirable land uses, for example protected areas.

(e) Linkages to other indicators: The interpretation of this indicator is significantly improved if it is considered with land quality. It is also closely linked to many other social, economic, environmental, and institutional indicators, such as those related to population (for example, population growth rate, rate of growth of urban population, population density, population dynamics in mountain areas), energy and mineral reserves, land affected by desertification, sustainable use of natural resources in mountain areas, arable land per capita, wood harvesting intensity, protected areas as a percent of total land area, and sustainable development strategies.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying definitions and concepts: The underlying concepts and definitions for land use classifications are widespread. Work coordinated by the United Nations Food and Agriculture Organization (FAO) is currently underway to harmonize classification systems and databases to improve national and international land use information. This includes the development of definitions and protocols, computerized land use database structure, and broadly accepted structure of land use classifications.

(b) Measurement method: Land use change data can be derived from periodic mapping and monitoring, partly on the basis of land cover information; from remote sensing, supported by ground truthing; and the use of land use aspects from agricultural census. It is essential to use a uniform classification of land use and cover. The Land Degradation Assessment in Dry lands (LADA) approach is recommended (see http://lada.virtualcentre.org/pagedisplay/display.asp?section=method). The Global Land Cover Network (GLCN) is actually developing a software which would be able to indicate changes in broad land use classes over the last twenty years in addition to complement the existing Land Cover Classification System (LCCS). Use of these tools will lead to the production of uniform results and statistics.

(c) Limitations of the Indicator: The indicator by itself does not identify the causes or pressures leading to the change in land use. At the international level, sufficient harmonization of land use classification has yet to be achieved. Georeferenced land use change data are generally not available.
Generally, inferences regarding sustainability of land management would depend on the degree of characterization of land uses (obviously the more detail the better). If land-use characterization is limited (e.g. restricted only to socio-economic purpose, as is the case for many countries), areas of “no change” may give rise to misleading inferences regarding sustainability.

(d) Status of the Methodology: A methodology has not been agreed to by any intergovernmental fora.

(e) Alternative definitions/Indicators: Not available.

4. ASSESSMENT OF DATA

(a) Data needed to Compile the Indicator: The data required includes updated statistics and remote sensing coverage, dependable agricultural census data on land uses, and dependable land use maps, all updated at regular intervals. Broad land use statistics are available for most countries. However, variable definitions, and the lack of consistent land use change data which is spatially referenced are serious impediments to, for example, temporal analysis and international comparisons.

(b) National and International Data Availability and Sources: Times series of land use data (related to agriculture and forestry) aggregated at the national level are available in FAOSTAT for all countries since 1961. Some time-series data related to livestock as well as modeled livestock distribution maps are also available in GLIPHA.

(c) Data References: Not available.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The Food and Agriculture Organization of the United Nations (FAO).

(b) Other Contributing Organizations: The United Nations Environment Programme is a partner in the development of this indicator. National experts from governments and institutes, for example the International Institute for Aerospace Survey and Earth Sciences and the Institute for Terrestrial Ecology, have also contributed.

6. REFERENCES

(a) Readings:

United Nations Environment Programme and Food and Agriculture Organization. Report of the UNEP/FAO Expert Meeting on Harmonizing Land Cover and Land Use Classifications. Geneva November 23-25, 1993. GEMS Report Series No. 25. Nairobi. March 1994.

(b) Internet Sites:

http://lada.virtualcentre.org/

Theme 9: Agriculture/ Land
Sub-Theme: Land Degradation – Desertification
Indicator 2: Land Affected by Desertification/ Degradation

LAND AFFECTED BY DESERTIFICATION		
Core indicator	Desertification	Land

1. INDICATOR

(a) Name: Land Affected by Desertification.

(b) Brief Definition: This is a measure of the amount of land affected by desertification and its proportion of national territory.

(c) Unit of Measurement: Area (Km^2) and % of land area affected.

(d) Placement in the CSD Indicator Set: Land/Desertification.

2. POLICY RELEVANCE

(a) Purpose: The indicator describes the extent and severity of desertification at the national level. It should be: (i) a measure of the state of the problem at any one time; (ii) an indication of the trend in the severity of the problem over time and success of response mechanisms; and (iii) a means of comparing the severity of the problem from one country to another.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The indicator should be a mechanism for determining the importance of this issue at the national level. Trend data over time can indicate success of response mechanisms. For dryland areas, desertification is a central problem in sustainable development. While many dryland ecosystems have generally low levels of absolute productivity, maintenance of that productivity is critical to the present and future livelihood of many hundreds of millions of people. Combating desertification is the core of sustainable development for large areas of the world. Severe degradation is a major impedent to sustainable development; moderate or slight degradation is also a significant barrier.

(c) International Conventions and Agreements: The two most significant agreements are: Agenda 21 of the 1992 UN Conference on Environment and Development; and the UN Convention to Combat Desertification, 1994. In addition, the Desertification Convention texts (INCD-10/ New York) spell out a sound methodology for developing indicators. No definitive set of indicators has been agreed upon within the context of the desertification Convention.

(d) International Targets/Recommended Standards: No specific targets have been defined, however, the goal should be to reduce the area and percentage of land affected by desertification, and/or reduce the severity of desertification.

(e) Linkages to Other Indicators: This state and trends indicator needs to be considered in conjunction with related driving force and response indicators, integrating physical and socio-economic processes, for meaningful interpretation and policy relevance at the national level. It is closely linked with indicators concerning land use, such as deforestation, use of marginal land, protected area as a percent of total land area, and population living below the poverty line.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: For the purposes of this indicator, desertification is defined as land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UN Convention to Combat Desertification, 1994). Land degradation means reduction or loss, in arid, semi-arid and dry sub-humid areas of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and, (iii) long-term loss of natural vegetation. Land degradation, therefore, includes processes which lead to surface salt accumulation and waterlogging associated with salt-affected areas.
Arid, semi-arid, and dry sub-humid areas means areas, other than polar and sub-polar regions, in which the ratio of annual precipitation to potential evapotranspiration falls within the range from 0.05 to 0.65 (UN Convention to Combat Desertification, 1994).

(b) Measurement Methods: Measurement for this indicator initially requires an assessment of the extent of land degradation throughout the arid, semi-arid, and dry sub-humid zones of the nation. This is best done by a combination of previous assessments represented in map form, carried out by the United Nations Environment Programme (UNEP) with the United Nations Office to Combat Desertification and Drought (UNSO), and the Food and Agricultural Organization (FAO); and updates from a combination of remote sensing and local knowledge.
The creation of an index that combines degrees of severity will require the following measures:

(i) Area subjected to severe land degradation xKm^2 (severe here includes both the severe and very severe categories of UNEP.

(ii) Area subjected to moderate land degradation yKm^2.

(iii) Area subjected to slight land degradation = zKm^2.

(iv) National area (excluding surface water bodies) nKm^2.

(v) National area of drylands (vulnerable to desertification, assuming that all drylands are potentially vulnerable to desertification. Hyper-arid lands are excluded), consisting of arid, semi-arid, and dry subhumid land = dKm^2.

From the above measurements, the following sets of numbers can be derived:
Indicator computations:

a. National area affected by desertification

$$= x + y + zKm^2$$

b. Percent of national area affected by desertification

$$= \frac{x + y + z}{n} \times 100$$

c. Percentages of national area affected by severe, moderate and slight desertification respectively can be calculated in the same way.

d. Percent of national drylands affected by desertification

$$= \frac{x + y + z}{d} \times 100$$

e. National area not affected by desertification

$$= n - (x + y + z)Km^2$$

f. National dryland area not affected by desertification

$$= d - (x + y + z)Km^2$$

Trends can be determined by comparing results computed for a sequence of years (for example, every five years).

A useful extension of the indicator would be for countries to report dryland areas (d) as a percentage of all agriculturally productive areas (e=n-hyper arid land) to give an indication of the overall vulnerability of the country to desertification.

While it is based on a combination of analytical and subjective assessment, if these are done systematically on an annual basis, a sound database can be developed. Given the importance of determining the extent and severity of desertification to the index, it may be that a periodic special survey using remote sensing and ground assessment may be important, though this may only be technically feasible for some countries.

An important issue in the basis measurement of degradation is the factors that are measured to assess the degree of local degradation. As Bie (1990) clearly points out, the two factors of productivity and resilience are the most important elements in assessing the existence and the extent of dryland degradation. Accurate measurement of land affected by desertification is a problem about which there is not yet complete consensus and further work needs to be done to agree on a comparable methodology for the various countries affected by desertification (UNEP, Atlas of Desertification; UNEP/ISRIC/ISS/FAO, Global Assessment of the Status of Human-induced Soil Degradation (GLASOD)).

(c) Limitations of the Indicator: There are a number of issues to be resolved before this indicator can be entirely satisfactory. The ecosystems addressed in this definition undergo cyclic episodes of more or less rainfall, as well as long-term degradation in many cases. Separating short-term fluctuations from longer-term trends is important, though scientists often find this difficult to determine, except for longer time periods. Also, the United Nations Environment Programme (UNEP) has generally defined desertification (degradation) in categories (severe, moderate, slight), and a national indicator needs to include an assessment of this kind. It has been a practice to include problems of water logging and salinization as part of desertification, if they occur within the ecosystems as defined above. In this case, the area affected by these problems should also be included in the desertified area.

Because of these issues, the indicator may well benefit from further refinement and definition. The concepts of land degradation in arid, semi-arid, and dry sub-humid areas are well defined and described in a number of UNSO, UNEP, and other UN publications, as well as in the academic literature. The translation of these concepts into agreed national level indicators has not been so well articulated. (Mabbutt, J.A. 1986; Maimuet 1991).

(d) Status of the Methodology: The methodology for this indicator is currently under revision in the context of the Land Degradation Assessment in Drylands (LADA) project implemented by the Food and Agricultural Organization (FAO) and partners. Consequently, the information contained in the present version mainly reflects the status of the methodology in the previous two editions of the CSD indicators.

(e) Alternative Definitions/Indicators: Not available.

4. ASSESSMENT OF DATA

(a) Data Needed to Complete the Indicator: The data needed to compile the indicator are the extent and severity of dry land degradation in the country concerned, the dry land area, and national area (excluding surface water bodies). The degree of accuracy and reliability of both spatial and statistical data varies considerably and are often poorly documented and/or out of date. For some countries, the data do not yet exist. Benchmark data on desertification is critical to measuring progress.

(b) National and International Data Availability and Sources:
The webpage of the LADA project contains a number of country case studies and a wealth of related information. Information on dry lands and national areas can also be obtained from national statistical institutions and publications, and can also be found in standard World Resources Institute (WRI), UN and World Bank publications. Some data on extent and degree of land degradation are available at the country level in national institutions or from non-government organizations, in donor countries, and in publications of the United Nations Development Programme (UNDP)/UNSO, UNEP, FAO and other international institutions.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency will be the Food and Agricultural Organization (FAO).

(b) Other Contributing Organizations: Other contributing organizations include: UNDP Dry land Development Centre, UNEP, Consultative Group on International Agricultural Research (CGIAR), International Fund for Agricultural Development (IFAD), World Soil Information (ISRIC).

6. REFERENCES

(a) Readings:

Bie, Stein W. 1990. Dryland Degradation Measurement Techniques, World Bank, Environment Work Paper No. 26, 42 p.

Dregre, H., Kassas M. and Rozanov, B. 1991 A new assessment of the world status of desertification. Desertification Control Bulletin 20. p. 6-18.

Dumanski, J. And Pieri, C. 1994. Comparison of available frameworks for development of land quality indicators. Agr. Tech. Div., World Bank. p. 14.

Mabbutt, J.A. 1986. Desertification Indicators. Climatic Change 9. P. 113-122.

Mainguet, M. 1991 Desertification: Natural Background and Human Mismanagement. Springer-Verlag, Berlin. 306 p.

Organization for Economic Co-operation and Development. 1998. "Towards Sustainable Development: Environmental Indicators". OECD. Paris.

O Connor, J. et al. 1995. Monitoring Environmental Progress(Draft). World Bank. 72 p.
UNDP/UNSO and NRI. 1995. Development of Desertification Indicators for Field Level Implementation. 53 p.

UNEP. 1992. World Atlas of Desertification. Edward Arnold. London.

UNEP. 1994. United Nations Convention to Combat Desertification in those countries experiencing drought and/or desertification, particularly in Africa. Text with Annexes. 71 p.

UNEP/ISRIC. 1988. Guidelines for General Assessment of the Status of Human-induced Soil Degradation (GLASOD).

UNEP/ISRIC. 1990. World Map of the Status of Human-induced Soil Degradation: An Explanatory Note (GLASOD).

UNEP/ISRIC. 1991. World Map of the Status of Human-induced Soil Degradation. (GLASOD).

UNEP/ISRIC/ISSS/FAO. 1995. Global and National Soils and Terrain Digital Databases (SOTER), Procedures Manual (revised edition). ISBN 90-6672-059-X.

UNEP/Netherlands National Institute of Public Health and Environment (RIVM). 1994. An Overview of Environmental Indicators: State of the art and perspective. UNEP/EATR.94-01:RIVM/402001001. Environmental Assessment Sub-Programme, UNEP, Nairobi. ISBN 92-807-1427-9.

WB/FAO/UNDP/UNEP. In print. Land Quality Indicators. World Bank Discussion Papers.

(b) Internet sites:

Food and Agricultural Organization: Land Degradation Assessment in Drylands http://lada.virtualcentre.org/pagedisplay/display.asp

FAO Webpage on Desertification: http://www.fao.org/desertification/default.asp?lang=en

United Nations Convention to Combat Desertification. http://www.unccd.ch

United Nations Development Programme's Dryland Development Centre: http://www.undp.org/drylands/
World Soil Information (ISRIC): http://www.isric.org/

Theme 9: Agriculture/ Land
Sub-Theme: Land Degradation – Desertification
Indicator 3: Vegetation Cover

Vegetation Cover		
Core indicator	Land Degradation – Desertification	Land

1. INDICATOR

(a) Name: Vegetation Cover

(b) Brief Definition: The indicator includes natural and plantation forest areas, as well as other wooded lands and rangelands tracked over time.
Land under forestry or no land use, spanning more than 0.005 km2 (0.5 hectares); with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. Please include mangroves and forests on wetlands according to the above height and canopy coverage.
Other wooded lands are those Lands under forestry or no land use, spanning more than 0.005 km2 (0.5 hectares); with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent. Please include mangroves and forests on wetlands according to the above height and canopy coverage.
Rangelands, Meadows and Pastures that occupy large areas in West Asia and Arab African Countries are the main form of vegetation cover. These permanently used land (i.e., for five years and more) for herbaceous forage crops. lands are covered by low vegetation (less than 2 meters) or sometime with no vegetation cover(only seasonal). Such rangelands area varies with the annual rainfall fluctuations, but still they constitute a significant part of the total area covered by vegetation.
(c) Unit of Measurement: %.
(d) Placement in the CSD Indicator Set: land/land degradation

2. POLICY RELEVANCE

(a) Purpose: The purpose of the indicator is to show the total land area occupied by forest, other wooded lands and rangelands, and the rate and causes of change over time.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Vegetation cover (forest, other wooded lands and rangelands) serve multiple ecological, socioeconomic and cultural roles in countries of the region. They provide many significant resources and functions including wood products and non-wood products: recreational opportunities, habitat for wildlife, water and soil conservation, and a filter for pollutants. They support employment and traditional uses, and biodiversity. There is general concern over human impact on forest and rangeland health, and the natural processes of their growth and regeneration.

A continuing and fast decreasing forest and rangelands and generally vegetation cover in a country might be an alarm signal of unsustainable practices. The availability of accurate data on a country's forest area, other wooded lands and rangelands, which is a basic characteristic of its natural resources, is an essential requirement for policy and planning within the context of sustainable development.

(c) International Conventions and Agreements: not available

(d) International Targets/Recommended Standards: not available

(e) Linkages to Other Indicators: The indicator is closely linked with several other environmental indicators, such as land use and land condition change, wood and non-wood, protected forest area, arable land, threatened species and sustainable use of natural resources. In some countries, it will also be generally linked to some of the socio-economic indicators, such as population growth and share of natural resource industries in manufacturing

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Definitions are available from the Food and Agriculture Organization of the United Nations (FAO) Forest Resources Assessments. The *forest area* is defined as "lands with a tree crown cover equal or more than ten percent of the area"; plantation as the artificial establishment of forests by planting or seeding; and *natural forests* as natural and/or semi-natural established forests. In addition, the definition of *forest* and rangeland exists in most countries. The comparison of vegetation cover over time using reference years allows the calculation of change in absolute values, and as a percentage of the degradation rate. Different land uses practices and ranges of ecological condition result in different forest types, such as tropical or temperate. These differences should be recognized, especially in country comparisons.

(b) Measurement Methods: The measurement methods for forest, other wooded lands and rangelands can be contained in national inventories, and obtained by sampling ground surveys, cadastral surveys, remote sensing, or a combination of these. The total areas are calculated as the sum of plantations and natural forest, other wooded lands and rangelands areas. This calculation is made at given reference year.

(c) Limitations of the Indicator: the data are not always comparable between countries because of changes in definitions and assessment methodologies.

(d) Status of the Methodology: not available

(e) Alternative Definitions/Indicators: not available

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: The total forest, other wooded lands and rangelands area of a country, including plantations, at different yearly intervals.

