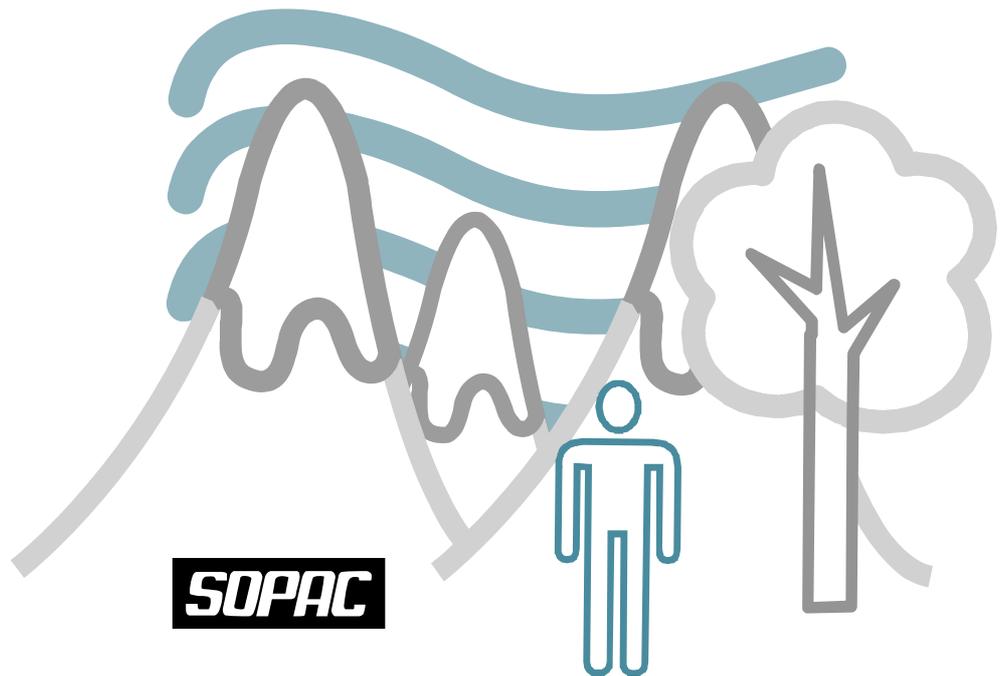




Manual: How to Use the Environmental Vulnerability Index (EVI)



EVI MANUAL

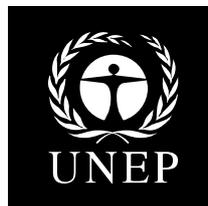


MANUAL: HOW TO USE THE ENVIRONMENTAL VULNERABILITY INDEX (EVI)



BY CRAIG PRATT, URSULA KALY & JONATHAN MITCHELL

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1. *Vulnerability index – environment*

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Purpose and Audience

This manual is for people and organisations wishing to better understand the issue of environmental vulnerability and resilience as a basis for ensuring sustainable development through the application of the *Environmental Vulnerability Index* (EVI). This manual provides a guide on how to generate EVI values for countries and for specific management areas and will be of value to non-profit organisations, community development and economic development organisations, and state and local government officials.

The purpose of this manual is to increase understanding of environmental vulnerability and resilience issues primarily at the national level. It provides a tool for initiating or furthering projects that focus on specific environmental management issues. It is hoped that those who use this manual, will be able to develop an understanding of environmental vulnerability and resilience, the *Environmental Vulnerability Index*, how to generate an EVI and apply the results obtained. (An electronic version of this manual can be found on the World Wide Web at <http://www.sopac.org/evi>).

The manual provides an introduction to the definition of environmental vulnerability and resilience, the importance of this issue in sustainable development, the approach taken by the EVI to measuring environmental vulnerability and the mechanics of the EVI with details on each environmental vulnerability indicator. Guidance is also given on how to calculate and EVI and evaluate the results. Emphasis is made on how to interpret results and use them to address issues of vulnerability or to protect and build resilience, necessary for sustainable development.

The manual encourages the active involvement of participants through an interactive process. The manual highlights useful resources as well as potential sources for environmental vulnerability data and aims to provide participants with the basic information needed to enable them to more effectively identify appropriate environmental vulnerability data and how to use them for national and international purposes.

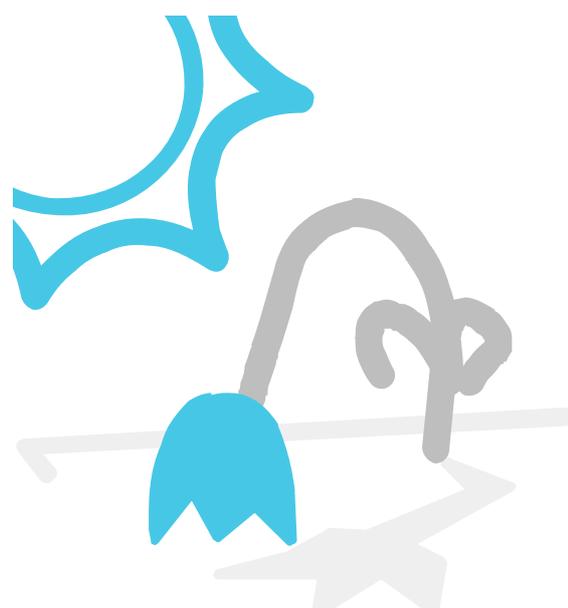
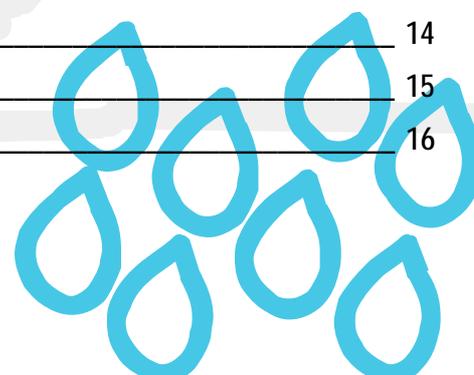
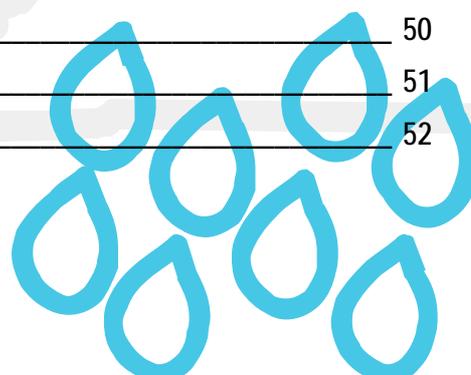


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1. Introduction

What is Vulnerability?

Definition - Oxford Dictionary

Vulnerable / *adj* / **Vulnerability** / *n* / hurt, harmed or attacked easily, especially because of being small or weak.

Resilient / *adj* / **Resilience** / *n* / ability to quickly recover from shock, injury, depression.

Vulnerability refers to the tendency of something to be damaged. The opposite of this is *resilience*, or the ability to resist and/or recover from damage. When we talk about vulnerability, we are automatically also talking about resilience because the two are opposite sides of a single coin. That is, something is vulnerable to the extent that it is not resilient, and *visa versa*.



The interesting thing about vulnerability is that it can be examined at different levels for different issues. That is, it can

be used to look at a single issue, or to assess a complex entity such as a country.

The idea of vulnerability/resilience applies equally well to physical entities (people, ecosystems, coastlines) and to abstract concepts (social systems, economic systems, countries). The factors that cause the damage are known as *hazards*, each of which will be associated with some level of *risk*, or likelihood of occurring.

Vulnerability / Resilience for a Single Issue

Simple vulnerability can be examined for a single issue. That means for any one issue, we could make an assessment of the likelihood of something being damaged in the future. For example, the vulnerability of a beach to storms might be high (and its resilience therefore would be low).

Vulnerability at a Higher Level

We can also examine vulnerability/resilience in an overall sense for a collection of issues. This might mean a whole country or even a region. Overall vulnerability would then be the result of many factors working together and could therefore be considered to be defined as:

EXPLANATION OF TERMS

Vulnerability management is emerging as a critical part of any sustainable development strategy. It focuses not only on conditions now, but also on likely conditions in the future. It examines risks of hazards; and natural and acquired abilities to resist damage (natural resilience and acquired vulnerability), giving us the opportunity to balance strengths and weaknesses.

Vulnerability is the tendency for an entity to be damaged.

Resilience is the opposite of vulnerability and refers to the ability of an entity to resist or recover from damage.

Entities can be physical (people, ecosystems, coastlines etc) or abstract concepts (societies, communities, economies, countries etc) that can be damaged (responders).

Vulnerability and **resilience** are two sides of the same coin. Something is vulnerable to the extent that it is not resilient.

Overall vulnerability (OV) is the result of many vulnerability factors working together. For example, we might be concerned with the OV of a country. It includes information on the risk of hazards, natural resilience and acquired vulnerability.

Hazards are things or processes that can cause damage, but can only be defined in terms of the entity (responder) being damaged. For example, a cyclone is a hazard to an island. Each hazard is associated with a level of risk.

Natural resilience (also known as **intrinsic resilience**) is the natural ability of an entity (responder) to resist damage. We would say that a person with a strong immune system is naturally more able to resist a cold than someone with a poor one.

Acquired vulnerability (also known as **extrinsic resilience**) is vulnerability gained from damage in the past. We might say a person who drinks and smokes would damage their immune system and be less resilient to a cold than someone who lived a healthier lifestyle.

What Does Vulnerability Mean for Small Island Developing States (SIDS)?