(b) National and International Data Availability and Sources: Data on the extent of forest areas (natural and plantations) are available for most countries, both at national and sub-national scales. The data are often estimates, which are not always comparable because of changes in definitions and assessment methodologies. International data are available from FAO Forest Resources Assessments (FRA). National data is available from ministries responsible for forestry and statistics.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The Food and Agriculture Organization of the United Nations (FAO).

(b) Other Contributing Organizations: The United Nations Environment Programme is a partner in the development of this indicator. National experts from governments and institutes, for example the International Institute for Aerospace Survey and Earth Sciences and the Institute for Terrestrial Ecology, have also contributed

6. REFERENCES

(a) Readings:

AOAD, 1995. Study on deterioration of rangelands and proposed development projects (Arabic). Khartoum, Sudan.

CAMRE/UNEP/ACSAD, 1996. State of desertification in the Arab Region and ways and means to deal with it. (Arabic with English summary), Damascus, Syria.

FAO Forestry Department Information Note on Criteria and Indicators for Sustainable Forest Management. http://www.fao.org/forestry/FODA/infonote/infont-e.stm

FAO Statistical Databases. http://apps.fao.org

FAO. 1993. *Forest resources assessment 1990: Tropical countries*. FAO Forestry Paper (FAO), no. 112 / FAO, Rome (Italy). Forestry Dept., 110 pp.

FAO. 1995. *Forest resources assessment 1990: global synthesis*. FAO Forestry Paper (FAO), no. 124 / FAO, Rome (Italy). Forestry Dept., 100 pp.

FAO. 1999. *State of the World's Forests* (FAO). / FAO, Rome (Italy). Forestry Dept., 154 pp.

FAO. *Forest Resources Assessments* 1980, 1990 and 2000.

Harcharik, D.A. 1995. *Forest Resources Assessment 1990: non-tropical developing countries*. / FAO, Rome (Italy). Forestry Dept., 12 pp.

International data provided by other institutions, for example World Resources Institute, are mostly based on the FAO Forest Resources Assessment information and data. http://www.wri.org/

The United Nations Environment Programme (UNEP). http://www.unep.org/

UNSD/UNEP, 2004 . Questionnaire 2004 on environment statistics UNEP, Nairobi, Kenya

Theme 9: Agriculture/ Land
Sub-Theme: Agriculture
Indicator 4: Arable and Permanent Crop Land Area

ARABLE AND PERMANENT CROPLAND AREA		
Core indicator	Agriculture	Land

1. INDICATOR

(a) Name: Arable and Permanent Crop Land Area.

(b) Brief Definition: Arable and permanent crop land is the total of "arable land" and "land under permanent crops". Arable land is the land under temporary crops, temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (for less than five years); and land under permanent crops is the land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest.

(c) Unit of Measurement: 1000 ha.

(d) Placement in the CSD Indicator Set: Land/Agriculture.

2. POLICY RELEVANCE

(a) Purpose: This indicator shows the amount of land available for agricultural production and, inters alia, the cropland area available for food production. The data when related to other variables such as population, total land area, gross cropped area, fertilizer use, pesticides use, etc., can also be used to study agricultural practices of the country. In order to be useful, it must be available as a time series.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Population growth in developing countries is driving a rapid increase in the demand for food and fiber. At the same time, rising population density in rural areas diminishes the farm size. Small farmers are forced to extend cultivation to new areas, which are fragile and not suitable for cultivation. Crop intensification, which has contributed significantly to agricultural growth in recent years, can ease the pressure on cultivating new lands but farm practices adopted for raising yields can also, in some situations, result in damaging the environment (such as when expanding into new areas). Changes in the indicator value over time or between various components may show increased or decreased pressure on agricultural land. This indicator is of value to land planning decision making.

(c) International Conventions and Agreements: Not available.

(d) International Targets/Recommended Standards: Not applicable.

(e) Linkage to Other Indicators: The indicator is primarily linked to other measures related to land resources covered in the Chapter 10: "Integrated Approach to the Planning and Management of Land Resources" and Chapter 14: "Promoting Sustainable Agriculture and Rural Development" of the Agenda 21. This includes indicators such as land use changes, share of irrigated area in the arable and permanent crop land area, per capita arable and permanent crop land area, etc.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The concept of arable land and land under permanent crop is clearly defined but "arable" is often misunderstood. Arable land is the land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category. Data for arable land are not meant to indicate the amount of land that is potentially cultivable. Similarly land under permanent crops is the land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber; this category includes land under flowering shrubs, fruit trees, nut trees and vines, but excludes land under trees grown for wood or timber.

(b) Measurement Methods: The indicator is connected to the use of land for agricultural activity and is historically based on point estimates derived from data collected in periodic agricultural censuses and surveys.

(c) Limitations of the Indicator: This indicator does not reveal anything about increased productivity of agricultural land, or of the spatial variation in land quality.

(d) Status of the Methodology: Concepts and methods of measurements for the indicator are well defined and documented. However, some of the countries follow somewhat different concepts. For example, some countries take arable land as the land that is potentially cultivable, whereas the actual definition excludes permanent fallow land and land under permanent meadows and pastures. Similarly, "permanent" status for pastures, etc., is taken as ten years by some countries instead of the period of five years recommended by the Food and Agriculture Organization of the United Nations (FAO).

(e) Alternative Definitions/Indicators: Agricultural land that includes permanent pastures and meadows is a more appropriate indicator which could universally be related to data on use of fertilizers, pesticides and statistics on irrigated area (as some countries have permanently cultivated pastures).

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Data on arable land and land under permanent crops. Data on permanent pastures and fallow land also would be useful for undertaking quality check.

(b) National and International Data Availability and Sources: National data for the indicator has been estimated generally through agricultural census/surveys. However, in the case of many countries such statistical exercises are undertaken only at selected points of time. At the international level data are being produced by FAO. This data set is produced as a continuous time series where missing data for intercensal/survey periods have been derived by using data from various official and non-official sources. Thus the data for many countries are of unknown reliability.

(c) Data References: The primary data source at the international level is the FAO Statistical Yearbook released annually by the FAO and available on FAOSTAT http://faostat.fao.org

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Food and Agriculture Organization of the United Nations (FAO). The contact point is the Director Statistics Division, FAO; fax no. (39 06) 5705 5615.

(b) Other Contributing Organizations: None.

6. REFERENCES

(a) Readings:

FAO. 2005. World Programme for the Census of Agriculture 2010. In: FAO Statistical Development Series (FAO), no. 11 / FAO, Rome (Italy). Statistics Div., 160 pp.

(b) Internet site:

FAO Statistical Databases. http://faostat.fao.org/

Theme 9: Agriculture/ Land
Sub-Theme: Agriculture
Indicator 5: Use of Fertilizers

FERTILIZER USE EFFICIENCY		
Core indicator	**Agriculture**	**Land**

1. INDICATOR

(a) Name: Fertilizer use efficiency.

(b) Brief Definition: Extent of fertilizer use recovery in agriculture per crop unit.

(c) Unit of Measurement: kg/kg

(d) Placement in the CSD Indicator Set: Land/Agriculture.

2. POLICY RELEVANCE

(a) Purpose: The purpose of this indicator is to measure the recovery of plant nutrients from mineral fertilizer application in crop husbandry (agriculture) for resource use efficiency.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Production increases in the next three decades are to be no smaller in absolute terms than in the past three decades, although the growth rates will be significantly lower. These future increases must be achieved starting from a resource base that is today much more stretched than in the past. The task of obtaining these production increases while minimizing adverse effects is thus more arduous than in the past. The prospect that growing shares of the increments in world production will originate in the developing countries further enhances such risks. This means that pressures will be increasingly gathering in the agro-ecological environments of the tropics, which are more fragile than the temperate ones and contain much of the world's biodiversity. In addition, in the developing countries, conventional objectives of agricultural development (food security, employment, export earnings) usually take precedence over those of sustainability and environment conservation. The preservation of the productive potential of their agriculture, however, is much more critical than it is for the industrial countries where agriculture is a small part of the economy.

Given scarcities of suitable agricultural land in several developing countries, there is no escape from the necessity for a good part of the required production increases to come by extracting more output from each hectare cultivated. That is, agriculture will be becoming ever more intensive. Obviously, what is required is intensification that can keep threats to the resource base and the wider environment within bounds not threatening the sustainability of the system. This indicator shows the potential environmental pressure from inappropriate fertilizer application. Intensive fertilizer application is linked to nutrient losses that may lead to eutrophication of water bodies, soil acidification, and potential of contamination of water supply with nitrates. The actual environmental effects will depend on the adoption of nutrient losses reducing commensurate with soil conditions and crop yields under prevailing meteorological conditions.

(c) International Conventions and Agreements: Not available.

(d) International Targets/Recommended Standards: Market forces drive the adoption of efficient fertilizer nutrient practices. Targets should be based on national situations.

(e) Linkages to Other Indicators: This indicator is closely linked to others in the agricultural, water (nutrient loads in ground water, surface water bodies and coastal aquatic ecologies), and atmospheric groups, such as, algae index, and emissions of greenhouse gases.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The concepts are available. Data on the quantities of fertilizers used are converted into the three basic nutrient components and aggregated. The three components are nitrogen (N), phosphorous (P_20_5), and potassium (K_20). Chemical composition of crops and their by-products are standardized. However, due to the limitations discussed in section 4(d) below, this indicator should be regarded as interim for sustainable development purposes.

(b) Measurement Methods: Data on fertilizers and yields are compiled from FAO statistics. Data for developing countries generally refer to domestic disappearance based on imported products. The derived figures in terms of nutrient application are then divided by the nutrient contents removed by harvested crops and their by-products.

(c) Limitations of the Indicator: Environmental impacts caused by leaching and volatilization of fertilizer nutrients depend not only on the quantity applied, but also on the condition of the agro-ecosystem, cropping patterns, and on farm management practices. In addition, this indicator does not include organic fertilizer from manure and crop residues. The indicator assumes even distribution of crop-fertilizer application in a country.

(d) Status of the Methodology: Described and applied in FAO: Agriculture, towards 2015-2030.

(e) Alternative Definitions/Indicators: A more relevant and sophisticated indicator focuses on nutrient balance to reflect both inputs and outputs associated with all agricultural practices. This addresses the critical issue of surplus or deficiency of nutrients in the soil and captions system losses, ceteris paribus, over a period of time.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Data on fertilizer use for N, P_20_5, and K_20; and crop yields.

(b) National and International Data Availability and Sources: Data for all countries exist at the national level only. The data are updated on a regular basis. At the international level, the Food and Agriculture Organization of the United Nations (FAO) is the primary source.

(c) Data References: see 6(a).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Food and Agriculture Organization of the United Nations (FAO). The contact point is the Assistant Director-General, Sustainable Development Department, FAO; fax no. (39 06) 5705 3152.

(b) Other Contributing Organizations: The USDA-ERS and the Fertilizer Institute – Washington are associated with the development of this indicator.

6. REFERENCES

(a) Readings:

FAO. 1996. Fertilizer use by crop, 3. International Fertilizer Industry Association, Paris (France); International Fertilizer Development Center, Muscle Shoals, AL (USA); FAO, Rome (Italy). Statistics Division, 49 pp.

FAO. 2000. Fertilizer requirements in 2015 and 2030. FAO Land and Water Development Division, 29 pp

FAO. 2001. Global estimates of gaseous emissions of NH3, NO and N2O from agricultural land. FAO Land and Water Development Division, 66 pp

FAO. 2004. Scaling soil nutrient balances. FAO Fertilizer and Plant Nutrition Bulletin no.15, 132 pp.

(b) Internet sites:

FAO Statistical Databases. http://faostat.fao.org/

International Fertilizer Association. http://www.fertilizer.org/

FAO Land and Water Development Division. FAO/AGL - Land and Water On-line documents

Theme 9: Agriculture/ Land
Sub-Theme: Agriculture
Indicator 6: Use of Agricultural Pesticides

USE OF AGRICULTURAL PESTICIDES		
Core indicator	**Agriculture**	**Land**

1. INDICATOR

(a) Name: Use of Agricultural Pesticides.

(b) Brief Definition: Use of pesticides per unit of agricultural land area.

(c) Unit of Measurement: Pesticide use in metric tons of active ingredients per 10 km^2 of agricultural land.

(d) Placement in the CSD Indicator Set: Land/Agriculture.

2. POLICY RELEVANCE

(a) Purpose: This indicator measures the use of pesticides in agriculture.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The challenge for agriculture is to increase food production in a sustainable way. One important aspect of this challenge is the use of agricultural pesticides which add persistent organic chemicals to ecosystems. Pesticides can be persistent, mobile, and toxic in soil, water, and air; and can have impact on humans and wildlife through the food chain. They tend to accumulate in the soil and in biota, and residues may reach surface and groundwater through leaching. Humans can be exposed to pesticides through food. Exaggerated use may result from government subsidies and/or failure of pesticide users to internalize health-related costs. The indicator is related to other agricultural intensification practices.

(c) International Conventions and Agreements: Some agricultural pesticides are banned by international trade agreements.

(d) International Targets/Recommended Standards: Not available.

(e) Linkages to Other Indicators: This indicator is closely linked to others in the agricultural area, such as fertilizer use. Use of pesticides can have wide implications for the environment, and is linked to the indicators listed under toxic chemicals and biodiversity.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The concepts are available; however, because of the limitations discussed below in section 4(d), it should only be regarded as an interim indicator.

More work is required to develop a more suitable pesticide indicator pertinent to sustainable development.

(b) Measurement Methods: Data on pesticide use are usually derived from sales or "domestic disappearance" and expressed as active ingredients. Agricultural area data are widely available. Interpretation will benefit from information on types of active ingredients in use, seasonal doses, rate of application, and variability on use for different crops and regions.

(c) Limitations of the Indicator: This indicator provides an aggregation, which ignores toxicity, mobility, and level of persistence; and spatial and application variances. It does not consider the use of pesticides outside of agriculture, which can be significant in developed countries. Data omissions and errors often occur during the transfer of the primary data to statistical authorities.

(d) Status of the Methodology: Not available.

(e) Alternative Definitions/Indicators: To meet some of the limitations expressed above in section 4(d), an indicator could be developed which would recognize the classification of pesticide into classes, ranging from less harmful to highly toxic. Such a pesticide index would show if pesticide use is becoming more sustainable or not. The interpretation value of this indicator would benefit from its application to crop types or agro-ecological zones. However, data availability does not support this in many areas.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Pesticide sales data; agricultural land area.

(b) National and International Data Availability and Sources: The land area data are readily available for most countries. However, pesticide supply-use data in metric tons are only available from international sources for selected countries and limited to the major types of pesticide. Some pesticide data are available for about 50-60 countries. The data are not regularly collected and reported, and not usually available on a sub-national basis. Some data are available on total national pesticide use from the Food and Agriculture Organization of the United Nations (FAO) and the Organization for Economic Co-operation and Development (OECD). Eurostat maintains a database of their members' data. Landell Mills Market Research Ltd. (Bath, UK) also has data.

(c) Data References: see 6(b).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Food and Agriculture Organization of the United Nations (FAO). The contact point is the Assistant Director-General, Sustainable Development Department, FAO; fax no. (39 06) 5705 3152.

(b) Other Contributing Organizations: OECD, the European Union, and Landell Mills Market

Research Ltd. have been involved in the development of this indicator.

6. REFERENCES

(a) Readings: Not available.

(b) Internet sites:

Food and Agriculture Organization of the United Nations (FAO). http://www.fao.org/

Organization for Economic Co-operation and Development (OECD). http://www.oecd.org/

European Union Eurostat. http://europa.eu.int/comm/eurostat/

Landell-Mills. http://www.landell-mills.com/

THEME 10: Coastal and Marine Environment

SUB THEME/ ISSUE	Indicators
Coastal Degradation	Percent of Total Population Living in Coastal Areas
	Annual Fish Catch
Marine Pollution	Releases of Nitrogen and Phosphorus to Coastal Waters

Theme 10: Coastal and Marin Environment
Sub-Theme: Coastal Degradation
Indicator 1: Percent of Total Population Living in Coastal Areas

PERCENTAGE OF TOTAL POPULATION LIVING IN COASTAL AREAS		
Core indicator	**Coastal and Marin Environment**	**Coastal Degradation**

1. INDICATOR

(a) Name: Percentage of Total Population Living in Coastal Areas.

(b) Brief Definition: Percentage of total population living within 100 kilometers of the coastline. A country might also consider percentage of population in the low elevation coastal zone (<10 meters elevation) or percentage of population in river deltas. See methodology for more information on defining the coastal zone.

(c) Unit of Measurement: %.

(d) Placement in the CSD Indicator Set: Ocean, Seas and Coasts/Coastal Zone.

2. POLICY RELEVANCE

(a) Purpose: This indicator serves two purposes. It quantifies an important driver of coastal ecosystem pressure, and it also quantifies an important component of vulnerability to sea-level rise and other coastal hazards.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Because of the economic benefits that accrue from access to ocean navigation, coastal fisheries, tourism and recreation, human settlements are often more concentrated in the coastal zone than elsewhere. Presently about 40% of the world's population lives within 100 kilometers of the coast. As population density and economic activity in the coastal zone increases, pressures on coastal ecosystems increase. Among the most important pressures are habitat conversion, land cover change, pollutant loads, and introduction of invasive species. These pressures can lead to loss of biodiversity, coral reef bleaching, new diseases among organisms, hypoxia, harmful algal blooms, siltation, reduced water quality, and a threat to human health through toxins in fish and shellfish and pathogens such as cholera and hepatitis A residing in polluted water.
Finally, it is important to recognize that a high population concentration in the low-elevation coastal zone (defined as less than 10 meters elevation) increases a country's vulnerability to sea-level rise and other coastal hazards such as storm surges.