Small Island Developing States (SIDS) are often quoted as being highly vulnerable to a wide variety of environmental, economic and social factors. These factors are numerous and some examples include:

- environmental factors: climate variability; climate change and sea level rise; natural hazards such as earthquakes; tsunamis and volcanic events; fragile ecosystems and geographic isolation
- economic factors: high external dependence (aid, imports) and poor insulation to global economic fluctuations; limited opportunities for economic diversification; small internal markets; small resource base and high dependence on natural resources; low savings to investment ratio and high impact of political instability
- social factors: high population growth; high urban migration and emigration; limited human resource capacity; increasing incidence of malnutrition, communicable and non-communicable diseases and food insecurity; impact of economic modernisation and globalisation on societies, cultures and traditional knowledge.

The perception of development disadvantages have made the issue of vulnerability of central concern globally for SIDS. International recognition of this issue and its implications for sustainable development was begun with the support of the United Nations at the Global Summit on Small Island Developing States convened in Barbados in 1994. In the resulting Programme of Action that focused on addressing key SIDS development issues, specific actions to address vulnerability were called for in paragraphs 113 and 114:

“113. Small island developing States, in cooperation with national, regional and international organizations and research centres, should continue work on the development of vulnerability indices and other indicators that reflect the status of small island developing States and integrate ecological fragility and economic vulnerability. Consideration should be given to how such an index, as well as relevant studies undertaken on small island developing States by other international institutions, might be used in addition to other statistical measures as quantitative indicators of fragility.

114. Appropriate expertise should continue to be utilized in the development, compilation and updating of the vulnerability index. Such expertise could include scholars and representatives of international organizations that have at their disposal the data required to compile the vulnerability index. Relevant international organizations are invited to contribute to the development of the index. In addition, it is recommended that the work currently under way in the United Nations system on the elaboration of sustainable development indicators should take into account proposals on the vulnerability index.”

The need to understand the issue of vulnerability is essential if we are to realise sustainable development. Increasing global focus on sustainability and its three pillars of development – environment, economy and society demands that we obtain a better understanding of how different aspects of vulnerability affect each of these pillars. Popular focus on economic and social issues has seen the development of a mixture of economic and social vulnerability indices. These indices, although providing some insight into vulnerability of these aspects of development, only provide a limited understanding of the broader vulnerability issue.

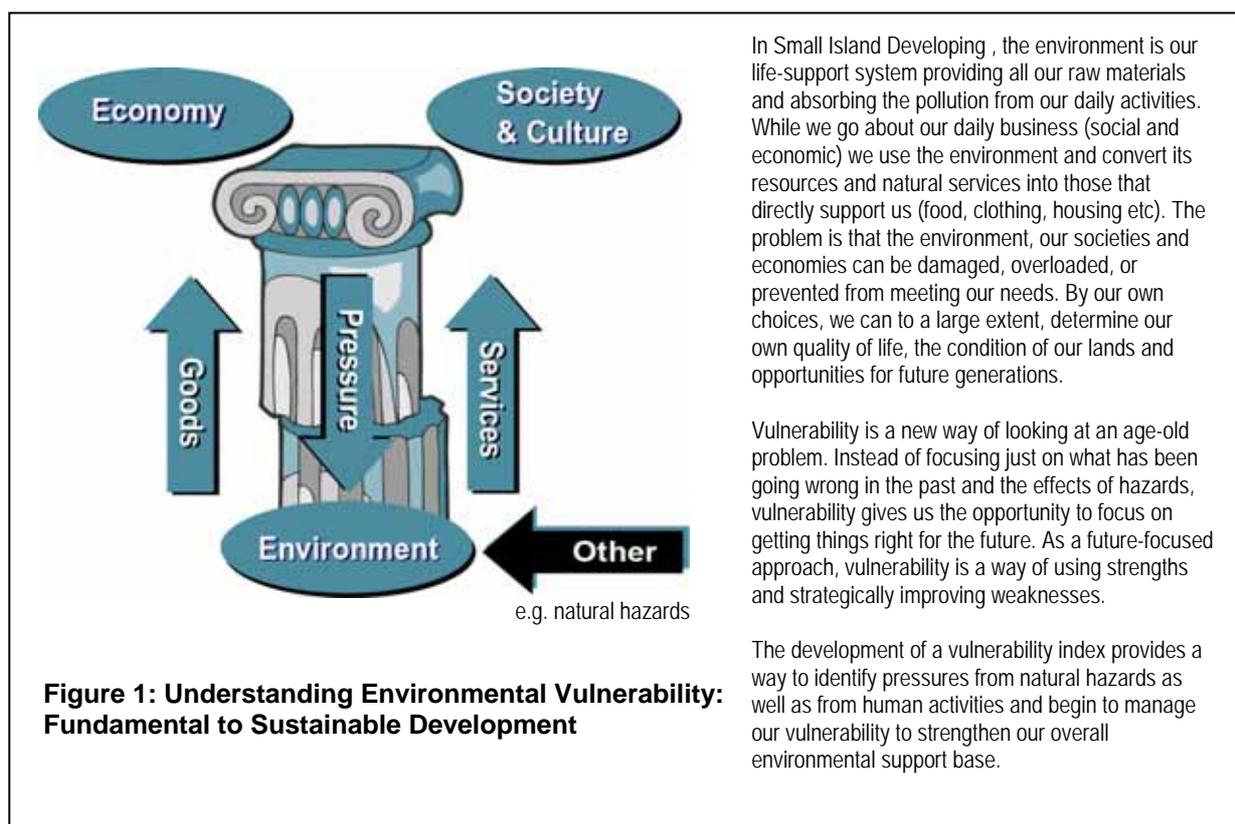
Why Focus on Vulnerability?

The vulnerability of our environmental, social and economic systems is made up of more than just the risk of disasters and good or bad management. It is not just about climate change, or globalisation, or trade agreements. It must also include an understanding of how well any system (environmental, social and economic) can cope with any hazards that may come its way and that might harm it. It would be impossible to work towards good quality of life and growth for countries under a sustainable development model if no account were made of the damage that can occur from **internal** and **outside influences** (Figure 1).

Most management of environmental, social and economic issues focuses on the present state of the system, good practices and understanding things that may have gone wrong in the past. These are all important steps and are part of good management. But they are not enough. For development to be sustainable, we clearly need to learn to manage our vulnerabilities and protect and improve our resilience. We need to be able to understand and/or manage hazards, natural resilience and acquired vulnerability. This understanding for the first time opens up opportunities for improving our overall vulnerability because it forces us to examine the problem from all angles, instead of just focusing on the risk of disasters.

There is also a need to ensure the future by focusing on how and why the systems we are managing might be damaged and by being able to see how well our actions might work to make sure a future we want actually arrives.

Unfortunately, not all vulnerabilities can be reduced directly; the only option is to build our resilience in seemingly unrelated areas. For example we cannot stop cyclones but by building a more resilient system we may be able to make the system better able to cope with potential impacts. By establishing a reserve on a reef we might be able to enable our reefs to be more resilient to cyclones because the reserve area will provide a safe refuge for a wider variety of species as well as enable surrounding areas to be repopulated with species from the reserve. Therefore the key to managing vulnerability is to be able to identify what the system is vulnerable to and take steps to make them more resistant to damage.



2. EVI Mechanics

Measuring Environmental Vulnerability

Many different forms of vulnerability of countries have been identified. For example, economic vulnerability is concerned with external forces which act on the economy, while social vulnerability occurs when natural or other disasters force massive upheavals of residence, traditions and society. The focus of the EVI is on vulnerability of the environment itself to both human and natural hazards. This includes effects on the physical and biological aspects of ecosystems, diversity, populations and communities of organisms and species, and productivity. **Unlike previously-developed vulnerability indices, human impact is considered an exogenous factor, and human systems are not the recipients of the impact.** See box below for a brief introduction to the economic vulnerability index.

Environmental vulnerability differs from vulnerability of human systems because the environment is complex with different levels of organisation from species to interdependent ecosystems and the complex linkages between them. Directly measured data are often not available and evaluating the health and vulnerability of the environment has to be physically measured requiring time and resources. Also as these measures may be heterogeneous nature they are not always expressible in common units.

This means that developing an index for the environment needed a new approach which relies largely on proxy indicators that may have different units of measurement and which would have to be mapped onto a common scale to allow for comparisons.

The term indicator is derived from the Latin verb *indicare* meaning “to point out or proclaim”. An indicator can therefore be explained as any component of the environment that quantitatively estimates the condition of ecological resources, the magnitude of stress, the exposure of a biological component to stress, or the amount of change in condition. Indicators usually focus on a small, manageable, tangible and telling piece of a system that can give people a sense of the bigger picture. The use of indicators is therefore fundamental to providing a simple model of the complex measurement of vulnerability. Alternatively complex investigations requiring large amounts of time and resources would be necessary to provide a similar overview of environmental vulnerability.

OXFORD COMPACT DICTIONARY DEFINITIONS

Indicator / *noun* / 1. a thing that indicates a state or level. 2 a gauge or meter of a specified kind.

Exogenous / *adj* / relating to external factors

Endogenous / *adj* / relating to an internal cause or origin.

Heterogeneous / *adj* / diverse in character or content

Proxy / *noun* / (pl. proxies) a figure used to represent the value of something in a calculation

Anthropogenic / *adj* / originating in human activity.

Key Points

- External forces - exogenous
- Environment complexity
- Measuring vulnerability
- Indicators

Notes





THE ECONOMIC VULNERABILITY INDEX

By Professor Lino Briguglio

The economic vulnerability of small island states is well documented and stems from several inherent characteristics of such states, notably:

- their small size, which limits their ability to reap the benefits of economies of scale and constrains their production possibilities;
- the high degree of economic openness rendering them very susceptible to economic conditions in the rest of the world;
- their dependence on a very narrow range of exports;
- their excessive dependence on imported energy and imported raw materials;
- their insularity and remoteness, leading to high transport costs;
- their fragile ecosystem, a condition often exacerbated by proneness to natural disasters.



What Does the Economic Vulnerability Index Measure?

In spite of these constraints, many small states register relatively high GNP per capita, when compared to other developing countries, giving the impression of economic strength, when in reality these economies tend to be very fragile and their success dependent to a very high degree on conditions outside their control.

The economic vulnerability index measures the precariousness of states, arising from their economic exposure, lack protection and peripherality. This approach essentially consists of averaging a number of sub-indices that were considered as representing different facets of economic vulnerability.

The sub-indices or components used for this purpose represent:

- Trade openness (export, imports or both as a ratio of GDP)
- Export concentration
- Peripherality (transport and freight costs in relation to foreign trade)
- Energy dependence (imported energy as a ratio of energy consumed)
- Financial dependence (aid or international debt as a ratio of GDP)



There are two basic methods for computing the index. The method most commonly used is to obtain data for the components of the index and then use a "normalisation" involving restriction of the values of between 0 and 1, with each observation adjusted to take a value within this range.⁵ The standardised variables for each country are then summed by assigning equal weights to each component.⁶ Composite indices using this methodology were those by Briguglio (1992;1993;1995;1997) by Chander (1996) and John Wells (1996) show that small island states tend to be more vulnerable than larger territories.

The other method utilised for this purpose is that proposed by Atkins et al. (1998) and Wells (1997). They assumed that GDP volatility is the result of vulnerability and use the regression method to find the relation between GDP volatility and three explanatory variables representing features of vulnerability. They then used the coefficients on the explanatory variables as weights. This method does not require normalisation of the variables and the weights are derived on the basis of the regression method. However it has a number of methodological defects, with the most important one being that the authors had to create a dependent variable which was supposed to measure vulnerability, thereby begging the question.



Key Points

- Economic Vulnerability Index

Notes

EVI Framework

The *Environmental Vulnerability Index* (EVI) provides an immediate measure of the vulnerability of the natural environment of a country. It is a relatively inexpensive way of characterising the vulnerability of environmental systems and is flexible enough to be applied at any level (i.e. region, country, province or smaller area providing there are data at that level). The index is capable of generating for each country an overall EVI value, scores for sub-indices that focus on key policy issues and a detailed country environmental vulnerability profile.

The EVI provides a new approach to managing vulnerability by allowing decision-makers to “see” the problem. The EVI identifies areas of vulnerability / resilience that can and cannot be directly affected by management. It also provides a new structural approach to help direct decision-makers towards sustainability.

Ecosystem integrity and its exposure to natural and anthropogenic hazards, is the fundamental basis for defining what environmental vulnerability means. To be able to measure and respond to environmental vulnerability, we need first to be able to understand its underlying components. Three aspects have been identified and these include:

1. **HAZARD** = *Risk Exposure Sub-Index (REI)* incorporates measures anthropogenic and natural risk. This sub-index captures the frequency and where possible, the intensity of hazardous events which may affect the environment. These are based on levels observed over the past 5-10 years for most hazards, but may include data for much longer periods for geological events. **These indicators measure potential risk only:** there is no logical expectation that patterns of risk expression during the immediate history of a country will necessarily result in similar risk levels today or in the future;
2. **RESISTANCE** = *Inherent Resilience Sub-Index* gauges the inherent internal characteristics of a country which would tend to make it less / more able to cope with natural and anthropogenic hazards; and
3. **DAMAGE** = *Acquired Vulnerability Sub-Index* results from external forces acting on the environment and describes the ecological integrity or level of degradation of ecosystems. The more degraded the ecosystems of a country (as a result of past impacts of natural and anthropogenic hazards), the more vulnerable it is likely to be to future risks.

Key Points

- Framework for measuring environmental vulnerability
- Hazard – risk exposure
- Resistance – inherent resilience
- Damage – acquired vulnerability
- Inherent resilience
- Acquired vulnerability

Notes

EVI Indicator Approach

The overriding principle in constructing the EVI was not to introduce complexities into the model unless there was a justifiable reason to do so.

The maintenance of ecosystem or ecological integrity is at the heart of the development of a vulnerability index for the environment, because it is ecosystem integrity that is threatened by natural and anthropogenic hazards. The notion of ecosystem integrity is so complex that it cannot be expressed through a single indicator, but rather requires a set of indicators at different spatial and temporal scales and hierarchical levels of ecosystems. Ecosystem integrity depends on biodiversity, ecosystem functioning and resilience, all of which are such interrelated variables, that factors which affect just one of these can have far-reaching consequences for the country.

EVI DEFINITIONS

The definitions given here are pragmatic and only to be used for the purposes of the EVI.

The EVI is a numerical indicator that reflects the status of a country's environmental vulnerability, where:

- **"Environment"** includes those biophysical systems that can be sustained without human support
- **"Vulnerability"** is the extent to which the environment is prone to damage and degradation;
- **"Damage"** is the loss of diversity, extent, quality and function of environments.

WHAT ARE THE HAZARDS?

- **Meteorological events**
 - Cyclones
 - Droughts
 - Floods
 - ENSO
- **Geological events**
 - Coastal processes
 - landslides
 - earthquakes
 - tsunamis
 - volcano
- **Anthropogenic events**
 - Pollution, toxic wastes, solid wastes
 - Urbanisation
 - Mining
 - Hydrocarbons
 - Tourism
 - Exploitation
- **Climate change**
 - Ozone depletion
 - ENSO
 - Sealevel rise

The risks to the environment are any events or processes that can cause damage to ecosystem integrity. These include natural and human events and processes such as 'the weather' and 'pollution'. Some researchers have identified natural hazards as those in which natural environmental conditions depart from 'normal' to such an extent that systems of interest (human, environmental) may be adversely affected.

Further, a problem arises when otherwise 'normal' events interact with seemingly unrelated human activities and impacts. It is becoming increasingly common that ecosystems under daily stress from pollution and overexploitation, suffer more and recover more slowly from natural events such as storms, droughts etc that they otherwise would. In our world, natural hazards need to be included as part of overall vulnerability.

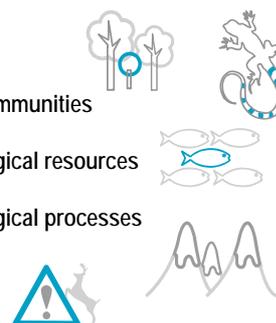
Although most identifiable risk events are capable of causing damage, it is only the larger and more intense events that are likely to cause wholesale changes in the environment,

at least in the short to mid-term. Some of the more important risks which can impact on the environment include meteorological events (e.g. cyclones, droughts, heatwaves, floods, tornadoes), geological events (earthquakes, tsunamis, volcanoes), anthropogenic impacts (mining, habitat destruction, resource overexploitation, pollution), biological events (plagues, blooms), climate change and sea-level rise.

WHAT IS VULNERABLE?

Environmental variables which are affected if the risks actually happen:

- Ecosystems
- Populations / communities
- Physical & biological resources
- Physical & biological processes
- Species



Defining Indicators

Environmental vulnerability has been characterised by three components or sub-indices. These sub-indices focus on ecosystem integrity and how it is threatened by anthropogenic and natural hazards. To be able to capture the complexity of these aspects of environmental vulnerability requires the development of a variety of indicators that target different spatial and temporal scales and hierarchical levels of the ecosystem. International initiatives to measure environmental condition or change range have developed anywhere from 4 to 260 indicators with increasing numbers being used to assess sustainable development progress or state of environment. The EVI utilises 50 ‘*smart indicators*’ to capture the key elements of environmental vulnerability. The term ‘*smart indicators*’ has been used to define EVI indicators which aim to capture a large number of elements in a complex interactive system while simultaneously showing how the value obtained relates to some ideal condition.

The basic assumption of *smart indicators* is that the value of a chosen indicator is a culmination of perhaps millions of transactions that must have been operating appropriately to result in the value obtained. Thankfully, this does not require our full knowledge of every transaction because if this were a requirement, we would never be able to use indicators at all. Simply it’s a bit like measuring our body temperature as an indicator of our health. If we have a high temperature it is a symptom of a potential health problem and we then rely on further tests and our doctor’s experience to find out what may be wrong. Indicators, like temperature in this case, do not tell us exactly what is wrong but are a helpful gauge that identifies a potential problem that requires further investigation.

The indicators selected for use in the EVI are based on the best scientific understanding currently available and have been developed in consultation with international experts, country experts, other agencies and interest groups. Some important environmental vulnerability issues are not yet measured because relevant data or robust measurement techniques are not yet available. However with new technological advances especially in the area of remote sensing further indicators may be developed for use in the EVI. The refinement of indicators and search for more appropriate smart indicators is on-going.

The 50 indicators been selected to measure environmental vulnerability are detailed in the appendix. Each indicator is classified into a range of sub-indices including:

- Hazards
- Resistance
- Damage
- Climate Change
- Biodiversity
- Water
- Agriculture and fisheries
- Human health aspects
- Desertification
- Exposure to Natural disasters

Each indicator is also accompanied by a short form key name, detailed definition, keywords and a description of the main signals for which it is a proxy as well as the indicators policy relevance (See appendix – EVI Description of Indicators).