(c) International Conventions and Agreements: The Millennium Ecosystem Assessment identified a number of international agreements relevant to coastal zone management, including the following:

- United Nations Convention on the Law of the Sea
- UN Regional Seas and Action Plans
- Global Programme of Action for the Protection of the Marine Environment from Land-

based Activities
• Jakarta Mandate on the Conservation and Sustainable Use of Marine and Coast Biological Diversity
• Ramsar Convention on Wetlands of International Importance
• Chapter 17 of Agenda 21
• Paragraph 29 of the World Summit on Sustainable Development Plan of Implementation

In addition, there are 76 international coastal management plans in place which are relevant.
The conservation of biological diversity and the sustainable use of its components are among the primary objectives of the Convention on Biological Diversity (CBD). This indicator is of particular relevance to several articles of the CBD, e.g.: Article 6 - General measures for conservation and sustainable use; Article 7 - Identification and monitoring.

(d) International Targets/Recommended Standards: None.

(e) Linkages to Other Indicators: Many of the CSD core environmental indicators can be linked to this one, particularly those relating to urbanization, biodiversity, agriculture, fisheries, algae concentration, and fresh water quality. A directly linked social indicator is the population growth rate. It also may have implications for economic performance and GDP per capita.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The coastal zone can be defined in different ways depending on the focus of interest and the availability of data. Typically a combination of distance-to-coast and elevation data is used. The Millennium Ecosystem Assessment used 100 kilometers from the coast as the distance threshold and 50 meters as the elevation threshold, choosing whichever was closer to the sea. McGranahan, Balk and Anderson (2006 and 2007) use 10 meters elevation contiguous with the coast and no distance threshold; in most places this delineated an area closer than 100km from the sea, though in some areas it extended farther. In general distance-based measures are best suited for indicators used to denote coastal pressures, while elevation-based measures are best suited for indicators used to denote hazard vulnerability.
Another approach would be to assess the population size or percentage of population residing in delta areas, which are important areas at the land-ocean interface.

(b) Measurement Methods: To measure the percent of total population living in the coastal zone two underlying pieces of information are required: spatially disaggregated data on a country's population distribution and information on the spatial extent of the coastal zone.
A Geographic Information System (GIS) should be used to measure this indicator. Many different types of free and proprietary GIS packages exist. Using a GIS, the percent population in the coastal zone can be calculated in three steps.
i. To measure the population in the coastal zone, the population data of a country needs to be disaggregated such that the population within the zone can be distinguished from the population in the rest of the country. Censuses usually offer population data disaggregated sub-nationally by administrative units, such as regions and districts. The smaller the geographic area covered by each unit, the better the precision can be in measuring where people live within

the country.
If a country's census administrative units line up with the coastal zone, the population from these units can be summed to estimate the population of the zone. It is far more likely, however, that the geographic administrative units will not match the area of the coastal zone exactly. In these cases, creating a gridded surface of population can provide an estimate of the population in the zone. The vector layer of administrative units with associated population can be converted into a raster layer made up of grid cells of an assigned size (e.g., 30 arc-seconds which equates to an approximately 1 km grid at the equator). The population of an administrative unit is distributed evenly among the grid cells within that unit. On the edges, where a grid cell is split by two or more units, a proportional allocation method can be used to assign population to the grid cell based on the area of each unit that falls within the cell. Countries wishing to skip this step may use one of three ready made gridded population datasets – Gridded Population of the World (GPW), Global Rural-Urban Mapping Project (GRUMP), or Landscan – which are described in greater detail, along with other useful data sets, in Section 4.
ii. Once the population data are gridded, a suitable map of the coastline needs to be selected and the spatial extent of the coastal zone needs to be delineated. Ideally the population and coastline data sets will have matching coastlines. If not, the next paragraph describes a possible remedy. Here we illustrate the separate methods required for the three different measures of the coastal zone.
100 kilometer buffer: To calculate the 100 kilometer coastal buffer of the land area, the data must be projected into an equidistant map projection appropriate for the country. Due to the curvature of the Earth, this will be different for each country. The map projection used to create the 100 kilometer buffer for Iceland won't create an accurate 100 kilometer buffer for India. An equidistant map projection will minimize distortion so that distance calculations can be measured with relative accuracy (examples include Polar Azimuthal Equidistant Projection and Equidistant Cylindrical Projection). Using such an equidistant map projection, the next step is to calculate an inland buffer of 100 kilometers. Subsequently, convert the buffered layer into the same map projection as the population data. If the coastlines of your population and land area layers do not exactly match, one can also include in the 100 kilometer buffer a thin band extending from the coastline into the ocean.
Low Elevation Coastal Zone (LECZ): To calculate the land area contiguous with the coast that is 10 meters or less in elevation, the following data are required: a gridded elevation data set, a gridded representation of the country's land area, and coastal boundary file (i.e., coastline). The gridded elevation data can be used in conjunction with the gridded country land area (in the same projection and resolution) to create a mask of land area where the elevation is 10 meters or less. This mask can be converted to a vector layer. Using the low-elevation mask along with vector coverage of the coastline, all of the polygons in the mask that are contiguous with the coast can be selected (thereby removing from consideration inland areas less than 10 meters in elevation). These selected polygons represent the LECZ and can be converted back into a grid to be used with the population grid.
iii. Once the population data are gridded and a coastal zone mask is created, both in the same projection and resolution, the coastal zone can be overlaid on the population grid and the GIS can be utilized to sum the population within that mask. This population can then be divided by the total country population (using the same data source as the gridded population data) and multiplied by 100 to obtain the percentage of the country's population in the coastal zone.

(c) Limitations of the Indicator: This indicator can be used in monitoring processes that affect coastal ecosystem pressures and coastal hazard vulnerabilities, but it does directly quantify such pressures and vulnerabilities. Quantification of pressures requires knowledge of the total population, not just percentages, and is further enhanced by information on environmentally significant human activities (e.g., industry, tourism, agriculture). In a similar vein, quantification of vulnerability requires information on the exposure to coastal hazards, the nature of the built environment, and measures of phenomena that affect coping capacity and resilience.

(d) Status of the Methodology: The methodology is described in section (b) above. Additionally, there are pre-prepared national-level data for two versions of this indicator available at: http://sedac.ciesin.columbia.edu/es/csdcoastal.html .

(e) Alternative Definitions/Indicators: Population density, rather than percentage of a country's population, provides more direct measurement of the pressures and impacts of human development in the coastal zone. Percentage of the coastal population that is urban can provide a proxy for how densely populated the area is. An alternate way to measure the relative human impact along the coastal zone is the length (or percentage) of the coastline that is built up. Two examples of data sources to provide this information are the Global Rural Urban Mapping Project (GRUMP) urban mask, or a land cover data set that includes urban areas as one of the land cover types (e.g., IGBP's Land Cover Characterization). The length of the coastline that is urban or 'built up' can then be divided by the total length of the coastline. Built up areas often result in the reduction and potential elimination of coastal ecosystems many of which provide services, such as buffering from coastal storms, and serve as important habitat for flora and fauna at the land-sea interface. In addition, the impermeable surfaces characterized by many built up areas reduce ground infiltration of rainfall, resulting in storm water discharge directly into coastal waters. The most appropriate coastal zone delineation to capture the direct consequences of built up areas might be an "immediate" coastal zone of 10 kilometers inland from the coast.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: The two pieces of spatial data needed to measure this indicator are gridded population and a coastal zone delineation (or mask). Countries may have the most detailed and accurate population and coastal zone data available for their own country. Where these data are not available, or where data incompatibilities make integration difficult, there are freely-available global datasets that can be used. For example, the Socioeconomic Data and Applications Center (SEDAC) of the Center for International Earth Science Information Network at Columbia University (CIESIN) have developed a digital database of global population distribution in 1990, 1995, and 2000. Known as Gridded Population of the World v.3 (GPW), this data set is available at a 2.5 arc-minute grid (equivalent to 21 km^2 at the equator), and its coastline closely matches the widely available coastline from the Digital Chart of the World (DCW). The Global Rural-Urban Mapping Project (GRUMP) is a related product that delineates urban areas using a variety of information sources (night-time lights, Digital Chart of the World, tactical pilotage charts, and classified satellite data), reallocating the population distribution of GPW to reflect higher densities in urban areas. GRUMP includes three data products: (1) a gridded population product at 30 arc-second

resolution (1 km^2 at the equator), (2) an urban extents grid (or urban mask), and (3) a global data points set of all urban areas with populations greater than 1,000 inhabitants. The Oak Ridge National Laboratory's Landscan population distribution map represents a modeled distribution of the world's population on a 30 arc-second grid, starting with census data then using a number of parameters such as road networks, night-time lights, elevation, and slope to allocate population to grid cells. Users should be cautioned that because land cover and elevation are among the parameters that drive the population allocation model, Landscan may be less appropriate as a monitoring tool than population data sets that do not assume a particular relationship between population and these factors.
Several data sets useful for compiling the coastal zone delineation are listed in section (c) below.

(b) National and International Data Availability and Sources: The primary sources for gridded population distributions at global, continental and country levels are the Socioeconomic Data and Applications Center (SEDAC) and the Oak Ridge National Laboratory (ORNL). Data sources for coastal zone delineation are listed in section (c) below.

(c) Data References: The Web site for the Gridded Population of the World and the Global Rural-Urban Mapping Project is: http://sedac.ciesin.columbia.edu/gpw/ . This Web site also has a grid identifying country areas (i.e., national identifier grid) on a 2.5 minute and a one kilometer resolution. Landsan can be downloaded from http://www.ornl.gov/sci/landscan/ . The Digital Chart of the World coastline can either be acquired on an individual country basis from the Pennsylvania State University Map Library web site, http://www.maproom.psu.edu/dcw/ , or by purchasing a CD-ROM from ESRI (http://www.esri.com). The Millennium Ecosystem Assessment has also produced a coastal boundary data set. For elevation data, Shuttle Radar Topography Mission (SRTM) 30 arc-second data can be obtained from http://www2.jpl.nasa.gov/srtm/ , and GTOPO 30 arc-second digital elevation model data can be obtained from
http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html .

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: Center for International Earth Science Information Network at Columbia University (CIESIN), Palisades, NY, USA. The focal point is Mr. Marc Levy. tel. No. (+1-845) 365-8988, email ciesin.info@ciesin.columbia.edu.

(b) Other Contributing Organizations: the United Nations Environment Programme (UNEP) Global Programme of Action for the Protection of the Marine Environment From Land-based Activities (GPA) Coordination Office. The contact point is the GPA Coordination Office, tel. no. (+31 70) 311.4467, fax no. (+31 70) 345.6648 and e-mail gpa@unep.nl .

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UNEP's Caribbean Environment Programme. http://www.cep.unep.org/

UNEP's Mediterranean Programme Action Plan. http://www.unepmap.org/

USGS Sea Level and Climate Change. http://pubs.usgs.gov/fs/fs2-00/

Theme 10: Coastal and Marin Environment
Sub-Theme: Coastal Degradation
Indicator 2: Annual Fish Catch

ANNUAL FISH CATCH		
Core indicator	**Coastal and Marin Environment**	**Coastal Degradation**

1. INDICATOR

(a) Name: Annual Catch by Major Species

(b) Brief Definition: Annual catch of major species in relation to spawning biomass if available or in relation to the year of maximum catches in the time series.

(c) Unit of Measurement: Metric tons.

(d) Placement in the CSD Indicator Set: coastal and marine environment

2. POLICY RELEVANCE

(a) Purpose: This indicator, in particular, if the data on spawning biomass are available, can provide a snapshot of the present status of a stock/species in a given country/area in respect to past trends, and can indicate sustainability of the sea.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): A reduced spawning biomass or a very high ratio of the catch peak value respect to present catches, can be considered as a warning that the fisheries could soon become unsustainable. However, it is necessary to take into account the high variability of populations of some commercial marine species as a consequence of changes of environmental conditions.

International Conventions and Agreements: The Draft Agreement for the Implementation of the Provisions of the UN Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Doc A/CONF 164/33), particularly Annex II, and of course the 1982 Convention itself, are of immediate relevance. The other significant draft agreement is the FAO Code of Conduct for Responsible Fisheries, which applies to all fisheries in marine and freshwater, and whose Article 6 also recommends the use of LRPs and TRPs.

(d) International Targets/Recommended Standards: The concept of using benchmarks and reference points as targets has been partly abandoned in recent fisheries conventions (see section 3e below). Given the great uncertainty with the stock size and condition of sea stocks, especially marine open stocks, two types of management bench marks are now proposed (See FAO reference in section 7 below). These are Target Reference Points (TRPs) focusing on the classical objectives of fisheries management; and Limit Reference Points (LRPs) which represent upper limits to the rate of fishing or fishing effort level (or lower limits to the population biomass or spawning biomass) that should not be passed. It is specified in the Conventions below that when LRPs are approached, action should be taken to ensure they are not exceeded.

With respect to national policy for exclusively national stocks, TRPs and LRPs should be estimated using the best scientific information available, and a precautionary approach applied where such information is inadequate. In the case of straddling, highly migratory, or transboundary stocks, such reference points and a joint exploitation strategy should be developed with other states sharing the same stock.

(e) Linkages to Other Indicators: As at the moment this is the only indicator related to productivity of the oceans it has no one direct relationships to other indicators presently listed.

This indicator is closely linked to the other measures proposed for marine resources in Agenda 21. In a more general sense, it is also linked to socioeconomic indicators, such as population growth rate.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The annual catches reported to FAO by countries are nominal catches that refer to the quantities on a landed weight basis. The Spawning Stock Biomass (SSB) is the total weight of all sexually mature individuals in the population (both males and females). The year of maximum catches based on five-year running means, is the year in which the biggest quantities of catches have been reported along the available time series (presently 1950-98) for a species in a given country/area

(b) Measurement Methods: If measurements of SSB are available, their time series values should be compared to those of catches of the same species. If SSB values are not available, the catches in the peak year, based on five-year running means, can be compared with the quantity of catches of the last year available. The elapsed time and the trend in the period since the catch peak should also be examined. The five-year running means is the average of catches of five continuous years. The calculated value is assigned to the middle-year in the five-year period.

(c) Limitations of the Indicator: The major defect of the MSY concept, and of these indicators, is that MSY is determined by fitting an empirical "control curve" of catch on exploitation intensity or effort. This does not always fully reflect processes of birth and death, effects of exploitation on non-target species, or inter-species interactions, nor does it reflect changes in methodology of fishing. To improve management, it is important that countries collect ancillary data (for example, on size and age composition of catches and populations) that can be used to produce more refined indicators of value for the management of the resource, as their research funds and skilled manpower allow.

For many countries, suitable data to calculate these indicators are scarce. In addition, major deficiencies are characteristic of many available data sets. For example, there are serious deficiencies in data series for annual catch due to poor statistical design, lack of consideration of catches by small scale fleets, or problems where the extent and nature of unit resources have not been defined or sharing taken into account. Not all national statistical offices collect the required data. In such cases, research institutes estimates are often developed from special research information collected and analyzed by one or several qualified scientists.

(d) Status of the Methodology: not available

(e) Alternative Definitions/Indicators: An alternative indicator that is commonly used to measure the state of the marine fisheries resources, and could be used instead of MSY-related indicators where these do not exist, is to specify what is the current biomass, or spawning biomass, as a percentage of the virgin biomass B[O], determined by surveys or other estimates of unexploited stock size, before the fishery had been established.
In summary, four alternative indicators are proposed:

(i) Ratio of current effort to that at MSY: (f[NOW]/f[MSY]);

(ii) Ratio of current fishing mortality rate to that at MSY:
(F[NOW]/F[MSY]);

(iii) Ratio of current population biomass (or spawning biomass) to that at MSY: (B[MSY]/B[MSY]);

(iv) Current biomass to that under virgin conditions, that is, before fishing began: (B[NOW]/B[0]).

The above indicators are given as ratios; they are pure numbers, as are the instantaneous rates of fishing mortality. It is generally possible to cross- reference these indicators under specific assumptions, so that the apparent diversity of indices simply provides a choice that allows for the different information sources available under different fishery management regimes. In all cases, the indicator could be expressed in terms of the ratio and the component numerical values being divided.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Annual catch by major species and Spawning Stock Biomass (SSB) values if available.

(b) National and International Data Availability and Sources: Most countries collect data on annual catch. Not many countries maintain data on fishing effort by national fleets; still fewer standardize effort levels by different fleets and arrive at an annual total. Unless size and age compositions are collected and/or estimated from properly sampled catches in ports, fishing mortality rates will not be estimated, which in any case requires a cadre of trained fisheries scientists working in an equipped fisheries or marine science laboratory. Regular direct biomass estimates will require regular fisheries surveys using standard vessels and procedures with trained observers/fisheries biologists on board.
Data Sources: National statistical offices often collect data on catches, and fleet size, but often require assistance in distinguishing species in the catch. At present, effort and mortality estimates, and other biological information used to develop the indicators mentioned above, are almost always performed by national marine resource institutes or
Universities.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency for the development of this indicator is the United Nations Food and Agriculture Organization (FAO). The contact point is the Assistant Director General, Sustainable Development Department, FAO; fax no. (39-6) 5225 3152.

(b) Other Contributing Organizations: the fisheries laboratories of the North Atlantic countries, particularly the UK, Canada and USA, and International Fisheries Commissions (notably the Inter-American Tropical Tuna Commission and the International Commission for Northwest Atlantic Fisheries (now defunct)) have sponsored the earliest applications of these indicators. The work of the International Center for living Aquatic resources Management (ICLARM), Manila has been aimed at applying these concepts in tropical fisheries.

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Theme 10: Coastal and Marine Environment
Sub-Theme: Marine Pollution
Indicator 3: Releases of Nitrogen and Phosphorus to Coastal Waters

RELEASES OF NITROGEN AND PHOSPHORUS TO COASTAL WATERS		
Core indicator	Coastal and Marin Environment	Marine Pollution

1. INDICATOR

(a) Name: Releases of Nitrogen and Phosphorus to Coastal Waters

(b) Brief Definition: Average annual load of nitrogen (N) and phosphorus (P) from land sources discharged into coastal waters.

(c) Unit of Measurement: Tons per year, reported separately for N and P, for a given watershed area, and when possible aggregated on a national basis.

(d) Placement in the CSD Indicator Set: not available

2. Policy Relevance

(a) Purpose: This indicator represents the potential for impacts of nutrient releases into enclosed or semi-enclosed marine environments.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme):
This indicator reflects the negative externalities of fertilizer use, as well as domestic and industrial discharges of nitrogen and phosphorus. It is an indication of inadequate sanitation and/or wastewater treatment facilities, or pollution control. Nutrient enrichment of coastal waters may have consequences to important economic and environmental goods and services, for example, tourism and recreation, maintenance of the fishery potential, and decline or preservation of estuarine and marine biodiversity. The importance of normal to lightly enriched freshwater discharge, if free of associated chemical contaminants, to fisheries production, is however only now being fully recognized.

Such impacts are likely to be negative if uncontrolled, and if close to the point of discharge. For example, water quality deterioration, eutrophication (with consequent decreased light penetration and reduced dissolved oxygen levels), and degradation of fishery resources (especially demersal and benthic species). Low to moderate releases may enhance fishery production, given that natural levels of discharges from rivers sustain marine production at moderate to high levels in estuarine and coastal waters.

(c) International Conventions and Agreements: The following conventions and agreements apply to this indicator: Helsinki Commission on the Baltic, 1982, 1992; Black Sea Convention on the Environment, 1994; Sofia Convention (Danube), 1994; European Economic Community (EEC) directives on nutrients to water bodies; EEC Convention on Transboundary Pollution, 1983.

(d) International Targets/Recommended Standards: Not available.

(e) Linkages to Other Indicators: The indicator is linked to many other socioeconomic, environmental, and institutional indicators including: use of fertilizers, land use and condition change, quality of freshwater resources, environmental protection expenditures, population growth in coastal areas, and participation in maritime agreements.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Concepts are available. The indicator needs to be specific to a watershed and a receiving water body whose degree of mixing/water retention is important to determine effects. Further chemical specification of the nutrients is needed. While the contribution of same-size fluxes of ammonium-nitrogen and nitrate-nitrogen would be similar in regard to eutrophication (provided nitrogen is the limiting nutrient), their impacts to the receiving water body will be quite different.

(b) Measurement Methods: The methodology is not yet ready for immediate application in many areas. The indicator needs to be measured using the mass balance principle through a technique called Regional Mass Flux Budgeting. First, system boundaries need to be established using the watershed, or drainage basin, as its horizontal extension. Vertical boundaries in the atmosphere and ground need to be selected. Within those boundaries, the processes or activities relevant to the nutrient mass cycle (input-output) are determined. A time period of one year is usually selected for nutrient balances. Balances can be established only for total elements (total-N or total-P) or specific compounds. Additional information is needed to determine impacts.

(c) Limitations of the Indicator: Effects will depend on assimilative capacity of water body (according to biophysical conditions). The indicator does not reflect the cumulative impact upon the water body. No indication is given as to the proportional contribution of different sources (including atmospheric deposition), or the prevalent paths of nutrients to coastal waters, unless broader information included in the preparation of the regional mass balance is available. In some cases, it is difficult to distinguish between anthropogenic nutrient loading and environmental conditions.

(d) Status of the Methodology: not available

(e) Alternative Definitions/Indicators: Releases of N and P by sources (agricultural, domestic, industrial) would indicate major contributions and guide policy action. Ratio of N/P releases would indicate which nutrient is the limiting factor for eutrophication. It would be appropriate for some countries which only border on one sea, to select either N or P as the indicator, depending on which is of primary influence.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Regional mass balances for nitrogen and phosphorus.

(b) National and International Data Availability and Sources: Very little data are available. Some input data on fertilizers and source-point measurements are available for specific areas.

(c) Data References: River and regional commissions and in studies on specific water bodies, for example the Mediterranean, Red Sea and the Arabian Gulf.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the United Nations Food and Agriculture Organization (FAO).
The contact point is the Assistant Director-General, Sustainable Development Department, FAO; fax no. (39 6) 5225 3152.

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Regional Seas Agreements, ROPME, PERSECA

THEME 11: Water

SUB THEME/ ISSUE	Indicators
Availability of Water by Source	Annual Withdrawals of Ground and Surface Water as a Percent of Available Water
Water Demand/ Utilization of Water Efficiency	Annual Utilization or Withdrawals of Water by Type (agriculture domestic industrial commercial, others demand)
Water Pollution	BOD in Water Bodies
Water Management	Waste Water Treatment by Category (primary, secondary, tertiary) in Urban Areas (additional)
Access to Water	Access to Safe Drinking Water

Theme 11: Water
Sub-Theme: Availability of Water by Source
Indicator 1: Annual Withdrawals of Ground and Surface Water as a Percent of Available Water

ANNUAL WITHDRAWALS OF GROUND AND SURFACE WATER AS A PERCENT OF AVAILABLE WATER		
Freshwater	**Water Quantity**	**Core indicator**

1. INDICATOR

(a) Name: Annual Withdrawals of Ground and Surface Water as a Percent of Available Water.

(b) Brief Definition: Total annual volume of groundwater and surface water withdrawn from their sources for human use (in the agricultural, domestic and industrial sectors), expressed as a percentage of the total volume of water available annually through the hydrological cycle (total renewable water resources). The terms water resources and water use are understood as freshwater resources and freshwater use.

(c) Unit of Measurement: %.

(d) Placement in the CSD Indicator Set: Freshwater/Water Quantity.

2. POLICY RELEVANCE

(a) Purpose: The purpose of this indicator is to show the degree to which total renewable water resources are being exploited to meet the country's water demands. It is an important measure of a country's vulnerability to water shortages.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The indicator can show to what extent freshwater resources are already used, and the need for adjusted supply and demand management policy. When the indicator is calculated by sector, it can reflect the extent of water resource scarcity with increasing competition and conflict between different water uses and users. Scarce water could have negative effects on sustainability constraining economic and regional development, and leading to loss of biodiversity. Sustainability assessment of changes in the indicator is linked to total renewable water resources. The indicator's variation between countries as well as in time is a function of climate, population, and economic development, as well as the economic and institutional capacity to manage water resources and demand.

(c) International Conventions and Agreements: For international water law, see reference in section 6(a) below. International water sharing agreements also exist between many countries.

(d) International Targets/Recommended Standards: No specific international target exists other than those set by international treaties between countries.
The indicator is included in the revised MDG monitoring framework, presented in 2007 to the General Assembly, to monitor the Millennium Development Goal Nr. 7 (Ensure environmental sustainability) and the associated target "Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources".

(e) Linkages to Other Indicators: The indicator's interpretation would benefit from linkage with established water vulnerability indicators, such as freshwater resources *per capita*, measures of the country's economy, such as Gross Domestic Product (GDP) (by industry), and poverty incidence as an indicator of equity of access. The indicator also needs to be matched with population, social and economic indicators, irrigation as a percentage of arable land, and drought frequency. Interpretation will benefit from linking this indicator with groundwater reserves and unused buffer water resources.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The *total renewable water resources* are defined as the sum of internal renewable water resources and incoming flow originating outside the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through formal or informal agreements or treaties and reduction of flow due to upstream withdrawal. This gives the maximum theoretical amount of water actually available for the country. The in this definition mentioned *internal renewable water resources* is defined as the average annual flow of rivers and recharge of groundwater generated from endogenous precipitation. For total renewable water resources, no differentiation has been made between surface water and groundwater. This approach brings a number of limitations which are described below.
(b) Measurement Methods: The indicator measures total water abstractions divided by total renewable water resources.

(c) Limitations of the Indicator: This indicator has several important limitations, most of them related to the computation of *total renewable water resources*:
• Accurate and complete data are scarce.
• Local sub-national variation of water resources and water use abstractions could be considerable, and this indicator does not reflect the local or individual river basin situation.
• Seasonal variation in water resources is not reflected. There is no consideration of distribution among uses and policy options for mitigating scarcity, for example, re-allocation from agricultural to other uses
• Total renewable water resources do not consider water quality and its suitability for use.
• Since abstraction can occur from fossil groundwater (considered being non-renewable) the indicator can, in principle, be greater than 1.

http://www.iucn.org/themes/wcpa/index.html

(d) Status of the Methodology: Not available.

(e) Alternative Definitions/Indicators: The indicator could consider withdrawals and water resources at the basis of a river basin. It could also take into account the efficiency of use and economic and environmental water costs and values. The data for such calculations, however, are not readily available. For some countries, calculation of the indicator at sub-national levels would be more appropriate. The indicator could be disaggregated to show total renewable water resources, withdrawals for different users, and efficiencies for these different users.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Annual water withdrawals divided by total renewable water resources. Current water uses need to be known.

(b) National and International Data Availability and Sources: Data is available for most countries, at the national level. Data consistency is a problem in AQUASTAT (see 4(c) below) as the data are estimated by country level at various periods, they are sometimes interpolated and national data on withdrawals are sometimes biased and could be intentionally over- or underestimated.

(c) Data References: Recent data are available at the country level and recorded by the Food and Agriculture Organization (FAO) of the United Nations in AQUASTAT (http://www.fao.org/ag/aquastat/).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the Food and Agriculture Organization of the United Nations (FAO). The contact point is the Assistant Director-General, Sustainable Development Department, FAO; fax no. (39 06) 570 53064.

(b) Other Organizations: Not available.

6. REFERENCES

(a) Readings:

Barberis, J.A. 1986. International groundwater resources law. *In*: *FAO Legislative Study* (FAO), no. 40 / Rome (Italy), FAO, 1986, 74 pp.

Caponera, D.A. 1992. *Principles of water law and administration: national and international.* Rotterdam (Netherlands), Balkema, 260 pp.

FAO. 1998. Sources of international water law. *In*: *FAO Legislative Study* (FAO), no. 65 /

FAO, Rome (Italy). Legal Office, 346 pp.

FAO. 2003. Review of world water resources by country. *Water Report 23*. FAO, Rome (Italy). Land and Water Development Division, 110 pp.

Mar del Plata 1977, Dublin ICDE 1992. International Water Law. Helsinki Rules on Use of Waters of International Rivers 1966 and Seoul Rules, International Groundwaters 1986.

Shiklomanov, I.A. 1990. Global water resources. *In*: *Nature and Resources* (UNESCO), v. 26(3) p. 34-43.

Shiklomanov, I.A. and Rodda, J.C. 2004. World water resources at the beginning of the Twenty-First Century. *International Hydrology Series*. UNESCO and Cambridge University Press.

UN. 1977. Water development and management; proceedings of the United Nations Water Conference, Mar del Plata, Argentina, 1977 - pt. 1-4 *In: Water Development, Supply and Management*, v. 1(pt.1-4); United Nations Water Conf., Mar del Plata (Argentina), 14-25 Mar 1977 / United Nations, New York, N.Y. (USA), 1978, 1 v. in 4.

WMO. 1990. *International Conference on Water and the Environment: Development Issues for the 21st Century*, Dublin (Ireland), 26-31 Jan 1992 / WMO, Geneva (Switzerland), 55 pp.

World Water Assessment Programme (WWAP). 2003. Water for people, water for life. *The United Nations World Water Development Report 1*. 576 pp.

World Water Assessment Programme (WWAP). 2006. Water, a shared responsibility. *The United Nations World Water Development Report* 2. 584 pp.

(b) Internet site:

FAO AQUASTAT. http://www.fao.org/nr/water/aquastat/main/index.stm

Theme 11: Water
Sub-Theme: Water Demand/ Utilization of Water Efficiency
Indicator 2: Annual Utilization or Withdrawals of Water by Type (Agriculture Domestic Industrial Commercial, Others Demand)

ANNUAL UTILIZATION OR WITHDRAWALS OF WATER BY TYPE (AGRICULTURE DOMESTIC INDUSTRIAL COMMERCIAL, OTHERS DEMAND)		
Core indicator	**Water Demand/ Utilization of Water Efficiency**	**Water**

1. INDICATOR

(a) Name: or Withdrawals of water by type (Agriculture Domestic Industrial Commercial Others demand).

(b) Brief Definition: The total annual volume of water (ground and surface water) abstracted for water uses (Agriculture Domestic Industrial Commercial Others demand).

(c) Unit of Measurement: Mcm/y (million m3/y).

(d) Placement in the CSD Indicator Set: Freshwater/Water Quantity

2. POLICY RELEVANCE

(a) Purpose: water resources are being exploited to meet the country's water demands.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The indicator can show to what extent freshwater resources are already used, and the need for adjusted supply and demand management policy. When the indicator is calculated by sector, it can reflect the extent of water resource scarcity with increasing competition and conflict between different water uses and users. Scarce water could have negative effects on sustainability constraining economic and regional development, and leading to loss of biodiversity. The indicator's variation between countries as well as in time is a function of climate, population, and economic development, as well as the economic and institutional capacity to manage water resources and demand.

(c) International Conventions and Agreements: For international water law, see reference in section 7 below. International water sharing agreements.

(d) International Targets/Recommended Standards: None

(e) Linkages to Other Indicators: The indicator's interpretation would benefit from linkage with established water vulnerability indicators, such as available freshwater resources per capita, measures of the country's economy, such as Gross Domestic Product (GDP), and poverty incidence as an indicator of equity of access. The indicator also needs to be matched with population, social and economic indicators, irrigation as % of arable land, and drought frequency. Interpretation will benefit from linking this indicator with groundwater reserves and unused buffer water resources.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: A major problem is to define available water and to differentiate between groundwater and surface water.
The only approach which respects the physical integrity of the water resources is to consider where it is produced internally, that is from precipitation inside the boundaries of the country/area. Internal renewable water resources does not account for water generated in neighboring countries nor does it make the distinction between groundwater and surface water. This approach brings a number of limitations which are described below.

(b) Measurement Methods: The indicator measures total water abstractions divided by available water.

(c) Limitations of the Indicator: This indicator has several important limitations, most of them related to the computation of available water.
Accurate and complete data are scarce. Countries may be able to use important non-renewable fossil groundwater at a sustainable rate. Available waters are internal from endogenous precipitation or shared and external from outside the country.
Except in a few cases, no consideration is given to recycling or the possible double counting of shared water resources. Available waters can be enhanced through water resources development (flow-regulating reservoirs, inter-basin transfers, groundwater development etc.), and policy measures (allocation and pricing), and need to be judged by economic and environmental considerations and institutional capacity. Return flows and percolation losses which could enhance available waters are not considered. Local sub-national variation of water availability and water use abstractions could be considerable, and this indicator does not reflect the local or individual watershed situation.
Seasonal variation in water availability is not reflected. There is no consideration of distribution among uses and policy options for mitigating scarcity, for example, re-allocation from agricultural to other uses.
Available water does not consider water quality and its suitability for use.

(d) Status of the methodology: not available

(e) Alternative Definitions: The indicator could consider withdrawals and available waters at different levels of use efficiency and economic and environmental water costs and values. The data for such calculations, however, are not readily available. For some countries, calculation of the indicator at sub-national levels would be more appropriate. The indicator could be disaggregated to show available water, withdrawals, and irrigation use.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Annual water withdrawals divided with average annual available water. Current water uses need to be known.

(b) National and International Data Availability and Sources: Data is available for most countries, at the national level. Data quality is a problem in AQUASTAT (see 5c below) as the data are estimated by countries at various periods, are often repeatedly developed from the same original sources, are often interpolated and national data on withdrawals and available water are sometimes biased and intentionally over- or underestimated.

(c) Data References: Recent data are available at the country level and recorded at the international level by the UN Food and Agriculture Organization (FAO) in AQUASTAT (1994/1995).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the United Nations Food and Agriculture Organization (FAO). The contact point is the Assistant Director General, Sustainable Development Department, FAO; fax no. (39 6) 5225 3152.

6. REFERENCES

(a) Readings:

Al-Zubari ,W.K. 2004. Development of Basic indicators on Integrated Water Resources Management in the ESCWA Region, ESCWA, Water Issues Team

FAO, AQUASTAT , http:// www.fao.org

National Water Statistics

Mar del Plata 1977, Dublin ICDE 1992. International Water Law. Helsinki Rules on Use of Waters of International Rivers 1966 and Seoul Rules, International Groundwaters 1986. Shiklomanov. Global Water Resources. 1990.

Theme 11: Water
Sub-Theme: Water Pollution
Indicator 3: BOD in Water Bodies

BIOCHEMICAL OXYGEN DEMAND IN WATER BODIES		
Core indicator	Water Quality	Fresh Water

1. INDICATOR

(a) Name: Biochemical oxygen demand (BOD) in water bodies.