EVI Indicators – Mapping Vulnerability

Measuring environmental vulnerability is a complex task which must incorporate measures for different levels of organisation from species to interdependent ecosystems and complex linkages between them. To simplify this complexity requires the use of an indicator approach. Indicators are used to provide a simplified model of a system that would otherwise require substantial resources or are too difficult to measure directly.

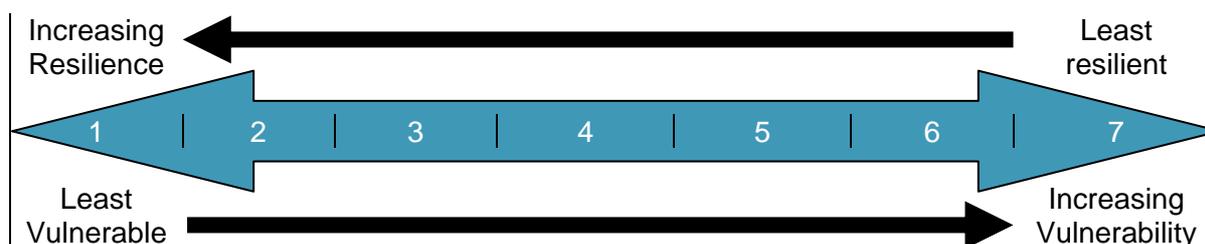
The EVI uses smart indicators to simplify measuring the various aspects of environmental vulnerability. Environmental indicators are of a heterogeneous nature, that is they include variables for which the responses are numerical, qualitative and on different scales (linear, non-linear, or with different ranges). As the EVI targets, quite varying and specific aspects of environmental vulnerability, several different indicators are used resulting in a wide variety of different unit measurements. Therefore to be able to accumulate indicators and generate an overall EVI value requires all indicators to be mapped onto a common environmental vulnerability scale.

For example: Indicator 44 – measures the number of vehicles per square kilometre of land area while indicator 31 – looks at the intensity of fertiliser use per year over the total land area (kg/yr/km²), averaged over the last 5 years. The only way to be able to add these indicators with very different units of measurement requires them to be mapped onto a vulnerability scale. Only then can they be added together to get an overall sense of vulnerability.

The EVI scale is a relative scale of vulnerability ranging from 1 – least vulnerable (most resilient) to 7 – most vulnerable (least resilient).

Sustainable conditions tend to be found near one end of the world's range for any one indicator. For most indicators we do not know the true cut-off values of sustainability. Where information does exist to support a level that would be considered 'sustainable' (e.g. protected areas should be 20% of the land or sea area), these values were used in the vulnerability scoring. Where values are not known, we scaled the values to spread them across global conditions and the best information available, often clumping extremely low or high values.

Most of the countries are forced into a clump at low values by the presence of just a few (sometimes only one or two countries) with extremely high values. Use of a logarithmic scale for many of the indicators helps us to distinguish between countries at the lower end of the scale where differences are smaller, shifts in values are likely to be relatively easy to achieve (improvements) and the level for sustainability is more likely to be located. Countries near the upper end of any indicator scale are not only very vulnerable, but may also be in a difficult position to effect improvements. They are often several orders of magnitude greater in value than conditions likely to be sustainable.



The use of mapping serves two important functions. Firstly, for the managers and scientists it forces us to decide on actual values for the indicator that are 'good' or 'bad'. In other words, what point does a species or ecosystem have to reach before it begins collapsing or is unable to maintain itself or its processes or functions begin to fail.

Identifying this sustainability threshold is not an easy task because information on the vulnerability and limits to viability of ecosystems is generally lacking. For example, we do not know the exact point at which a reef ecosystem will collapse following a cyclone. However we do know that a reef system that is degraded because of overexploitation of fisheries and pollution is more likely to collapse than a system that is in a relatively pristine state. It is this

Calculation of Country EVIs

To be able to calculate an EVI requires the compilation of relevant environmental vulnerability data for the 50 indicators. Once compiled then this data must be used to calculate each indicator. As the indicators are heterogeneous, include variables for which responses are numerical, qualitative and on different scales (linear, non-linear, or with different ranges) they are mapped onto a 1 – 7 vulnerability scale. Where data is not available, no value is given for the indicator and the denominator of the average adjusted down by one value. Where an indicator is considered 'non-applicable' in a country (such as volcanic eruptions in Tuvalu which has no volcanoes), the lowest vulnerability score of 1 is attributed to that indicator. The vulnerability scores for each indicator are then accumulated either into categories or sub-indices and the average calculated. An overall average of all indicators is calculated to generate the country EVI.

The EVI is accumulated into three sub-indices:

- Hazards
- Resistance
- Damage

The 50 EVI indicators are also divided up in the issue categories for use as required:

- Climate change
- Biodiversity
- Water
- Agriculture and fisheries
- Human health aspects
- Desertification
- Exposure to natural disasters

Vulnerability scores for each EVI indicator are then presented graphically (Figure 2). This profile gives an immediate visual representation of what the most important vulnerability issues are for the environment. Clearly this provides a simple tool for identifying the most significant vulnerability issues and helps to explain priority issues to the non-scientist. See example below for details. Highlighted in the boxes are the issues of highest vulnerability – wet periods, slides, isolation and oil spills which all have an EVI score of 7. The areas of highest resilience EVI = 1 for this example country profile include volcanoes, tsunamis, relief, migratory species, degradation, fragmentation, biotechnology, SO₂, vehicles, legislation and war.

Key Points

- | |
|--|
| <ul style="list-style-type: none"> • Calculating EVI indicators • EVI Vulnerability Mapping • Aggregating indicators • Sub-indices calculation • EVI scores |
|--|

Notes

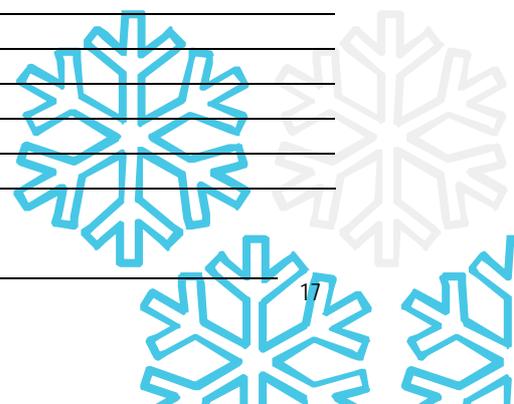
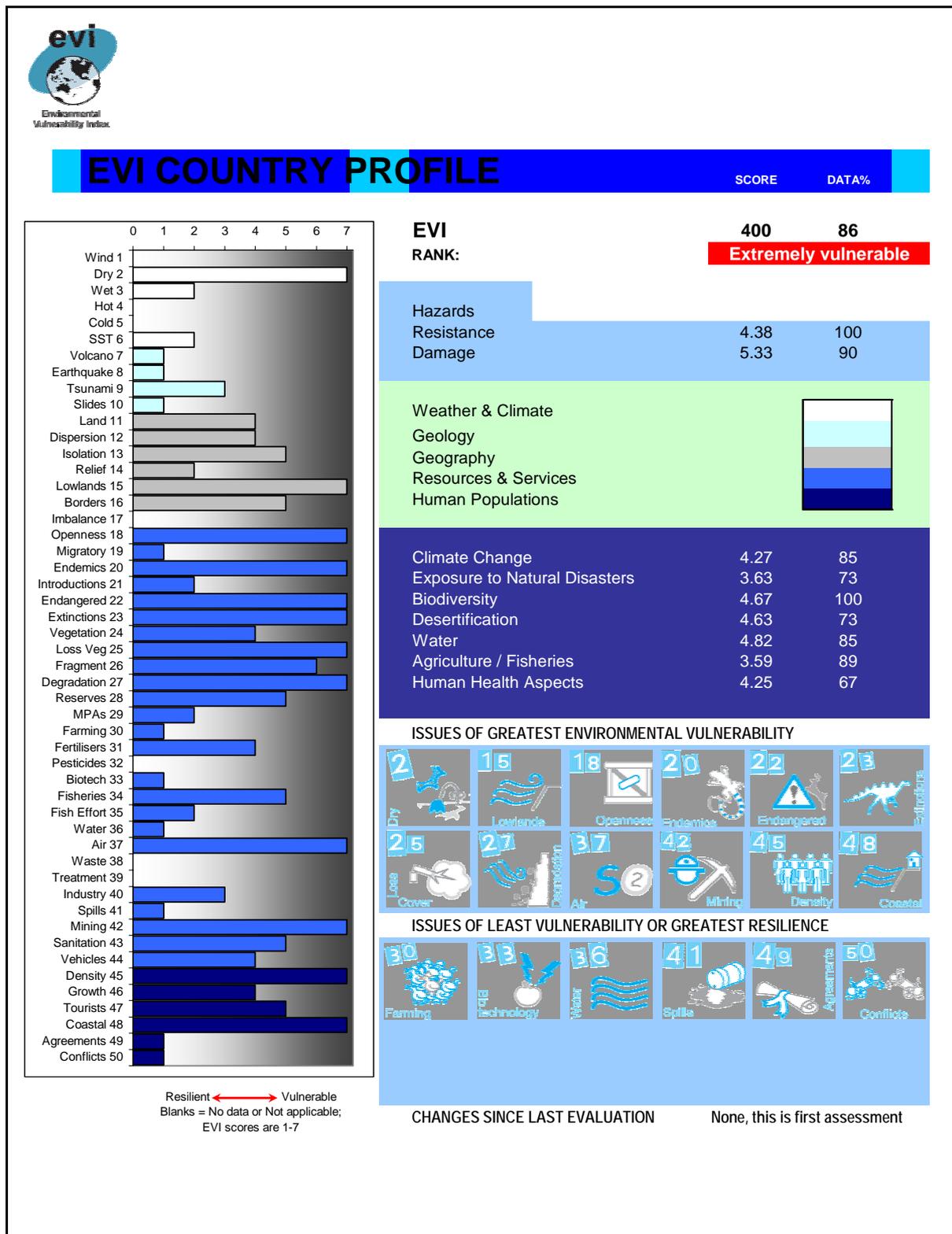