(b) Brief Definition: BOD measures the amount of oxygen required or consumed for the microbiological decomposition (oxidation) of organic material in water.

(c) Unit of Measurement: mg/l of oxygen consumed in 5 days at a constant temperature of 20°C in the dark.

(d) Placement in the CSD Indicator Set: Fresh water/Water quality.

2. POLICY RELEVANCE

(a) Purpose: The purpose of this indicator is to assess the quality of water available to consumers in localities or communities for basic and commercial needs. It is also one of a group of indicators of ecosystem health.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Sustainable development is heavily dependent on suitable water availability for a variety of uses ranging from domestic to industrial supplies. Strict water quality standards have been established to protect users from health and other adverse consequences of poor water quality. The presence of high BOD may indicate faecal contamination or increases in particulate and dissolved organic carbon from non-human and animal sources that can restrict water use and development necessitate expensive treatment and impair ecosystem health. Human ill health due to water quality problems can reduce work capability and affect children's growth and education. Increased concentrations of dissolved organic carbon can create problems in the production of safe drinking water if chlorination is used, as disinfection by-products, such as trihalomethanes and other compounds toxic to humans, may be produced. Increased oxygen consumption poses a potential threat to a variety of aquatic organisms, including fish. It is, therefore, important to monitor organic pollution to identify areas posing a threat to health, to identify sources of contamination, to ensure adequate treatment, and provide information for decision making to enhance water sustainability. BOD is also a useful measure to assess the effectiveness of current water treatment processes.

(c) International Conventions and Agreements: The Resolution II and Plan of the United Nations Water Conference recommended governments reaffirm the commitment made at Habitat to "adopt programmes with realistic standards for quality and quantity to provide water for rural and urban areas". The goal of universal safe water coverage was reiterated at the World Summit for Children in 1990.

(d) International Targets/Recommended Standards: Not available.

(e) Linkages to Other Indicators: Several indicators are directly linked to the concentration of organic material in freshwater. These measures include annual withdrawals of ground and surface water, domestic consumption of water per capita, concentration of faecal coliforms in freshwater, percent of population with adequate excreta disposal facilities, access to safe water, infant mortality rate, nutritional status of children, environmental protection expenditures as a percent of Gross Domestic Product, and expenditure on waste collection and treatment, and ecosystem health.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Biochemical oxygen demand (BOD) is an empirical test to provide a measure of the level of degradable organic material in a body of water. There are two main methods for measuring BOD:

Method 1: This is the most common method used. It simply involves the incubation of a water sample over a specified period (usually five days) at a constant temperature of 20°C in the dark.

Method 2: This method involves the incubation of a water sample that is diluted with de-ionised water saturated with oxygen. The incubation of the diluted sample is identical to the first method, i.e., it is conducted over 5 days at a constant temperature of 20°C in the dark.

These tests represent standard laboratory procedures usually referred to as the BOD5 test.

These procedures are used to estimate the relative oxygen consumption of wastewaters, effluents, and other waters affected by organic pollution. Microorganisms (mainly bacteria although other microorganisms, algae, plants and animals can also make significant contributions in some aquatic systems) use the oxygen in the water for oxidation of polluting organic matter and organic carbon produced by algae, plants and animals.

(b) Measurement Methods:

Method 1: This method consists of filling to overflowing an airtight bottle of specified size with the water sample to be tested. It is then incubated at a constant temperature for five days in the dark. Dissolved oxygen is measured initially and after incubation. The BOD5 is then computed from the difference between the initial and final readings of dissolved oxygen.

Method 2: This method consists of filling a bottle with incremental levels of a water sample that is then diluted with de-ionised water. The dilution water contains a known amount of dissolved oxygen. The bottles are completely filled, freed of air bubbles, sealed and allowed to stand for five days at a controlled temperature of 20 °C (68 °F) in the dark. During this period, bacteria oxidize the organic matter using the dissolved oxygen present in the water. At the end of the five-day period, the remaining dissolved oxygen is measured. The relationship of oxygen that was consumed during the five days and the volume of the sample increment are then used to calculate the BOD.

(c) Limitations of the Indicator: The main limitation of the indicator is that it provides empirical and not absolute results. It gives a good comparison among samples, but does not give an exact measure of the concentration of any particular contaminant. Further, it was designed to assess the impact of point-source organic effluents on source waters and is not generally suitable for environmental monitoring. Further, the BOD can increase due to an increase in nutrient (e.g., nitrogen and phosphorus) loads to a water body (eutrophication) without a concomitant increase in external organic carbon loading. The increase in nutrients stimulates the growth of algae and aquatic plants (primary production), which causes an indirect increase in biological (usually mainly bacterial) oxygen consumption. However, bacterial activity can be directly increased in some waters with low nutrient concentrations. It is important to follow laboratory procedures precisely to obtain consistent results. The five-day time frame to obtain results represents the main operational drawback of the indicator. In addition, the methodologies outlined are not indicative of in situ oxygen consumption rates because of the artificial incubation conditions, i.e., bottling water with its associated microbial communities with no air flow, currents, light etc.

(d) Status of the Methodology: Operational.

(e) Alternative Definitions/Indicators: Chemical Oxygen Demand (COD) is an alternative measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical exigent. COD can be empirically related to BOD5. After this correlation is determined for a specific source, it is a useful measure obtained from an instantaneous chemical test. Dissolved oxygen concentration (DO) is a better general environmental monitoring indicator that is also applicable to assessing organic pollution. DO also has known concentration limits for a variety of aquatic species.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: BOD5 results from laboratories.

(b) National and International Data Availability and Sources: Data are normally available on a routine basis from municipal wastewater treatment and discharge facilities, the laboratories of water or public health authorities, water research institutes, and universities. At the national level, the data sources include national water authorities, water supply utilities, ministries of health or environment, and research institutions.

(c) Data References: None.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the United Nations Environment Programme (UNEP). The contact point at UNEP is the Director, Division of Environmental Information, Assessment and Early Warning, fax no. (254-2) 62- 4274.

(b) Other Contributing Organizations: Other agencies assisting in the development of this indicator include the World Health Organization (WHO), the UNEP Global Environment Monitoring System (GEMS/Water) Programme, the United Nations Children's Fund (UNICEF); United Nations Centre for Human Settlements (Habitat); and the United Nations Food and Agriculture Organization (FAO).

6. REFERENCES

(a) Readings:

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater. 20th Edition. 1999.

International Standards Organization. Water Quality--Determination of Biochemical Oxygen Demand after Five Days (BOD5). ISO 5815. 1989.
International Standards Organization. Water Quality--Determination of the Chemical Oxygen Demand. ISO 6060. 1989.

(b) Internet site:

UNEP/GEMS Programme for Freshwater Quality Monitoring and Assessment at the National Water Research Institute of Environment Canada: http://www.gemswater.org

Theme 11: Water
Sub-Theme: Water Management
Indicator 4: Waste Water Treatment by Category (primary, secondary, tertiary)

WASTE WATER TREATMENT BY CATEGORY (PRIMARY, SECONDARY, TERTIARY)		
Core indicator	**Freshwater**	**Water Quality**

1. INDICATOR

(a) Name: Waste Water Treatment by Category (primary, secondary, tertiary) in Urban Areas.

(b) Brief Definition: Proportion of wastewater that is treated, in order to reduce pollutants before being discharged to the environment, by level of treatment.

(c) Unit of Measurement: Percentage of volume of generated wastewater treated by primary treatment, secondary treatment, tertiary treatment or not treated.

(d) Placement in the CSD Indicator Set: Freshwater/Water Quality.

2. POLICY RELEVANCE

(a) Purpose: This indicator assesses the potential level of pollution from domestic and industrial/commercial point sources entering the aquatic environment, and monitors progress towards reducing this potential within the framework of integrated water resources management. It helps to identify communities where wastewater treatment action is required to protect the ecosystem.

Wastewater from households and different industries represent a significant pressure on the environment and treatment is normally required before discharge. The indicator assesses the proportion of wastewater that undergoes different (primary, secondary and tertiary) levels of treatment. It includes the volume of wastewater treated at public wastewater treatment plants, industrial wastewater treatment plants and by independent wastewater treatment systems. For treated wastewater from households (sometimes mixed with industrial wastewater in a public collecting system) to be considered acceptable it should undergo at least secondary treatment either at a public wastewater treatment plant, an independent wastewater treatment plant or in an industrial wastewater treatment plant (where usually the industrially generated wastewater is dominating). Industrial wastewater needs to undergo a treatment process which is to remove the specific pollutants generated by the production process to a limit which does not negatively affect the aquatic environment or human uses (in the case of direct discharges), or allows a proper treatment together with wastewater originating from household activities in a public wastewater treatment plant (indirect discharges).

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Wastewater effluents can result in increased nutrient levels, often leading to algal blooms; depleted dissolved oxygen, sometimes resulting in fish kills; destruction of aquatic habitats with sedimentation, debris, and increased water flow; and acute and chronic toxicity to aquatic life from chemical contaminants, as well as bioaccumulation of chemicals in the food chain. Treatment plants remove varying amounts of contaminants from wastewater, depending on the level of treatment they provide. In many countries a large proportion of wastewater is discharged to the environment with little or no treatment. This is economically, socially, and environmentally unsustainable, especially recognizing the increasing demands on finite water resources, rapidly expanding populations particularly in urban areas, industrial expansion, and the need to expand irrigated agriculture. Low water quality reduces the availability of water resources for specific uses, in particular domestic needs, and has adverse implications for public health. As well as containing organic matter and nutrients, wastewater can also contain hazardous substances. The level of treatment of these hazardous substances before discharge and the sensitivity of the receiving waters will affect their impact on the aquatic ecosystem.

(c) International Conventions and Agreements: None

(d) International Targets/Recommended Standards: None

(e) Linkages to Other Indicators: This indicator has important linkages to Annual Withdrawal of Ground and Surface Water as Percent of Renewable Water, Water Use Intensity by Economic Activity, Biochemical oxygen demand (BOD) in Water Bodies, Concentration of Faecal Coliform in Freshwater, Population Growth Rate, Generation of Waste and Population with Access to Safe Sanitation.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts:
Wastewater treated by primary treatment + wastewater treated by secondary treatment + wastewater treated by tertiary treatment + wastewater discharged without treatment have to add up to 100% of wastewater generated. Volumes should only be accounted for under the highest treatment category to which they were subjected.
Wastewater is defined as water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere.

For the purpose of this indicator on wastewater treatment it is important to refer only to the volume of wastewater generated by households and economic activities which would negatively affect the aquatic environment or human beings if pollutants are not reduced to an acceptable and widely accepted limit before discharge. Therefore, it excludes unpolluted cooling water (in this context heat is not considered as pollutant; however, discharges of heated cooling water may have negative effects on aquatic life of a particular lake or a certain downstream river stretch). It furthermore excludes wastewater which will be reused (reclaimed wastewater), because it will contribute to discharges into the environment only after the reuse by another economic unit.

Industrial (process) wastewater is water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes.

Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public collecting systems, this process wastewater is understood to be subjected to ex-process in-plant treatment. For the purpose of this indicator cooling water is not considered to be industrial wastewater.

Wastewater treatment: Process to render wastewater fit to meet applicable environmental standards before being discharged to the environment. Three broad types of treatment are distinguished: primary, secondary and tertiary. For purposes of calculating the total amount of treated wastewater, volumes and loads reported should be shown only under the "highest" type of treatment to which they were subjected:

Primary treatment: Treatment of wastewater by a physical and/or chemical process involving settlement of suspended solids, or other process in which the Biological Oxygen Demand (BOD5) of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50%.

Secondary treatment: Post-primary treatment of wastewater by a process generally involving biological or other treatment with a secondary settlement or other process, resulting in a Biological Oxygen Demand (BOD533) removal of at least 70% and a Chemical Oxygen Demand (COD34) removal of at least 75%.

Tertiary treatment of public wastewater: Treatment (additional to secondary treatment) of nitrogen and/or phosphorous and/or any other pollutant affecting the quality or a specific use of water: microbiological pollution, color etc. For organic pollution the treatment efficiencies that define a tertiary treatment are the following: organic pollution removal of at least 95% for BOD and 85% for COD, and at least one of the following:

- nitrogen removal of at least 70%
- Phosphorus removal of at least 80%
- Microbiological removal achieving a faecal coliform density less than 1000 in 100 ml

In the case of industrial wastewater treatment tertiary treatment means the reduction of pollutants to a concentration not adversely affecting the aquatic environment and human water uses before direct discharge. In the case of indirect discharges into a public wastewater collecting system this means that the treatment processes (pre-treatment plus treatment in the public wastewater treatment plant) achieve standards as defined above. For both, direct and indirect discharge, in addition to removal of organic pollution and nutrients this means in particular the removal of toxic substances, acids and alkalis, hard organics or oils and greases (depending on the composition of the wastewater). Typical methods are chemical immobilization, neutralization or precipitation. Dilution of polluted wastewater is not considered as wastewater treatment.

Public wastewater treatment (synonym “urban wastewater treatment”) is defined as treatment of wastewater in public wastewater treatment plants (PWWTPs). PWWTPs can be operated by public authorities or by private companies. Wastewater can arrive to the PWWTPs through the public wastewater collecting system or can be delivered there on trucks.

Industrial wastewater treatment can be either in form of pre-treatment before discharge into a public wastewater collecting system or as final treatment in an industrial wastewater treatment plant (as part of the production establishment or operated externally) before direct discharge to the environment. To avoid double counting, only final treatment before direct discharge should be included here. Volumes pre-treated and discharged into a public collecting system will be counted under public wastewater treatment.

Independent wastewater treatment: Systems of collection, preliminary treatment, treatment, infiltration or discharge of domestic wastewater from dwellings generally between 1 and 50 population equivalents, not connected to a public wastewater collection system. Examples of such systems are septic tanks. Excluded are systems with storage tanks from which the wastewater is transported periodically by trucks to a public wastewater treatment plant. These systems are considered to be connected to the public wastewater system. Independent wastewater treatment systems usually achieve primary or secondary treatment level.

(b) Measurement Methods: The volume of wastewater generated by households can be calculated with population statistics and the application of per capita water use coefficients (e.g. from research centers, water associations or water suppliers). One has to take into account that water use volumes (and consequently the generated wastewater volumes) may be different for households connected to the public water supply network and those households which have to self-abstract their water.

The volume of wastewater generated by industries can be taken from industry surveys and, in the case of missing data, be calculated with the help of wastewater generation factors. In the case of industrial discharges into a public collecting system usually the operators of these systems have data on volumes wastewater collected from industries.

The volume of wastewater treated at different levels of treatment can be obtained from public wastewater treatment plants, from industrial wastewater treatment plants and from independent wastewater treatment systems. The volume of household wastewater treated in public wastewater treatment plants or independent wastewater treatment systems can also be calculated with water use coefficients on the basis of areas of a community connected to the sewerage system linked to the treatment plant and the population inhabiting these localities. The classification of the type of treatment (primary, secondary or tertiary) should preferably be based on actually achieved removal rates.

(c) Limitations of the Indicator: This indicator provides information about wastewater volumes generated by point sources but not about wastewater volumes generated and discharged by diffuse sources.

The indicator does not give information about the quality of the wastewater discharged. Wastewater treatment plants are often overused beyond their design capacity so the quality of the treated wastewater that is discharged into the environment can also be questionable. The indicator also does not address the level of treatment required to meet the requirements of specific ecosystems.
Ideally, it would be more informative to measure an indicator such as the overall removal rates for selected parameters (e.g. BOD5, COD, nitrogen or phosphorus) from all types of wastewater treatment plants (including industrial and independent wastewater treatment plants), including

untreated wastewater from point sources and diffuse sources, another important information for political decision processes would be the total loads of discharges from different types of point sources (after treatment and without treatment) and diffuse sources, classified according to households and economic activities. However, in practice these data are more difficult to obtain.

(d) Status of the Methodology: Methodologies on data generation are recommended in the Data Collection Manual for the OECD/Eurostat Joint Questionnaire on Inland Waters Tables 1 – 7 (version 2.0) of Eurostat (2006) and the UNSD International Recommendations for Water Statistics (2008, in preparation).

(e) Alternative Definitions/Indicators: The percentage of population connected to the different levels of wastewater treatment (primary, secondary or tertiary) which is the sum of percentage of the population connected to different levels of public wastewater treatment, independent wastewater treatment and industrial wastewater treatment. This may be easier to measure but it does not consider wastewater generated by industrial or other economic activities.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: The data required would be the volume of wastewater generated by households and all economic activities (excluding cooling water and reused wastewater) and the volume of wastewater treated at different levels (primary, secondary, tertiary) by public wastewater treatment plants, independent wastewater systems and directly discharging industrial wastewater treatment plants.

(b) National and International Data Availability and Sources: At the national level, data sources would include national water or environmental authorities, municipal authorities and national statistical offices. At the international level, data are collected through two Questionnaires on environment statistics: the UNSD/UNEP Questionnaire which covers non-OECD countries and the Joint OECD/Eurostat Questionnaire which covers OECD/Eurostat countries. Data are often not available, or are incomplete.

(c) Data References:
UNSD Web site: http://unstats.un.org/unsd/environment

OECD website: http://www.oecd.org/statisticsdata

Eurostat website:
http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136239,0_45571444&_dad=portal&_schema=PORTAL)

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: United Nations Statistics Division. The contact point is the Chief, Environment and Energy Statistics Branch, UNSD. The fax no. (1 212) 963 0623.

(b) Other Organizations: OECD and Eurostat

6. REFERENCES

(a) Readings:

Eurostat (2006): Data Collection Manual for the OECD/Eurostat Joint Questionnaire on Inland Waters Tables 1 – 7

OECD/Eurostat Joint Questionnaire 2006 on Environment Statistics – Inland Waters Section.
United Nations (2006). System of Environmental-Economic Accounting for Water (SEEAW). Final Draft.

United Nations (2008). International Recommendations for Water Statistics (forthcoming).

UNSD/UNEP Questionnaire 2006 on Environment Statistics – Water Section.

(b) Internet site:

UNSD home page: http://unstats.un.org/unsd/environment/

Theme 11: Water
Sub-Theme: Access to Water
Indicator 5: Access to Safe Drinking Water

ACCESS TO SAFE DRINKING WATER		
Core indicator	**Access to Water**	**Water**

1. INDICATOR

(a) Name: Access to Safe Drinking Water

(b) Brief Definition: Percentage of population with access to an adequate amount of safe drinking water (in the home or with reasonable access) in the following categories of supply:
1) Continuous water supply inside the dwelling and of adequate amount
2) Intermittent (discontinuous) supply inside the dwelling
3) Supply within a convenient distance from the dwelling

Or Proportion of population with access to an adequate amount of safe drinking water in a dwelling or located within a convenient distance from the users dwelling.

(c) Unit of Measurement: %

(d) Placement in the CSD Indicator Set: access to water

2. POLICY RELEVANCE

(a) Purpose: To monitor progress in the accessibility of the population to safe drinking water. The indicator provides a measure of the access to safe drinking water and thus to potential health effects of dependence on inadequate or unsafe supplies in three common categories of supply. Unreliable supply or inconvenient access may encourage unsafe water storage in the home and may exacerbate risks of water-borne diseases. Interpretation can be assisted by (dis)/ aggregating the data by urban/ rural settings

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Accessibility to safe drinking water is of fundamental significance to lowering the faecal risk and frequency of associated diseases. Its association with other socioeconomic characteristics, including education and income, also makes it a good universal indicator of human development. When broken down by geographic (such as rural/urban zones), or social or economic criteria, it provides useful information on equity issues.

(c) International Conventions and Agreements: The International Drinking Water Supply and Sanitation Decade (IDWSSD) 1980-1990 is an international agreement relevant to this indicator. It is a component of the WHO Global Strategy for Health for all by the Year 2000.

(d) International Targets/Recommended Standards: International targets for this indicator have been established under the auspices of the World Health Organization (WHO). The

Global Strategy for Health and the more regent Ninth General Programme provide targets of 100% by the year 2000, and more than 85% by the year 2001 respectively. In addition, many countries have established national targets.

(e) Linkages to Other Indicators: This indicator is closely associated with other socioeconomic indicators on the proportion of people covered by adequate sanitation. These indicators are among the elements of primary health care, and other water indicators related with withdrawals, reserves, consumption, or quality such as waste water treatment coverage, Exceedance of WHO drinking water guidelines for microbiological parameters; Exceedance of WHO drinking water guidelines for chemical parameters ;Access to safe drinking water; Supply from public drinking water supplies; Access to drinking water complying with WHO guideline values; Access to adequate sanitation ; Diarrhoea mortality in children; Diarrhoea morbidity in children; Outbreaks of water-borne diseases

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Safe water: water which either naturally, or as a result of treatment, is free from any micro-organisms, parasites and substances which, owing to their numbers or concentration, constitute a potential danger to human health.
Adequate amount of water: an amount of water, sufficient to meet the needs of the user for drinking and hygiene: the minimum volume required is 20 litres per person per day.
Continuous supply: a supply which operates, without interruption, 24 hours per day.
Intermittent supply: a supply, which operates on a discontinuous basis, e.g. regularly for less than 24 h/day or occasionally for more than 3 days per year)
Access inside the dwelling**.**
Convenient distance: defined as 15 minutes walking distance each way, or < 1000 meters.
Total population: total resident population

(b) Measurement Methods: This indicator may be calculated as follows: The numerator is the number of persons with access to an adequate amount of safe drinking water in a dwelling or located within a convenient distance from the users dwelling multiplied by 100. The denominator is the total population.

The indicator can be computed for each of the respective three conditions as:

$$100 * (Pa_i / P_t) \text{ for } i = 1 \div 3$$

Where Pai is the number of people with access to safe water supplies in each category, and Pt is the total population

(c) Limitations of the Indicator: The existence of a water outlet within reasonable distance is often used as a proxy for availability of safe water.
The existence of a water outlet, however, is no guarantee in itself that water will always be available or safe, or that people always use such sources.

(d) Status of the methodology: not available

(e) Alternative Definitions: This indicator may be also expressed as the percent of population without access to sufficient and safe drinking water.

Thus the population indicated in the numerator would be those who do not have access to adequate and safe drinking water. If these data are available in terms of the proportion of households, it should be possible to convert this into a percentage of the population, using average figures for household size.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator:

- Number of people with access to safe drinking water category 1)
- Number of people with access to safe drinking water category 2)
- Number of people with access to safe drinking water category 3
- Optionally in category 2, for local assessments, typical number of hours per week of available water
- Total population

Data on the availability of, and access to, piped or public water supplies or water supplies provided under the above mentioned three conditions may be obtained both from censuses and from relevant administrative authorities (e.g. water companies, public water departments).
Data on total population are available from national censuses and should be reliable.

(b) National and International Data Availability and Sources: Routinely collected at the national and sub-national levels in most countries using censuses and surveys.

(c) Data References: Two sources are common: administrative data that report on new and existing facilities, and population data derived from some form of household survey or census.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the World Health Organization (WHO). The contact point is the Director, Office of Global and Integrated Environmental Health, WHO; fax o. (41 22) 791 4123.

(b) Other Contributing Organizations: UN-Habitat, ORC Macro International, United Nations Environment Programme

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MDG Indicators: http://mdgs.un.org/unsd/mdg/Default.aspx

THEME 12: Biodiversity

SUB THEME/ ISSUE	Indicators
Degradation of Ecosystem	Abundance of Selected Key Species
	Protected Area as a Percent of Total area
	Area of Selected Key Ecosystems
Loss of Species	Percentage of Threatened Species
Alien (Invasive) Species	Number of Alien (Invasive) Species/Abundance

Theme 12: Biodiversity
Sub-Theme: Degradation of Ecosystem
Indicator 1: Abundance of Selected Key Species

ABUNDANCE OF SELECTED KEY SPECIES		
Core indicator	Species	Biodiversity

1. INDICATOR

(a) Name: Abundance of Selected Key Species.

(b) Brief Definition: This indicator uses estimates of population trends in selected species to represent changes in biodiversity, and the relative effectiveness of measures to maintain biodiversity. The indicator can be applied to individual species groups (e.g. birds, butterflies), or can be aggregated to incorporate a number of taxa (e.g. in a fashion similar to the Living Planet Index), according to data availability and indicator applicability.

(c) Unit of Measurement: Number of mature individuals or other relevant indicator of abundance within a given area or population.

(d) Placement in the CSD Indicator Set: Biodiversity/Species.

2. POLICY RELEVANCE

(a) Purpose: The indicator has the potential to illustrate the effectiveness of national measures designed to conserve biological diversity and ensure its use is sustainable, including the measures implemented in fulfillment of obligations accepted under the Convention on Biological Diversity (CBD).

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The CBD recognizes that biodiversity has its own intrinsic value and that biodiversity maintenance is essential for human life and sustainable development. Many biological resources, at gene, species and ecosystem level, are currently at risk of modification, damage or loss.

(c) International Conventions and Agreements: The conservation of biological diversity and the sustainable use of its components are among the primary objectives of the Convention on Biological Diversity. This indicator is of particular relevance to several articles of the CBD, e.g., Article 6 - General measures for conservation and sustainable use; Article 7 - Identification and monitoring; and Article 10 - Sustainable use of components of biological diversity.

This indicator is relevant to many other global agreements for which the maintenance of biological diversity is important, including: Convention on the Conservation of Migratory Species of Wild Animals (Bonn); Convention on International Trade in Endangered Species (CITES) ; United Nations Convention on the Law of the Sea (UNCLOSS); Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar); International Convention for the Regulation of Whaling.

Related regional conventions and agreements include: Convention on the conservation of European wildlife and natural habitats (Berne); Program for the Conservation of Arctic Flora and Fauna (CAFF); Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR); Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA).

(d) International Targets/Recommended Standards: The international community has committed "to achieve a significant reduction of the current rate of biodiversity loss at the global, regional, and national level as a contribution to poverty alleviation and to the benefit of all life on earth by 2010". This "2010 Target" was formally adopted by governments at the 6th Conference of the Parties of the Convention on Biological Diversity in 2002, and endorsed later that year at the World Summit on Sustainable Development. The 2010 target, and the targets relating to the general objectives of the CBD, relate specifically to Parties to the Convention on Biological Diversity, but could also be used as a guide for non-Party states.

(e) Linkages to Other Indicators: This indicator can be linked to the majority of the CSD Environmental Core Indicators, eg. annual fisheries catch by major species. There may also be indirect links to social indicators, such as changes in human population. This indicator is also directly related to the suite of indicators measuring progress towards the CBD's target to reduce the rate of biodiversity loss by 2010, which are being implemented by the members of the 2010 Biodiversity Indicators Partnership (2010BIP; www.twentyten.net). It particularly relates to the indicator on "Trends in abundance and distribution of selected species", which includes the Living Planet Index (LPI) and associated population indices, and the Global Wild Bird Index.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Few of the concepts and definitions are as yet clearly and consistently applied. Some important points are noted below.
'Abundance' - This may be defined as the number of mature individuals within the population or area under study. Where it is difficult or inappropriate to survey individuals, comparable surrogate units of measurement, such as number of nests (marine turtles) or spawning stock biomass (fishes), may be acceptable.

'Key species' - It is possible to suggest general criteria for selecting key species, but it will be the responsibility of nations to undertake this selection. This should be done in a consultative way that ensures that regional and global interests are evaluated in addition to national priorities. No single organism or related group of organisms can be expected to reflect comprehensively the patterns of distribution and abundance of all other taxa, and effective biodiversity indicators are likely in most cases to be based on an indicator group composed of several appropriate species. The following categories of species might be considered as 'key species' when developing a biodiversity monitoring programme:

˜ **Keystone species**: A taxon whose impact on the ecosystem or community studied is disproportionately large relative to its abundance (Caro and O'Doherty, 1998). The loss of these species will significantly impact upon the population sizes of other species in the ecosystem, potentially leading to further species loss ('cascade effect').

˜ **Rare or locally endemic species**: Any area contributes to global biodiversity by the overall number of different species within it (and the different higher taxa that are represented), and by the proportion of those that do not occur anywhere else (species endemic to the area). Conservation of endemic species, particularly those sharing a discrete geographic area, can be a cost-effective way to maintain global biodiversity levels.

˜ **Threatened species**: By definition, a threatened species represents actual or potential decline in biodiversity, and recovery of threatened species following management intervention is strongly indicative of successful conservation measures.
Any candidate 'key species' selected from the above categories, or whatever other categories may be deemed appropriate, can be further selected on the basis of other more general biological and logistic criteria. The following are among the characteristics that effective indicator species are likely to possess (e.g., Noss, 1990; Pearson, 1994):

- taxonomically well known, so that populations can be reliably identified, usually in the field,
- biologically well understood,
- easy to survey (e.g., abundant, non-cryptic) ,
- widely distributed at higher taxonomic levels (e.g., order, family, tribe, genus) across a large geographic and habitat range,
- diverse and include many specialist taxa at lower taxonomic levels (e.g., species or species populations) which would be sensitive to habitat change,
- representative to some extent of distribution and abundance patterns in other related and unrelated taxa,
- actually or potentially of economic importance.

(b) Measurement Methods: Information on species abundance should be collected through the consistent, long-term, application of an appropriate survey technique that is widely accepted by the scientific community. Examples of publications with details of field study methodologies for certain groups are given below. Retrospective population information may be obtained through review of published literature, including previous field study reports, seeking material that is appropriate for comparison with the ongoing methodologies adopted.

While it is in most cases impossible to count every individual within a population or area, knowledge of habitat requirements and species population density in sample areas, coupled with data on climate, altitude, soil type or vegetation cover may be used to estimate population size in the area of interest. A geographic information system (GIS) is commonly used to analyse the spatial data. It is important that population size predictions are verified by fieldwork.

This indicator will be better capable of international integration if, after recording, abundance values are processed in a way that minimises or avoids the effects of different scales of change in species that are biologically very different. For example, raw abundance values derived from a large terrestrial predator and from Antarctic krill would need to be measured on scales possibly several orders of magnitude apart, making any comparison between them meaningless. This also bears on national selection of key species, whenever the goal is to derive a single integrated national indicator value for biodiversity change over time.

By definition, monitoring of indicator species will be a continuing process, but for studies within a set timeframe, species should have a life history that complements this period, i.e., there may be little benefit from attempting to monitor very long-lived species over a five-year period only. For studies within a set area it is preferable to avoid selecting taxa that are directly influenced by external events, for example species that annually migrate outside of the study area. For many purposes, it will be preferable to avoid species that show high amplitude annual or irregular variation in population number.

(c) Limitations of the Indicator: Application of this indicator is constrained by several factors, but these can mostly be overcome if resources and personnel are available. The main factor preventing the immediate and widespread application of this indicator is the scarcity of suitable time-series of population data. In practice, change in biodiversity at species and habitat level has to date very often been identified retrospectively, on an ad hoc basis, by means of largely anecdotal evidence, and using terms and units of measurement that are highly case-specific. A structured monitoring framework is preferred, with a secure project lifetime of many years. For comparative purposes, perhaps seeking to build a comprehensive continental or global picture from national data, it is important that similar parameters are measured in similar terms. Care should be taken in interpreting the results of studies based on indicator groups, since the empirical relationship between biodiversity in different groups of organisms has been little investigated.

It is important to note that more species population data are available from temperate than tropical regions of the world, whereas species richness is higher in the tropics. Aside from the issue of data availability this does not have the same implications for national-scale indicators as it does for regional or global aggregate indices. The LPI overcomes this problem by dividing data by biome (terrestrial/freshwater/marine) depending on the principle habitat of the species, and then according to the biogeographic realm or ocean they inhabit.

(d) Status of the Methodology: No single practicable and universally accepted methodology for national-level indicators of abundance of selected key species currently exists. However, through the Living Planet Index, UNEP-WCMC and WWF (Loh et al. (1998, 1999, 2000, 2005) have designed and implemented a system to generate indicators of biodiversity change over time, principally at global or continental level. Output from this system was first used in the WWF Living Planet Report 1998 and has been regularly updated since then (in 2000, 2002 and 2004). This method is designed to make use of the very imperfect data that are available. The index value for each period is derived by normalising the geometric mean change over the period in the sample of populations. A line graph of these index values provides an indicator of biodiversity change. In principle, range area could be used where population counts are not available. This system is limited ultimately by the number of populations for which quantitative size (or area) estimates are available.

Bird Life International's Wild Bird Index (WBI) (Gregory et al, 2003, 2004, 2005; Roberts et al 2005; van Strien 2001) measures average population trends of a suite of representative wild birds, as an indicator of the general health of the wider environment. The WBI can be disaggregated geographically and by habitat for analysis, interpretation and communication. The methodology is already well developed and has been peer-reviewed. The WBI is currently used in Europe to measure aspects of sustainable human development, and is in the process of being expanded to the global scale.

A similar method has been used in the UK Government's indicators programme (see http://www.environment.detr.gov.uk/sustainable/) to show population change in bird groups. Other related approaches have been used, and several other proposed biodiversity indicators remain at the design stage.

(e) Alternative Definitions/Indicators: The percentage of a country's flora or fauna that is categorised as threatened with extinction provides a static view of the status of national biodiversity, and change over time in this proportion, or the changing membership of particular status categories (e.g., 'Extinct in the Wild' or 'Critically Endangered'), could illustrate the effectiveness of measures for maintaining particular elements of biological diversity. This approach requires a stable species-level taxonomy, and a standard system for assessing conservation status. The IUCN Red List Categories and Criteria offer such a system (see indicator Assessment of Threatened Species). This indicator is only of value if changes in Red List Categories can be attributed to actual change in the conservation status of species, rather than changes in taxonomy or in the availability of information, for example.

Permanent reduction in habitat area or quality will tend to lead to loss of some species originally present. Therefore, indicators of change in habitat area and quality (assessment of the latter is problematic) also have the potential to indicate change in overall biodiversity.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: The preferred input would be sets of quantitative data on the population size (or proxy of population size) of selected species within a given area, assessed at suitable time intervals using a standardised method. Data can include total population estimates (e.g. counts of an entire species), direct measures (e.g. the number of birds per km of transect), biomass or stock estimates (e.g. for commercial fish species), and proxies of population size (e.g. number of nests of marine turtle species on various nesting beaches).

(b) National and International Data Availability and Sources: In the absence of any comprehensive global programme for species monitoring, and of universal standards for national monitoring, suitable data are in relatively short supply. Several developed countries hold data that would be suitable as a basis for this indicator. These data have variously been collected by amateur field biologists or as part of official monitoring programmes. It is in some cases probable that much more information exists with individuals, groups and organisations than is generally known, and the problem is thus one of gaining access to suitable data. However, although the number of field surveys and biodiversity assessments has increased greatly in recent years, very little true monitoring has taken place in developing countries or biodiversity-rich countries in the tropics. These are the nations most likely to face difficulties in developing monitoring programmes, but also to be much in need of them. By far the greatest volume of readily available time-series data relate to stock estimates and catch levels (the latter not usually suitable for abundance estimation) in the marine fish populations targeted by industrialised fisheries of developed countries. The various management bodies are often sources of these data. The bird species that are surveyed regularly by networks of mainly amateur ornithologists in developed countries are by far the best-known large terrestrial group.