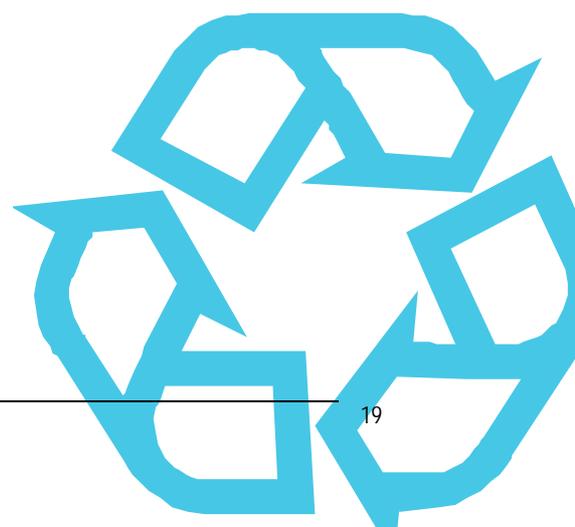
Figure 2: Example of an EVI Country Profile



4. Application of EVI

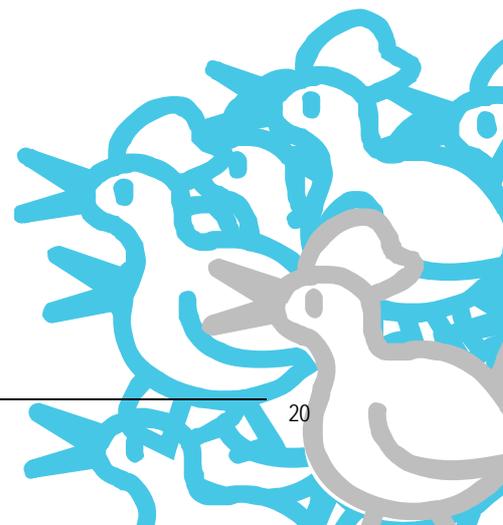
Uses of the EVI

National Scale



Regional Scale

Global scale



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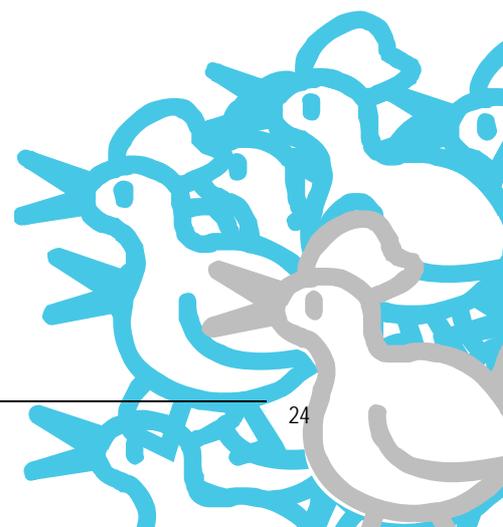
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6. Appendix

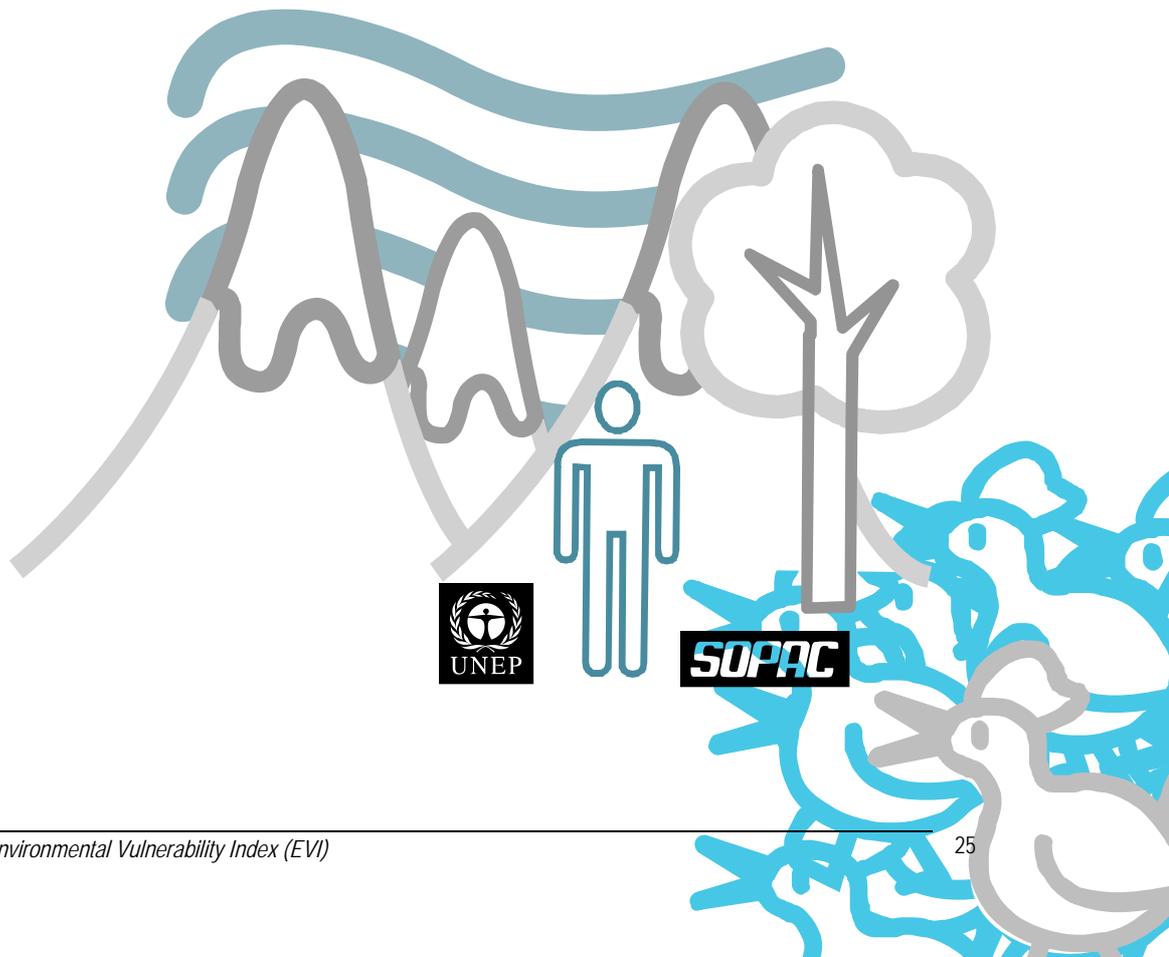
EVI: Description of Indicators – December 2004





Environmental Vulnerability Index EVI: Description of Indicators

20 December 2004



Vulnerability ⇔ Inherent characteristics of a country + Forces of nature + Human use + Climate change

The overall vulnerability of a country is the result of a large number of interacting forces. Some of these can be influenced by our policies and actions. Others, like the forces of nature, cannot be directly changed by our choices. Where we have no power to change a factor, such as the weather or volcanoes, we can still improve our overall position by increasing resilience or reducing vulnerability in seemingly-unrelated aspects of our environment. In the indicator descriptions that follow, we highlight some of the direct and indirect approaches that could be used to respond to vulnerability issues.

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HIGH WINDS

HIGH WINDS

Average annual excess wind over the last five years (summing speeds on days during which the maximum recorded wind speed is greater than 20% higher than the 30 year average maximum wind speed for that month) averaged over all reference climate stations.

Categories	Data sources
Hazards / Weather & Climate	NOAA GHCN

Vulnerability to cyclones, tornadoes, storms, erosion, habitat damage, disturbance. This indicator captures the likelihood of damage from frequent and severe wind that can affect forests, fan fires, create storm surges, dry soils, spread air pollution, and interact with other stressors. Because this indicator is expressed in relation to the 30 year monthly means, a high score could indicate shifts in weather patterns and climate, and could negatively affect a country’s resilience to other hazards. The signal generated captures not only the frequency of high winds, but also their strength.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCCC, CCD, ISDR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover).

Indicator scaling: (cut-off values are knots of excess wind annually)





DRY PERIODS

DRY PERIODS

Average annual rainfall deficit (mm) over the past 5 years for all months with more than 20% lower rainfall than the 30 year monthly average, averaged over all reference climate stations

Categories	Data sources
Hazards / Weather & Climate	NOAA GHCN

Vulnerability to drought, dry spells, stress on surface water resources. This indicator captures not only the number of months with significantly lower rainfall, but also the strength of the deficit. Two countries could have the same average number of months over the past 5 years with less than 20% lower than the monthly average rainfall, with one only having a small deficit, while another a very large one. This indicator ensures that the amount of rain 'missed' is captured. Frequent and severe drought months could indicate shifts in weather patterns and climate, and could negatively affect a country's resilience to other hazards (e.g. fires, water movements, ability of ecosystems to attenuate pollution).

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCCC, CCD, ISDR, RAMSAR, World water Forum, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover; improve water management)

Indicator scaling: (cut-off values are mm annual rainfall deficit)





WET PERIODS

WET PERIODS

Average annual excess rainfall (mm) over the past 5 years for all months with more than 20% higher rainfall than the 30 year monthly average, averaged over all reference climate stations

Categories	Data sources
Hazards / Weather & Climate	NOAA GHCN

Vulnerability to floods, cyclones, wet periods, stress on land surfaces and ecosystems subject to flooding and disturbance. This indicator captures not only the number of months with significantly higher rainfall, but also the amount of the excess. Two countries could have the same average number of months over the past 5 years with more than 20% higher rainfall than the monthly average, with one only having a small excess, while another a very large one. This indicator ensures that the amount of rain 'in excess' is captured. Frequent and severe wet months could indicate shifts in weather patterns and climate, and could negatively affect a country's resilience to other hazards (e.g. water movements, the spread of and ability of ecosystems to attenuate pollution)

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCC, CCD, ISDR, World Water Forum, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover; promote good landuse practices)

Indicator scaling: (cut-off values are mm annual rainfall excess)





HOT PERIODS

HOT PERIODS

Average annual excess heat (degrees) over the past 5 years for all days more than 5°C (9°F) hotter than the 30 year mean monthly maximum, averaged over all reference climate stations.

Categories	Data sources
Hazards / Weather & Climate	NOAA GHCN

Vulnerability to heat waves, desertification, water resources, temperature stress, bleaching. This indicator is designed to capture stress on land surfaces and nearshore or shallow aquatic environments to periods of high temperatures that can affect productivity, oxygen levels, pollution, reproduction and symbiotic relationships and lead to mass mortality. On land, periods of high temperatures can also lead to interactive effects such as fires. This indicator captures not only the number of days with significantly higher temperatures, but also the amount of the excess. Two countries could have the same number of days with more than 5°C higher temperatures than the monthly average, with one only having a small excess, while another a very large one. Frequent and severe hot days could also indicate shifts in weather patterns and climate, and could negatively affect a country’s resilience to other hazards (e.g. ability of forests to regenerate if disturbed).

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, IPCC, CCD, ISDR

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover; reduce other stresses on fragile ecosystems such as forests, steppes, wetlands and coral reefs)

Indicator scaling: (cut-off values are degrees Celsius of excess heat annually)





COLD PERIODS

COLD PERIODS

Average annual heat deficit (degrees) over the past 5 years for all days more than 5°C (9°F) cooler than the 30 year mean monthly minimum, averaged over all reference climate stations.

Categories	Data sources
Hazards / Weather & Climate	NOAA GHCN

Vulnerability to cold snaps, unusual frosts, effects on water resources, temperature stress, pollution attenuation rates, reproductive success. This indicator is designed to capture stress on land surfaces and nearshore or shallow aquatic environments to periods of low temperatures that can affect productivity, oxygen levels, pollution, reproduction and symbiotic relationships and lead to mass mortality. This indicator captures not only the number of days with significantly lower temperatures, but also the amount of the “heat deficit”. Two countries could have the same number of days with more than 5°C lower temperatures than the monthly average, with one only having a small deficit, while another a very large one. Frequent and severe cold days could also indicate shifts in weather patterns and climate, and could negatively affect a country’s resilience to other hazards (e.g. ability of lakes and rivers to attenuate pollutants).

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCC, CCD, ISDR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover; reduce other stresses on fragile ecosystems such as forests and steppes)

Indicator scaling: (cut-off values are degrees Celsius of heat deficit annually)





SEA TEMPERATURES

SEA TEMPERATURES

Average annual deviation in Sea Surface Temperatures (SST) in the last 5 years in relation to the 30 year monthly means (1961-1990).

Categories	Data sources
Hazards / Weather & Climate	University of British Columbia

This indicator captures vulnerability to fluctuations in productivity, fisheries, currents, eddies, ENSO, cyclones & storms, blooms and coral bleaching. The indicator captures the total amount of the anomalies in SST, either as excess or deficit (using absolute values). Frequent and severe deviations from the 30 year moving average could herald shifts in currents, upwelling, weather patterns and climate, and could negatively affect a country’s resilience to other hazards (e.g. for water movements, the spread of and ability of ecosystems to attenuate pollution). Effects would be especially important when other stresses have already driven populations to low levels.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCC, CCD, ISDR, GOOS, Regional Strategies, National Plans, SOE

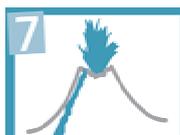
Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. build coastal resilience by controlling pollution, types of developments and resource use; maintain / improve forest cover).

Indicator scaling: (cut-off values are average degrees/year)



This indicator is not applicable to land-locked countries unless they have inland seas.





VOLCANOES

VOLCANOES

Cumulative volcano risk as the weighted number of volcanoes with the potential for eruption greater than or equal to a Volcanic Explosively Index of 2 (VEI 2) within 100km of the country land boundary (divided by the area of land).

Categories	Data sources
Hazards / Geology	NOAA / NESDIS / National Geophysical Data Centre / World Data Centre-A / Colorado USA

Vulnerability to Eruptions, landslides, geysers, gas (e.g. SO₂ and CO₂), fires, ash, dust, marine kills, biodiversity of habitat & species, potential for repeated and long term habitat disturbance. This indicator captures the risk of damage to ecosystems from the physical, chemical and biological disturbances associated with volcanic eruptions. Because the risk associated with volcanoes varies according to size and type, the signal incorporates the number of volcanoes capable of affecting a country, and its potential for damage.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCC, ISDR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover; promote good landuse practices; create reserves)

Indicator scaling: (cut-off values are weighted numbers of volcanoes VEI 2+)





EARTHQUAKES

EARTHQUAKES

Cumulative earthquake energy within 100km of country land boundaries measured as Local Magnitude (ML) ≥ 6.0 and occurring at a depth of less than or equal to fifteen kilometres (≤ 15 km depth) over 5¹ years (divided by land area).

Categories	Data sources
Hazards / Geology	NOAA / NESDIS / National Geophysical Data Centre / World Data Centre-A / Colorado USA

Vulnerability to habitat disturbance through movements of land, water and slides. This indicator captures the risks of damage to the environment from large-scale disturbances such as fluidisation of soils and muds, diversion of rivers and other water bodies, tsunamis, slides, and direct damage to organisms associated with earth movements.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement and which reduce the impacts of development activities (e.g. maintain / improve forest cover; promote good landuse practices).

Indicator scaling: (cut-off values are number of earthquakes of ML ≥ 6 , Depth ≤ 15 km)



¹ In its final form, this indicator will include earthquakes over a 5 year period, it is presently based on a 6-year period.



TSUNAMIS

TSUNAMIS

Number of tsunamis or storms surges with run-up greater than 2 metres above Mean High Water Spring tide (MHWS) per 1000 km coastline since 1900.

Categories	Data sources
Hazards / Geology	Tsunamis: NOAA/NESDIS/NGCC; Length maritime coast from WRI 2000-2001 and CIA 2001

This indicator captures the potential loss of shorelines, coastal ecosystems and resources, and loss of species due to catastrophic run up of seawater onto coastal lands. Countries with frequent and severe tsunamis are at risk of severe or permanent damage to biodiversity, productivity and the ability to recover from other stressors.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCC, ISDR, Regional Strategies, National Plans, SOE

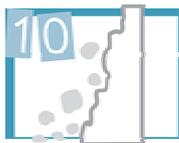
Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve coastal forest cover; careful design of coastal structures and developments; promote good landuse practices)

Indicator scaling: (cut-off values are number of tsunamis / surges with run-up >2m above MHWS (years 1900-2000) / length of coastlines (maritime) * 1000)



This indicator is not applicable to land-locked countries





SLIDES

SLIDES

Number of slides recorded in the last 5 years (EMDAT definitions), divided by land area

Categories	Data sources
Hazards / Geology	EMDAT OFDA/CRED International Disaster Database 2001

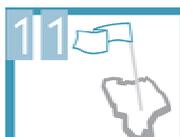
Vulnerability to habitat disturbance and persistence of ecosystems and species from catastrophic shifts in the land surface. The primary and cumulative effects of slides would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, but resilience against effects could be built up in other areas which are amenable to improvement (e.g. maintain / improve forest cover; promote good landuse practices)

Indicator scaling: (cut-off values are Number of slides recorded between 1996-2000, divided by area of land (km²))





LAND AREA

LAND AREA

Total land area (km²).

Categories	Data sources
Resistance / Geography	WRI 2000-2001; CIA Fact sheets 2001

This indicator captures the richness of habitat types and diversity, availability of refuges if damage is sustained or for protection, and species and habitat redundancy. It is generally considered that larger countries will have more options and the 'critical mass' required for ecological systems to persist and re-seed each other in the face of ecosystem stressors. There will also be more options for the human populations to allow areas that have been damaged to recover.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, MDG, CBD, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, and is part of the inherent characteristics of a country. General environmental resilience could be built up by improving resource use; appropriate developments and increasing the area under reserves.

Indicator scaling: (cut-off values are square kilometres of land area



M=millions; K=thousands



COUNTRY
DISPERSION

COUNTRY DISPERSION

Ratio of length of borders (land and maritime) to total land area.

Categories	Data sources
Resistance / Geography	WRI 2000-2001; CIA Fact sheets 2001, 2002

This indicator captures the degree to which a country's land area is fragmented and 'thin'. Countries which are highly fragmented, comprised of many islands, or which have many peninsulas or land areas in thin strips are likely to be prone to more transboundary effects. The land areas may also be more exposed to damage from natural disasters and human impacts (e.g. cyclones, fires, effects of war) in such areas, because the presence of refuges and ecosystem types that may form breaks are likely to be limited. Although fragmentation may also bring with it the possibility that damage could be limited by intervening areas of land or sea, there are likely to be higher risks that ecosystems and species (particularly if many are endemic) will not persist. This could be especially true if there are interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, MDG, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, and is part of the inherent characteristics of a country. General environmental resilience could be built up by improving resource use; increasing the area under reserves.