Suggestions for taxa that can be focused upon therefore include farmland and woodland birds, as well as butterflies which are also well-surveyed in a number of countries.

(c) Data References: Selected references only are mentioned as a general guide to the kinds of work that exist in this field. Population data and analytic tools for birds and other groups can be accessed at the website of the United States Geological Survey Patuxent Wildlife Research Centre (http://www.pwrc.usgs.gov), and see, for example, Sauer et al., 2000. Bird populations are the focus of one headline indicator in the UK Government's strategy for sustainable development: DETR Government Statistical Service, 1999, Indicators for a Strategy of Sustainable Development for the UK: a baseline assessment. Extensive documentation on fish populations in the North Atlantic region is available at the website of the International Council for the Exploration of the Sea (ICES) (http://www.ices.dk). Results of the Living Planet Index methodology are presented in Loh et al. (1998, 1999, 2000). The methodology and results have been published and peer-reviewed (Loh et al 2005).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agencies are the UNEP World Conservation Monitoring Centre (UNEP-WCMC), and the World Wide Fund for Nature (WWF International) and Zoological Society of London (ZSL) who are jointly responsible for the Living Planet Index.

(b) Other Contributing Organisations : The number of other organisations and individuals with the potential to contribute data or advice, or otherwise interested in further development of this indicator is very large. At global level, they would include inter alia: the Secretariat of the Convention on Biological Diversity (CBD), BirdLife International, and IUCN – The World Conservation Union. Other concerned organisations include the Organisation for Economic Cooperation and Development (OECD), the National Institute of Public Health and the Environment (RIVM) in The Netherlands.

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Theme 12: Biodiversity
Sub-Theme: Degradation of Ecosystem
Indicator 2: Protected Area as a Percent of Total Area

PROTECTED AREA AS A PERCENT OF TOTAL AREA		
Core indicator	**Degradation of Ecosystem**	**Biodiversity**

1. INDICATOR

(a) Name: Protected Area as a Percent of Total Area

(b) Brief Definition: This indicator measures the area of protected land ecosystems, inland water ecosystems, and marine ecosystems expressed as a percentage of the total area of land ecosystems, inland water ecosystems and marine ecosystems respectively. Protected Area refers to all or partially protected areas of at least 1000 hectares that are designated as national parks, natural monuments, natural reserves or wildlife sanctuaries, protected landscapes and seascapes or scientific reserves with limited public access. The data do not include sites protected under local or provincial law.

(c) Unit of Measurement: %

(d) Placement in the CSD Indicator Set: biodiversity

2. POLICY RELEVANCE

(a) Purpose: The indicator represents the extent to which areas important for conserving biodiversity, cultural heritage, scientific research (including baseline monitoring), recreation, natural resource maintenance, and other values, are protected from incompatible uses. It shows how much of each major ecosystem is dedicated to maintaining its diversity and integrity. The indicator shows effectiveness of conservation measures.

Sustainable development depends on a sound environment, which in turn depends on ecosystem diversity. Protected areas are essential for maintaining ecosystem diversity, in conjunction with management of human impacts on the environment.
International Conventions and Agreements: This indicator shows implementation of Article 8(a) of the Convention on Biological Diversity.

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Protected areas are an essential tool for ecosystem conservation, with functions going well beyond the conservation of biological diversity. As such, they are one of the building blocks of sustainable development.

(c) International Conventions and Agreements: None exist for this indicator.

(d) International Targets/Recommended Standards: A Strategy for Sustainable Living establishes a target of 10% protected area for each major ecological region for countries by the year 2000 (see section 7a below). A similar target was agreed to by the IVth World Congress on National Parks and Protected Areas in 1992 (see McNeely reference in section 7a below). Both targets reflect recognition that representation of ecosystem diversity is more meaningful than a flat percentage of the country's area.

(e) Linkages to Other Indicators: This indicator is linked to other indicators which have implications for land and resource use. These would include; Forest Area as a % of Land Area, Wood Harvesting Intensity, Area of Selected Key Ecosystems, Ratification of Global Agreements, etc. This indicator is most meaningful when accompanied by indicators of the status of ecosystem diversity, particularly of ecosystem modification and conversion. Thus, the indicator of ecosystem protection would show how much of each major ecosystem is protected; and the indicator of ecosystem modification and conversion would show how much of each major ecosystem has been lost or excessively fragmented. This indicator is also linked to indicators of species diversity and environmental quality.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The World Conservation Union defines six management categories of protected area in two groups. Totally protected areas are maintained in a natural state and are closed to extractive uses. They comprise Category I, Strict Nature Reserve/Wilderness Area; Category II, National Park; and Category III, National Monument. *Partially protected areas* are managed for specific uses (e.g., recreation) or to provide optimum conditions for certain species or communities. They comprise Category IV, Habitat/Species Management Area; Category V, Protected Landscape/Seascape; and Category VI, Managed Resource Protected Area (IUCN 1994).

Totally protected areas are necessary to protect as wide a range as possible of intact communities and the species that depend on them. For such communities to persist and evolve "naturally", buffered as far as possible against human activities, the areas need to be large.

Partially protected areas are useful when certain human activities are actually required to protect particular species or communities. They are also necessary to protect landscapes and seascapes as valued expressions of human relationships with nature. The size of the area is usually less important. Therefore, it is desirable to distinguish:

(i) the total percentage of the ecosystem area that is covered by totally protected areas;

(ii) the percentages of the ecosystem area covered by totally protected areas in different size classes (e.g., < 1 000 ha, ≥ 1 000 ha, ≥ 10 000 ha, ≥ 100 000 ha, ≥ 1 000 000 ha [larger size classes are possible only in large countries]);

(iii) the total percentage of the ecosystem area that is covered by partially protected areas.

For the purpose of this indicator, ecosystems are usually defined as ecoregional units. The minimum size of the units varies depending on the classification system and the size of the country (or other territory) being assessed.

(b) Measurement Methods: The usefulness of this indicator depends on clearly distinguishing totally protected areas and partially protected areas, since they have different, although complimentary, functions. Each requires a separate expression of the indicator as follows: Calculate the combined area of totally protected areas of 1000 ha. or more. Calculate the combined area of partially protected areas regardless of size. Calculate the percentage of the total area occupied by each group.

The indicator can be mapped in two layers and linked to a database. One layer maps the ecosystems, the other the protected areas. The mapping software will usually calculate the sizes of the ecosystems and protected areas. Smaller protected areas may be mapped as points, in which case their size should be recorded in the database separately. The category of protected area should also be entered in the database, to distinguish totally protected and partially protected areas.

(c) Limitations of the Indicator: The effectiveness of this indicator is limited by two problems. First, it represents de jure not de facto protection. It does not indicate the quality of management or whether the areas are in fact protected from incompatible uses. Second, the indicator does not show how representative the protected areas are of the country's ecological diversity. This is a significant deficiency, since a large proportion of some ecosystems may be protected to the neglect of others.

(d) Status of the methodology: The Indicator in the DSR Framework: This indicator represents a Response to threats to ecosystems, species, and genetic diversity. It also partially reflects the state of ecosystem biodiversity.

(e) Alternative Definitions: An alternative definition could be coverage of ecosystem diversity by protected area. This uses the same concepts and measurement methods, but distinguishes the percentages of each main ecosystem type that are in protected areas in different size classes.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Classification of protected areas that can be matched to the IUCN categories. Area of each totally and partially protected area, preferably by size class. Total land and marine area of the country. Classification of ecological regions and ecosystem types, with their areas and locations recorded in a geographical information system is desirable.

(b) National and International Data Availability and Sources: National data on protected areas are available for virtually all countries. Sub-national data are available for many. Data on ecological regions and ecosystem types are not so widely available.

(c) Data References: National sources include agencies responsible for parks and protected areas. The international source is the World Conservation Monitoring Centre (WCMC).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the World Conservation Union (IUCN).
The contact point is the IUCN International Assessment Team; fax no. (1 604) 474 6976.

(b) Other Contributing Organizations: The WCMC has contributed to the development of this indicator.

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Theme 12: Biodiversity
Sub-Theme: Degradation of Ecosystem
Indicator 3: Area of Selected Key Ecosystems

AREA OF SELECTED KEY ECOSYSTEMS		
Core indicator	**Ecosystems**	**Biodiversity**

1. INDICATOR

(a) Name: Area of Selected Key Ecosystems.

(b) Brief Description: This indicator will use trends in the extant area of identified key ecosystems to assess the relative effectiveness of measures for conserving biodiversity at ecosystem level and as a tool to estimate the need for specific conservation measures to maintain the biological diversity in a country or region.

(c) Unit of Measurement: Area (km^2 or ha) of selected ecosystem types.

(d) Placement in the CSD Indicator Set: Biodiversity / Ecosystems.

2. POLICY RELEVANCE

(a) Purpose: The indicator has the potential to illustrate the effectiveness of national measures designed to conserve biological diversity and ensure its use is sustainable, including the measures implemented in fulfillment of obligations accepted under the Convention on Biological Diversity (CBD).

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The CBD recognizes that biodiversity has its own intrinsic value and that biodiversity maintenance is essential for human life and sustainable development. Many biological resources, at gene, species and ecosystem level, are currently at risk of modification, damage or loss.

(c) International Conventions and Agreements: The conservation of biological diversity and the sustainable use of its components are among the primary objectives of the Convention on Biological Diversity. This indicator is of particular relevance to several articles of the CBD, e.g., Article 6 - General measures for conservation and sustainable use; Article 7 - Identification and monitoring; Article 8 - In-situ Conservation; and Article 10 - Sustainable use of components of biological diversity. The Convention has, in several COP decisions explicitly recognised the need for an ecosystem approach, and further formalised this position in Decision V/6 made at the fifth COP held in Nairobi in May 2000.
This indicator is relevant to many other global agreements for which the maintenance of biological diversity is important, including: Convention on the Conservation of Migratory Species of Wild Animals (Bonn); Convention on International Trade in Endangered Species (CITES) ; United Nations Convention on the Law of the Sea (UNCLOSS); Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar); Convention for

the Protection of the World Cultural and Natural Heritage (World Heritage Convention).
Related regional conventions and agreements include: Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention); Program for the Conservation of Arctic Flora and Fauna (CAFF); Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).

(d) International Targets/Recommended Standards: The international community has committed "to achieve a significant reduction of the current rate of biodiversity loss at the global, regional, and national level as a contribution to poverty alleviation and to the benefit of all life on earth by 2010". This "2010 Target" was formally adopted by governments at the 6th Conference of the Parties of the Convention on Biological Diversity in 2002, and endorsed later that year at the World Summit on Sustainable Development. Avoiding further loss of biodiversity could variously involve measures designed to maintain current levels of biodiversity, or to reverse current declining trends (e.g., in natural forest cover). Article 8 (In-situ Conservation) of the CBD, states that contracting parties shall, as far as possible and as appropriate, promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings.
The 2010 target and general objectives of the CBD provide targets for Parties to the Convention; these objectives could be used as a guide for non-Party states.

(e) Linkages to Other Indicators: This indicator has links to other environmental indicators relating to agriculture, forests, desertification, urbanisation, the coastal zone, fisheries water quality and species. Its trends are also linked to those in populations and in economic indicators.

It is closely related to the suite of indicators being implemented by the members of the 2010 Biodiversity Indicators Partnership (2010BIP; www.twentyten.net) to measure progress towards the CBD's 2010 target, and in particular to the indicator on Trends in extent of selected biomes, ecosystems, and habitats.

This indicator also relates to a number of the indicators that come under the "Environmental" category of the CSD Core Indicator Framework. These include: Arable and Permanent Crop Land Areas, Forest Area as a Percent of Land Area, and Coverage of protected areas as a percentage of total area and with a breakdown by biome and habitat.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Few of the concepts and definitions are as yet clearly and consistently applied. Some important points are noted below.
'Ecosystem' refers to the plants, animals, micro-organisms and physical environment of any given place, and the complex relationships linking them into a functional system. Individual ecosystem types may be defined either according to composition in terms of life forms and species, or with respect to ecological processes such as nutrient cycling or carbon sequestration. The former is generally more straightforward for the purposes of area assessment. At present there is no standard classification of ecosystems.
'Key ecosystems' will vary on a country-by-country basis. They can in theory be defined as

either those ecosystems for which it is most important to measure changes in extent, or those ecosystems for which it is possible for measure changes in extent. It will be the responsibility of countries to undertake the selection of 'key ecosystems', based on consultation to ensure regional and global interests are evaluated in addition to national priorities, and constrained by the level of detail in the data available.

'Key ecosystems' for a particular country can be selected according to a number of criteria:

- Ecosystems containing rare or locally endemic or threatened species (see the indicator on Abundance of key species), and especially those with concentrations of these species;
- Ecosystems of particularly high species richness;
- Ecosystems that represent rare or unusual habitat types;
- Ecosystems severely reduced in area relative to their potential original extent;
- Ecosystems under a high degree of threat;
- Ecosystems with high actual or potential economic importance.

However, the most important factor is likely to be the availability of good quality remotely-sensed spatial data for the ecosystems in question, to ensure that they can be mapped and so that the indicator can be calculated.

'Area' refers to the spatial extent of the ecosystem. This requires the definition of limits or boundaries to the ecosystem, which is difficult where similar or related ecosystems are adjacent. This is especially true if the condition or status of the ecosystem is also of concern. For example, forest area may remain relatively constant despite removal of a substantial proportion of the trees and attendant change in ecological processes.

(b) Measurement Methods: Ecosystem area will normally be derived from mapped data on land cover. This is most efficiently done using data in electronic form and Geographic Information System (GIS) software. Increasingly, land cover maps are derived from remotely sensed data, and these will be combined with biological and other ancillary information to produce ecosystem maps. In some cases, retrospective information may be obtained from historical data sets to provide context and longer-term trends. The greatest difficulty is in arriving at an agreed ecosystem classification that is compatible with the available data. It is also fundamental to ensure consistency of the classification and the method of measurement, including considerations of spatial scale and resolution, over time.

How and whether data on different ecosystems should be combined into a single indicator has yet to be determined. It is possible that trends in ecosystem area may be combined in ways that are analogous to the approaches used for species population trends.

(c) Limitations of the Indicator: Application of this indicator is constrained by several factors, but these can mostly be overcome if resources and personnel are available. The main factor preventing the immediate and widespread application of this indicator is the scarcity of suitable time-series of land cover data. Availability of this data will vary on a country-by-country basis. The reliability of evaluating the extent and uniqueness of ecosystems depends on the detail, quality and compatibility of ecosystem classifications applied across continuous terrestrial and marine areas.

Ecosystem diversity distribution has not been mapped at an appropriate scale for many areas of high biological diversity. A structured monitoring framework using standardised classification procedures would provide one solution to this problem, but might well not meet the full range

of needs for this type of data.
The indicator fails to account for variation in ecosystem status other than extent. Perturbations that do not affect total area will not be recognised through monitoring this indicator, nor will it be possible to anticipate likely future trends in ecosystem status through this indicator alone. Measures of ecosystem condition and protection status are needed to answer this deficiency.

(d) Status of the Methodology: No single universally accepted methodology currently exists. Assessments of land cover and of forest area have been carried out in a number of contexts, including the Forest Resources Assessment 2000 conducted by FAO, but the evaluation of specific forest types is more problematic. There has been little area assessment of other ecosystem types, although global and other land cover data sets do provide some relevant data. It is possible that trends in the areas of many ecosystems can be standardized and combined into a single index using an approach similar to that developed for use with species population data by UNEP-WCMC and WWF: the Living Planet Index (Loh et al., 1998, 1999, 2000) (see indicator Abundance of selected key species). In this method, an index value for each period is derived by normalizing the geometric mean change over the period in the sample of species populations. Using ecosystem area in place of population size, a line graph of these index values would provide an indicator of change in the area of key ecosystems. The numbers and types of ecosystems included would be decided according to the types of criteria outlined above.

(e) Alternative Definitions/Indicators: Area may not be the best indicator of ecosystem status for biodiversity preservation. Many alternatives are area-related and include measures of fragmentation and of naturalness or exposure to the impacts of human activities (UNEP-WCMC 2000), and analysis of the protection status of ecosystems (Lysenko & Henry 2000; Lysenko et. al 1995), particularly in areas of high conservation priority.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: The principal data needed for this indicator is land cover data to which an agreed ecosystem classification has been applied. Agreement on the classification will depend upon consensus on key ecosystem types and on the type and quality of raw remotely sensed or other primary data. Supplementary data on distribution of key species, priority areas for biodiversity conservation, distribution of human population and infrastructure as well as protected areas could also be useful.

(b) National and International Data Availability and Sources: Land cover data are available at the global scale from the EROS Data Centre and also at regional (e.g., CORINE) and national scales for many countries. The challenge is in agreeing an appropriate classification that can be applied to the existing data. A further limitation is the frequency with which most such data sets are updated. Mapped data on global priority areas for biodiversity conservation, such as Centres of Plant Diversity, Endemic Bird Areas (EBAs), Important Bird Areas (IBAs), and Ramsar sites are held at UNEP-WCMC. Data on protected areas worldwide are held by UNEP-WCMC in the World Database on Protected Areas (WDPA) and updated frequently. Useful regional and national data sets are held by WWF-US, UNEP-GRID centres, national conservation and academic institutions.