Indicator scaling: (cut-off values are total length of land and sea borders (km) / land area of country (accumulated across islands, if present) (1000 sq km))





ISOLATION

ISOLATION

Distance to nearest continent (km)

Categories	Data sources
Resistance / Geography	Times Comprehensive World Atlas 2000

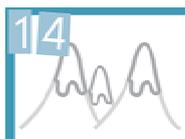
This indicator captures the proximity of a country to the nearest continent. Note that if a country is within a continent, this value is zero. Isolated countries may have a greater risk of loss of ecosystem types and species during periods of stress if they are far away from refuges and sources of recolonisation. Isolated countries also likely to support fewer species than those which are close to large continents, or biogeographic centres of radiation. Additionally, there is less chance of genetic interchange (part of genetic resilience) in isolated areas. The likelihood of isolation being an important part of a country's ecological resilience would be especially important if there are interactions with on-going human impacts. Countries close to sources of recolonisation are likely to be less at risk of permanent species losses, compared with those far away, particularly if they are small or fragmented.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, MDG, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, and is part of the inherent characteristics of a country. General environmental resilience could be built up by maintaining forest cover, improving land and resource use and increasing the area under reserves.

Indicator scaling: (cut-off values are distance (km) to the nearest continent)





RELIEF

RELIEF

Altitude range (highest point subtracted from the lowest point in country)

Categories	Data sources
Resistance / Geography	CIA World Fact Book 2001

This indicator examines the vulnerability of a country related to biodiversity of habitats and species and the potential for habitat disturbance through movements of water and slides. A country with a large altitude range is likely to have a greater variety of ecosystems, which in very high altitude areas, or very low ones (e.g. the Black Sea) leads to the formation of “endemic habitat types”. These can be an integral part of the character of a country, and if lost, the same arguments as for endemic species applies.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, UNFCCC, MDG, CBD, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, and is part of the inherent characteristics of a country. General environmental resilience could be built up by maintaining / improving forest cover, improving land use patterns, and increasing the area under reserves.

Indicator scaling: (cut-off values are altitude range in metres)





LOWLANDS

LOWLANDS

Percentage of land area less than or equal to 50m above sea level

Categories	Data sources
Resistance / Geography	Encarta 2004 World Atlas

The final form of this indicator will be: *Percentage of land area less than or equal to 10m above sea level*. Data are currently being developed for this indicator, and are expected to become available within a short period of time.

This indicator focuses on the presence of lowlands in a country with implied impacts associated with pollution, ecosystem disturbance, flooding and coastal vulnerability. Areas of lowlands are those that will tend to be the first to flood, will tend to accumulate pollution that is mobilised by surface run-off, provide an important entry point (and extraction point) for groundwaters and if on the coasts of the sea or lakes may be subject to storm surges, tsunamis or sea level rise. They tend to be areas of high biodiversity and/or form critical habitats. They may also be critical areas for productivity, soil formation, erosion, natural resources and pollution attenuation. A country's resilience to future hazards will be related to risks on lowland areas. This would be especially important if there are many sensitive ecosystems susceptible to the loss of key species and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, MDG, CBD, UNFCC, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue cannot be directly influenced by human actions, and is part of the inherent characteristics of a country. General environmental resilience could be built up by maintaining / improving forest cover, through good land use practices, reducing pressures on lowlands and increasing the area under reserves.

Indicator scaling: (cut-off values are percent of land area less than or equal to 50m above sea level)





BORDERS

BORDERS

Number of land and sea borders (including EEZ) shared with other countries.

Categories	Data sources
Resistance / Geography	CIA Fact file 2000; Encarta World Atlas 1999, 2000; SOPAC EEZ Maps for the Pacific

This indicator captures the risk to terrestrial and aquatic ecosystems from transboundary risks including species introductions, lack of control of effects from neighbouring countries, lack of control of straddling stocks of resources, and uncontrolled migrations of humans (e.g. refugees). We consider that the greater the number of different jurisdictions bordering a country by land or sea, the greater the risks of neighbour effects – that is risks to the environment caused by the policies and behaviours of other countries. The effects of these factors would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, ISDR, MDG, CBD, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue can be directly influenced by human actions through agreements designed to reduce transboundary risks such as pollution, movements of migratory species and use of shared resources.

Indicator scaling: (cut-off values are number of other countries connecting with the borders of a country)





**ECOSYSTEM
IMBALANCE**

ECOSYSTEM IMBALANCE

Weighted average change in trophic level since fisheries began (for trophic level slice ≤ 3.35).

Categories	Data sources
Damage / Resources & services	University of British Columbia, Fisheries Centre, Lower Mall Research Station

This indicator captures the risk of ecosystem stress, loss of diversity, damage to the trophic structure of ecosystems, and loss of balance. It focuses on the risk to aquatic ecosystems associated with shifting the natural relationships, diversity and energy-flows within and among ecosystems. Although fisheries data are used, the indicator is more generally concerned with the downstream effects on habitats and other organisms. The greater the downward (negative) trend in trophic level change, the more likely that the marine biomass and trophic structures have been damaged. Such changes could lead to outbreaks or overgrowth of unexpected or pest organisms, monopolies of certain species, and losses of ecosystem elements that may be dependent on the behaviour or populations of others. The effects of these factors would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPOA, WSSD, CSD, ISDR, MDG, CBD, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue can be directly influenced by human actions though the adoption of ecosystem approaches to management of aquatic and terrestrial areas, and the use of their resources.

Indicator scaling: (cut-off values are trophic level change values)





ENVIRONMENTAL
OPENNESS

ENVIRONMENTAL OPENNESS

Average annual USD freight imports over the past 5 years by any means per km² land area

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001

The final form of this indicator will be: *Average annual tonnage of freight imported per year over the past 5 years by any means / sq km land area.* Tonnage rather than USD will provide a better signal for this indicator focusing on amounts of materials moved rather than their value. It is expected that data for this indicator will become available.

This indicator captures the risk of damage to a country through the importation of foreign materials (physical, chemical and biological) by land, air or sea through the large volumes of freight that move around the globe annually. Countries with large amounts of freight moving into them are considered more at risk of inadvertent introductions of diseases, species and genetically modified organisms, than those with lower levels of freight movements. The likelihood of such introductions negatively affecting a country's resilience would be especially important if there are many endangered species, sensitive ecosystems that could be affected by key species, and interactions with on-going human impacts. This includes the importing of hazardous wastes. Freight imports may also be a mechanism for the introduction of pollution risks not normally found in a country – e.g. the import of radioactive substances, oil, chemicals.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Basel Convention, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue can directly influenced by quarantine control of freight movements and limiting or eliminating waste trading. Mechanisms could be put in place to contain accidental introductions where possible. General resilience building through management of rare and endangered organisms and establishing more reserves could also be undertaken.

Indicator scaling: (cut-off values are average annual freight density as thousands of USD of freight moved into the country per sq km of land)





MIGRATIONS

MIGRATIONS

Number of known species that migrate outside the territorial area at any time during their life spans (including land and all aquatic species) / area of land

Categories	Data sources
Resistance / Resources & services	GROMS Database (includes: IUCN Red Book of Endangered Organisms 2000; African mammal database (AMD) 1998; Erasien Anatidae Atlas; Artic Bird Database 1998; WCMC Turtle Database 1999; Fishbase 1998; Slender-billed curlew database 2000; Maps of non passerine birds 1992-2001)

This indicator focuses on species which pass outside of the control of the country and which during that time may be affected by actions of surrounding countries, or distant nations utilising them as a resource. It focuses on biodiversity, resilience and persistence of species with large variances in population numbers and or /that are susceptible to local extinctions. Straddling stocks of migrating mammals and fishes may also be key species in determining ecosystem conditions in a country, and damage to these while they are outside the country may lead to indirect effects on ecosystems within the country (e.g. migrating mammals as determinants of grasslands in Africa and America). Species could become endangered or threatened in a country, despite good internal management, with implied impacts on biodiversity, ecosystem integrity and resilience to future hazards. This would be especially important if there are many sensitive ecosystems susceptible to the loss of keystone species and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue can be influenced through bilateral and multilateral treaties designed to reduce transboundary risks such as pollution, movements of migratory species and use of shared resources. General resilience building through management of rare and endangered organisms and establishing more reserves could also be undertaken.

Indicator scaling: (cut-off values are density of migratory species expressed as number of species per 1000 sq km land area under various categories of GROMS migrants)





ENDEMICS

ENDEMICS

Number of known endemic species per million square kilometre land area

Categories	Data sources
Resistance / Resources & services	WRI 2000-2001

This indicator focuses biodiversity and the risk of losing unique species. The more endemic species a country has, the more vulnerable it is because localised extinction cannot be re-supplied from elsewhere by natural or augmented recolonisation. Losses of key species can affect ecosystem function and the goods and services they provide.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue can be influenced through identification and preservation of species and habitats unique to a country. General resilience building could be achieved through creating more reserves in terrestrial and aquatic habitats.