Some mechanisms exist for the international coordination of ecosystem monitoring. The

International Global Observing Strategy – Partnership (IGOS-P) includes IGOL (International Global Observation of Land), and GTOS (Global Terrestrial Observing System) which includes GOFC-GOLD (Global Observation of Forest Cover and Land Dynamics), as well as those agencies and academic organizations that are leading implementation of global monitoring including the ESA (European Space Agency), the UN FAO (Food and Agriculture Organization), and several laboratories supported by NASA (US National Air and Space). All of these fall under the GEOSS framework (Global Earth Observation System and Systems).

(c) Data References: Selected references only are mentioned as a general guide to the kinds of data that are available for this type of work. UNEP-WCMC holds data on priority areas for biodiversity conservation and on coverage of some types of ecosystems (see http://www.unep-wcmc.org). Land cover data are available from Eros Data Centre (see http://edcdaac.usgs.gov/glcc/glcc.html) and from the CORINE programme (see http://www.satellus.se).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: There are a number of agencies leading the development of global scale indicators of trends in extent of various ecosystem or habitat types. These include UNEP-WCMC (coral reefs) and FAO (forests etc.). The NASA/NGO Working Group on Biodiversity also carries out relevant remote-sensing activities. This members of this Working Group include the American Museum of Natural History, Nature Serve, Conservation International, Conservation Biology Institute, Smithsonian Institution, NASA, The Nature Conservancy, UNEP, Wildlife Conservation Society, and the World Wildlife Fund – US.

(b) Other Contributing Organizations: The number of other organisations and individuals with the potential to contribute data or advice, or otherwise interested in further development of this indicator is very large. At global level, they would include inter alia: the Secretariat of the Convention on Biological Diversity (CBD), the World Wide Fund for Nature (WWF), and IUCN – The World Conservation Union. Other concerned organisations include the Organisation for Economic Cooperation and Development (OECD), the National Institute of Public Health and the Environment (RIVM) in The Netherlands, and a very large number of governmental and non-governmental organisations, mainly in developed countries.

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Timmins, K. B. Jones, and B. L. Jackson. 1995. A factor analysis of landscape pattern and structure metrics. Landscape Ecology 10:23-39.

(b) Internet sites:

http://www.biodiv.org/
http://www.ramsar.org

Theme 12: Biodiversity
Sub-Theme: Loss of Species
Indicator 4: Percentage of Threatened Species

PERCENTAGE OF THREATENED SPECIES		
Core indicator	**Loss of Species**	**Biodiversity**

1. INDICATOR

(a) Name: Percentage of Threatened Species

(b) Brief Definition: Number of species at risk of extinction in proportion to the total number of native species.

(c) Unit of Measurement: %

(d) Placement in the CSD Indicator Set: Biodiversity/Species.

2. POLICY RELEVANCE

(a) Purpose: The purpose of this indicator is to represent the maintenance or, conversely, the loss of species diversity. Percentage of threatened species as percent of total native species represents actual or potential decline in biodiversity, and recovery of threatened species following management intervention is strongly indicative of successful conservation measures**.**

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): Maintenance of the biodiversity (the flora and fauna of the countries of the regions)is essential for ecosystem wellbeing. Species diversity is one of the three main levels of biodiversity the others being ecosystem and genetic diversity.

(c) International Conventions and Agreements[11]: The conservation of biological diversity and the sustainable use of its components are two of the three primary objectives of the Convention on Biological Diversity.
Convention on the Conservation of Migratory Species of Wild Animals (Bonn); Convention on International Trade in Endangered Species (CITES); United Nations Convention on the Law of the Sea (UNCLOSS); Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar); International Convention for the Regulation of Whaling.
Related regional conventions and agreements include: Convention on the conservation of European wildlife and natural habitats (Berne); EU Habitats and Species Directive and the EU Birds Directive; Program for the Conservation of Arctic Flora and Fauna (CAFF); Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR); Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA).

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[1]- Source: UN. Economic and social affair, 2007, Indicators of Sustainable Development: Guidelines and Methodologies – Third edition

(d) International Targets/Recommended Standards[2]: The international community has committed "to achieve a significant reduction of the current rate of biodiversity loss at the global, regional, and national level as a contribution to poverty alleviation and to the benefit of all life on earth by 2010". This "2010 Target" was formally adopted by governments at the 6th Conference of the Parties of the Convention on Biological Diversity in 2002, and endorsed later that year at the World Summit on Sustainable Development. The 2010 target, and the targets relating to the general objectives of the CBD, relate specifically to Parties to the Convention on Biological Diversity but could also be used as a guide for non-Party states.

The revised MDG monitoring framework, presented in 2007 to the General Assembly, includes the new target "Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss" under MDG 7 (Ensure environmental sustainability), in addition to the original target "Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources".

(e) Linkages to Other Indicators: This indicator is linked to other indicators which have implications for biodiversity. These would include: protected area as a percent of total area, land use change, wood harvesting intensity, population growth, etc.

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: The underlying concepts are well articulated, although countries may use variations of terminology. Threatened species are those at risk of extinction, and include endangered, vulnerable , rare, and indeterminate species as defined by the World Conservation Union (IUCN). Extinction means no longer existing anywhere in the world, at least in the wild. Extirpation means no longer existing in the country or area of interest. Species are defined as full native species (not introduced species), to sub-species or other infraspecific taxa. Threatened species relates to Class, the third highest level in the taxonomic hierarchy, after kingdom and phylum.

(b) Measurement Methods : Select all classes for which numbers of native species are known (or estimated), and whose status is monitored or assessed from time to time. For each class, calculate the percentage of threatened native species against total native species in this class.

It is recommended to report on 4 sub-indicators:

i) % threatened vascular plant species, total all classes;
ii) % threatened species within each vascular plant class;
iii) % threatened vertebrate species, total all classes; and
iv) % threatened species within each vertebrate class.

[2] Source: UN. Economic and social affair, 2007, Indicators of Sustainable Development: Guidelines and Methodologies – Third edition

Sub-indicators i) and iii) give an overall picture for plants and animals respectively. Sub-indicators ii) and iv) show which classes are most threatened.

Countries may wish to make separate compilations for each of the 4 sub-indicators of species at risk of extinction, and species at risk of extirpation.

(c) Limitations of the Indicator: It is possible to monitor only the more conspicuous and well-known species, which make up a small proportion of total species diversity. Genetic variation within some species may be as important as differences between species, but may be missed by reporting at the species level alone.

(d) Status of the Methodology: not available

(e) Alternative Definitions:

An alternative, or complementary, indicator could be one that uses estimates of population trends in selected species to represent changes in biodiversity, and the relative effectiveness of measures to maintain biodiversity. Please refer to the indicator Abundance of selected key species.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Total number of species and number of threatened species, preferably for all vascular plant and vertebrate animal classes.

(b) Data Availability: National data are available for most countries for higher plants (up to 11 classes, but not reported by class); and for four animal classes (amphibians, reptiles, birds, and mammals). National data on threatened fishes are also available for many countries, but not reported by class, and usually for freshwater only. National data on total numbers of fish species are not as widely available. Few countries have sub-national data. Many countries hold the data, but for some, it is easier to obtain them from international sources.

(c) Data Sources: National sources include agencies responsible for wildlife management and/or implementing the Biodiversity Convention. The international source is the World Conservation Monitoring Centre (WCMC).

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The lead agency is the World Conservation Union (IUCN). The contact point is the IUCN International Assessment Team; fax no. (1 604) 474 6976.

(b) Other Contributing Organisations: Other organizations contributing to the development of this indicator include WCMC, World Resources Institute (WRI),
and the Secretariat of the Biological Diversity Convention.

6. <u>REFERENCES</u>

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Theme 12: Biodiversity
Sub-Theme: Alien (invasive) Species
Indicator 5: Number of Alien (Invasive Species)

ABUNDANCE OF INVASIVE ALIEN SPECIES		
Core indicator	Species	Biodiversity

1. INDICATOR

(a) Name: Abundance of Invasive Alien Species.

(b) Brief Definition: This aim of this indicator is to monitor trends in invasive alien species (IAS) at the national scale. An additional component could be to measure the cost of invasions of such species.

(c) Unit of Measurement: Number of invasive alien species in a given country or region.

(d) Placement in the CSD Indicator Set: Biodiversity/Species.

2. POLICY RELEVANCE

(a) Purpose: The indicator has the potential to illustrate the effectiveness of national measures designed to conserve biological diversity and ensure its use is sustainable, including the measures implemented in fulfilment of obligations accepted under the Convention on Biological Diversity (CBD).

(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme): The CBD recognises that biodiversity has its own intrinsic value and that biodiversity maintenance is essential for human life and sustainable development. Many biological resources, at gene, species and ecosystem level, are currently at risk of modification, damage or loss.

(c) International Conventions and Agreements: The conservation of biological diversity and the sustainable use of its components are among the primary objectives of the Convention on Biological Diversity. This indicator is of particular relevance to several articles of the CBD, e.g., Article 6 - General measures for conservation and sustainable use; Article 7 - Identification and monitoring; Article 8 – In-situ conservation (Article 8 h) calls upon countries to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species) and Article 10 - Sustainable use of components of biological diversity.

This indicator is relevant to many other global agreements for which the maintenance of

biological diversity is important, including: Convention on the Conservation of Migratory Species of Wild Animals (Bonn); Convention on International Trade in Endangered Species (CITES) ; United Nations Convention on the Law of the Sea (UNCLOSS); Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar); International Convention for the Regulation of Whaling.
Related regional conventions and agreements include: Convention on the conservation of European wildlife and natural habitats (Berne); Program for the Conservation of Arctic Flora and Fauna (CAFF); Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR); Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA); African Convention on the Conservation of Nature and Natural Resources.

(d) International Targets/Recommended Standards: The international community has committed "to achieve a significant reduction of the current rate of biodiversity loss at the global, regional, and national level as a contribution to poverty alleviation and to the benefit of all life on earth by 2010". This "2010 Target" was formally adopted by governments at the 6th Conference of the Parties of the Convention on Biological Diversity in 2002, and endorsed later that year at the World Summit on Sustainable Development. The 2010 target, and the targets relating to the general objectives of the CBD, relate specifically to Parties to the Convention on Biological Diversity, but could also be used as a guide for non-Party states.

(e) Linkages to Other Indicators: This indicator can be linked the indicator on abundance of selected key species. It is also directly related to the suite of indicators measuring progress towards the CBD's target to reduce the rate of biodiversity loss by 2010, which are being implemented by the members of the 2010 Biodiversity Indicators Partnership (2010BIP; www.twentyten.net). It particularly relates to the focal area on threats to biodiversity, and the 'Composite Global Indicator: Invasive Alien Species' being developed by the Global Invasive Species Programme

3. METHODOLOGICAL DESCRIPTION

(a) Underlying Definitions and Concepts: Some important points are noted below.
'Invasive alien species': A species introduced outside its normal distribution whose establishment and spread modifies ecosystems, habitats, or species. Although humans have been responsible for species introductions to new areas for thousands of years, the number of such introductions has greatly increased with improvements in transportation and the globalisation of trade. Most introductions fail, but those that do establish themselves as invasive alien species can have a major impact on native biodiversity. IAS may threaten native species as direct predators or competitors, as vectors of disease, by modifying the habitat, or altering native species dynamics. IAS have been a major cause of extinction, especially on islands and in freshwater habitat.
Species introductions may be intentional (e.g. species released for hunting or biological

control), but more commonly are unintentional (e.g. introduced with traded goods such as lumber, or in the ballast water of ships).

(b) Measurement Methods: At present there is no clearly defined, single methodology for national-level indicators of trends in invasive alien species. However a number of IAS indicators have been developed and implemented at a range of scales, albeit with varying methodologies. Examples include the Swiss Agency for the Environment, Forests and Landscapes indicator on 'size of forest area dominated by non-indigenous trees', and the UK Government indicator on 'numbers of IAS present in different taxonomic groups'. The Heinz Center is in the process of developing IAS indicators relating to forest, farmland, grassland and shrubland, coastal and oceanic, and freshwater habitats.

Since these indicators are developed at the national level, there is some room for variation in the methodologies used. However, it may be additional useful for the national indicators to be developed in a way that enables them to contribute towards a regional or global process. For this the methods used to acquire data on each indicator should facilitate up-scaling of the information, and should be gathered at scales that are comparable across nations and ecosystems.

It may be advisable to direct sampling or data acquisition based on a process that prioritises threat, risk, rate of change, and maximum benefit per unit effort. Pilot studies are recommended, and should form part of the indicator testing.

(c) Limitations of the Indicator: While it is clear that invasive alien species are having a major impact on biodiversity and are costing society billions of dollars, and that there is information available in a variety of databases and other sources, the information from the various sources is often incompatible, and does not generally include time series information (UNEP/CBD/SBSTTA10/INF/17). However this is generally more of a problem at global or regional levels, rather than the national level. If statistics for a country (or region) are derived using a consistent methodology then it is possible to calculate trends.

Measuring the costs of invasions of alien species would be a useful additional component to this indicator; however in many cases information on financial costs is extremely limited.

(d) Status of the Methodology: Thus far, the indicator originally proposed by the CBD on 'numbers and cost of alien invasions / trends in invasive species' has not been widely used. Very few programmes monitoring trends in invasive alien species are in place, the availability of data is very limited, and to date there has been no concerted effort to develop a global indicator. However, although there has been limited progress at the global level, various single indicators have been developed and applied in a number of countries and regions, and using a range of taxa and ecosystems.

While 'number of invasive alien species' categorised by taxon and threat appears to be the most widely used indicator, several others have been proposed and developed to varying extents at the national level. For example the Heinz Center has used the percentage of plant cover made up of non-native species, as well as percentage of invasive birds, to monitor the ecological condition of grasslands and shrublands. The Australian Natural Heritage Trust used 'area and density of weeds under active management', as well as 'new incursions of significant weeds' for monitoring invasive alien species and management responses.

(e) Alternative Definitions/Indicators: not available.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator: Key data required for this indicator include: identification of all relevant IAS in a particular country, and time series data for monitoring trends in those IAS. Data on the ecology and distribution of those IAS, and the species which they predominantly affect, would be useful for interpretation of the indicator. It would also be relevant to collate information on the costs incurred as a result of invasions (i.e. costs of mitigating impacts and removing invasives).

(b) National and International Data Availability and Sources: Despite the general lack of data on invasive alien species, there are a number of databases that contain relevant information, as well as a number of national-level monitoring programmes, both of which could be used as a basis to provide the information needed for an IAS indicator. In addition, there are a number of other databases and/or monitoring programmes which – although not focussed on IAS – may incorporate information on IAS in some way, and might be able to be used as a basis for at least some measures which would comprise an IAS indicator. For example, information on species listed on the IUCN Red List now makes reference to what are the main threats to those species, including the impacts of IAS. A possible measure could therefore be, what percentage of Red Listed species for a given country are threatened as a consequence of IAS. Appropriate data on birds might also be available from BirdLife International. Similarly, monitoring programmes on protected areas may include, or could be expanded to include, information on the level of threat posed to the protected area in terms of numbers of individual invasive species, as well as the percentage of area they impact.

Many databases are available that include a subset of data on IAS, and these may provide sufficient data for single, national-level indicators. These include at least four metadatabases that list and/or have links to other databases of IAS – including the Global Invasive Species Database of the ISSG, and the North European and Baltic

Network on IAS. Each single database contains some or all of the following information for particular taxa, ecosystems, countries or states, and geographic regions:

- Species list
- Classification
- Natural history
- Ecology
- Distribution
- Impacts
- Risk assessments
- Control measures
- Literature citations.

The Global Invasive Species Database (GISD) contains comprehensive profiles of invasive species ranging from plants, mammals, invertebrates, birds, reptiles, fish, and amphibians, to macro-fungi and micro-organisms. GISD profiles cover the biology, ecology, native and alien range of invasive species, impacts, pathways of introduction, and management information. Information in the GISD is created and/or reviewed by acknowledge international invasive species experts, and is updated on an ongoing basis.

An important development in the field is the establishment of the Global Invasive Species Information Network (GISIN: www.gisinetwork.org). GISIN will provide a platform through which IAS information and data from participating databases can be accessed.

In addition, several countries have ongoing, systematic monitoring programmes for IAS. Sixteen countries have thus far indicated monitoring programmes of one form or another for one or more selected IAS: Belgium, China, Denmark, Estonia, Germany, Hungary, Israel, Latvia, Lesotho, Lithuania, Mauritania, Morocco, Namibia, Niue, Norway, and the UK.

(c) Data References: Not available.

5. AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR

(a) Lead Agency: The Global Invasive Species Programme (GISP) is leading on efforts to develop a global-scale composite indicator on IAS as part of the 2010 Biodiversity Indicators Partnership initiative.

(b) Other Contributing Organisations: IUCN (and the Zoological Society of London) are involved in collating data on threats from IAS in the Red List database. The SEBI2010 initiative is undertaking relevant indicator work at the European regional scale.

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(b) Internet sites:

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Convention on Biological Diversity: www.biodiv.org
The Global Partnership for Plant Conservation: http://www.plants2010.org

The Ramsar Convention On Wetlands: http://www.ramsar.org
UN Millennium Development Goals: http://www.un.org/milleniumgoals/

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