Indicator scaling: (cut-off values are species per million sq km land area)





INTRODUCTIONS

INTRODUCTIONS

Number of introduced species per 1000 square kilometre of land area

Categories	Data sources
Damage / Resources & services	FAO 2002

This indicator captures past species introductions to a country with implied impacts on biodiversity and ecosystem integrity. This may include impacts at the levels of populations, genetics, species and ecosystems through complex ecological interactions. Past introductions of species could negatively affect a country's resilience to future hazards. This would be especially important if there are many endangered species, sensitive ecosystems that could be affected by key species, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue is difficult to rectify once introductions have occurred and exotic species have become established. This issue can directly influenced by quarantine control of freight movements and mechanisms could be put in place to contain accidental introductions where possible. General resilience building through management of rare and endangered organisms and establishing more reserves could also be undertaken.

Indicator scaling: (cut-off values are species per 1000 sq km land area)





ENDANGERED
SPECIES

ENDANGERED SPECIES

Number of endangered and vulnerable species per 1000 sq km land area (IUCN definitions)

Categories	Data sources
Degradation / Resources & services	IUCN Red Book 2000

This indicator focuses on those species that have become endangered or threatened in a country with implied impacts on biodiversity and ecosystem integrity. These are the species most likely to next become extinct, and may already be resulting, by their reduced numbers, in impacts at the levels of populations, genetics, species and ecosystems through complex ecological interactions. The reduction of populations of species could negatively affect a country's resilience to future hazards. This would be especially important if there are many sensitive ecosystems susceptible to the loss of key species and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This issue can be influenced through identification and preservation of species and habitats under threat in a country. General resilience building could be achieved through reducing pressure on threatened environments and species and by creating more reserves in terrestrial and aquatic habitats.

Indicator scaling: (cut-off values are species per 1000 sq km land area)





EXTINCTIONS

EXTINCTIONS

Number of species known to have become extinct since 1900 per 1000 sq km land area (IUCN definitions).

Categories	Data sources
Degradation / Resources & services	IUCN Red Book 2000

This indicator focuses on those species that have become extinct in a country with implied impacts on biodiversity and ecosystem integrity. The loss of these species has resulted in a loss of biodiversity, and may also have resulted in impacts on ecosystem structure and function through complex ecological interactions. The loss of species could negatively affect a country's resilience to future hazards. This would be especially important if there are many sensitive ecosystems susceptible to the loss of keystone species and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: Extinctions that have already occurred. Most actions will be concerned with preventing further extinctions through management of rare and endangered organisms and habitats under threat in a country. General resilience building could also be achieved through creating more reserves in terrestrial and aquatic habitats.

Indicator scaling: (cut-off values are species per 1000 sq km land area)





VEGETATION COVER

VEGETATION COVER

Percentage of natural and regrowth vegetation cover remaining (include forests, wetlands, prairies, tundra, desert and alpine associations).

Categories	Data sources
Degradation / Resources & services	WRI 2000-2001; FAO State of the World’s Forests, 1995, 2000

This indicator focuses on the loss of natural vegetation cover in a country with implied impacts on biodiversity and ecosystem integrity. The loss of natural vegetation has resulted in a loss of biodiversity, and may also have resulted in impacts on ecosystem structure and function through complex ecological interactions. Areas of natural vegetation are viewed as refuges for threatened species, those unknown to science, or those which may act as a future resource (e.g. for biochemical applications). Natural forests and vegetated areas are also likely to be important areas for groundwater intake, soil production, CO₂ – oxygen relationships and attenuating air and water pollution. A country’s resilience to future hazards will be related to the rate and total loss of naturally vegetated areas. This would be especially important if there are many sensitive ecosystems susceptible to the loss of keystone species and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, UNFCC, World Water Forum, Regional Strategies, National Plans, SOE

Reducing vulnerability: The first action will be to prevent further losses of whatever natural vegetation cover remains in a country. General resilience building could also be achieved through rehabilitation of degraded habitats, allowing areas to regenerate, better land use and creating more reserves in terrestrial habitats.

Indicator scaling: (cut-off values are percent of land area under natural original or regrowth vegetation cover)





LOSS OF COVER

LOSS OF COVER

Net percentage change in natural vegetation cover over the last five years

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001; FAO State of the World's Forests, 1995, 2000

This measures the rate of loss or gain of natural vegetation cover in countries. It focuses on biodiversity, ecosystem resilience, the capacity of a country to attenuate pollution, prevention of soil loss and on-going soil development, reduction of runoff, recharging of ground waters and soil formation.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, World Water Forum, Regional Strategies, National Plans, SOE

Reducing vulnerability: The first action will be to prevent further losses of whatever natural vegetation cover remains in a country. General resilience building could also be achieved through rehabilitation of degraded habitats, allowing areas to regenerate, better landuse and creating more reserves in terrestrial habitats.

Indicator scaling: (cut-off values are percent net change in forest cover over the last 5 years)





HABITAT FRAGMENTATION

Total length of all roads in a country divided by land area.

Categories	Data sources
Damage / Resources & services	World Bank World Development Indicators 2001

This is a proxy measure for pressure on ecosystems resulting from fragmentation into discontinuous pieces. It also relates to habitat disturbance and degradation. Fragmentation is likely to affect biodiversity, affecting species with variability in population numbers, keystones, those susceptible to local extinctions, those that use migration corridors and the persistence of species with large home ranges. For many large mammals and some birds viable fragments of habitat are size-dependent, despite the fact that the overall area available in a country may still sum to a relatively large area. This indicator measures a specific aspect of habitat availability that relates to size and quality of patches. The effects of fragmentation would be particularly important if there are other natural and human stresses operating on susceptible organisms and ecosystems.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: Mechanisms that reduce fragmentation of the land area would include the use of wildlife corridors, and planning to build the road network in ways that maximise uninterrupted space in non-urban areas. General resilience building could also be achieved through improvements in related issues, such as rehabilitation of degraded habitats, allowing deforested areas to regenerate, and creating more reserves in terrestrial habitats.

Indicator scaling: (cut-off values are latest measure of length of all roads in the country (km) / land area (sq km).





DEGRADATION

DEGRADATION

Percent of land area that is either severely or very severely degraded (FAO/AGL Terrastat definitions)

Categories	Data sources
Damage / Resources & services	FAO / AGL Terrastat: Severity of human induced degradation

This indicator captures the status of loss of ecosystems in a country. Degraded land means that which can no longer revert to its natural ecosystem without active and costly rehabilitation by humans to reverse permanent damage, if at all. Types of degradation include water and wind erosion, chemical and physical deterioration, agriculture, deforestation and grazing. These can be associated with salinisation and desertification. This indicator highlights the breakdown of ecosystems which leads to decreasing biodiversity, soil quality, resilience against natural events and the assimilative capacity of the environment.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, World Water Forum, Regional Strategies, National Plans, SOE

Reducing vulnerability: Mechanisms that are degrading the land should be identified and arrested as soon as possible. Programmes for rehabilitation and/or allowing natural regeneration could be put in place. General resilience building could also be achieved through improvements in land use and other related issues, such as creating more reserves in terrestrial habitats.

Indicator scaling: (cut-off values are percent of land area that is severely or very severely degraded FAO/AGL Terrastat definitions - lighter forms of degradation are not included).





TERRESTRIAL RESERVES

TERRESTRIAL RESERVES

Percent of terrestrial land area legally set aside as no take reserves

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001

Data refer to area of land especially dedicated to the protection and maintenance of biological diversity, of natural and associated cultural resources, and which are managed through legal or other effective means. This indicator captures the increase in resilience, function of pollution attenuation, groundwater recharge, limits to losses of biodiversity and refuges afforded by the presence of adequate terrestrial reserves (including aquatic ecosystems located within the land area) in a country. The indicator focuses on areas with the most intact terrestrial environments and the level of environmental management. The benefits of areas set aside as terrestrial reserves increase with increasing area, increasing representation of ecosystem types, increasing degree of protection and period of time of protection. Permanent no-take reserves that are representative of major ecosystem types and occupy 20% of the land area would be considered ideal. Reserves would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts in the country. Reserves may be one of the few ways managers could off-set some other environmental damage and build resilience against natural events that can damage the environmental support system.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, World Water Forum, Regional Strategies, National Plans, SOE

Reducing vulnerability: This is one of the few general resilience building indicators. Setting aside reserves of 20% of the land area is probably the most powerful action that could be taken to build resilience against all other pressures on the environment. Terrestrial reserves can be used as water catchment areas.

Indicator scaling: (cut-off values are percent of total land area legally set aside as reserves)





MARINE RESERVES

MARINE RESERVES

Percentage of continental shelf legally designated as marine protected areas (MPAs).

Categories	Data sources
Hazards / Resources & services	UNEP WCMC 1999 (Using IUCN categories Ia to VI); WRI 2000-2001 (for area of continental shelf)

This indicator captures the increase in resilience, function of pollution attenuation and fisheries production, limits to losses of biodiversity and refuges afforded by the presence of adequate marine reserves in a country. The indicator focuses on areas with the most intact marine environments and the level of environmental management. The benefits of areas set aside as marine and coastal reserves increase with increasing area, increasing representation of ecosystem types, increasing degree of protection and period of time of protection. Permanent no-take reserves that are representative of major ecosystem types and occupy 20% of the shelf area would be considered ideal. Reserves would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts in the country. Reserves may be one of the few ways managers could off-set some other environmental damage and build resilience against natural events that can damage the environmental support system.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: This is one of the few general resilience building indicators. Setting aside reserves of 20% of the marine area is probably the most powerful action that could be taken to build resilience against all other pressures on the environment.

Indicator scaling: (cut-off values are percent of total area of the continental shelf legally set aside as reserves)



This indicator is not applicable to land-locked countries.




 INTENSIVE
 FARMING

INTENSIVE FARMING

Annual tonnage of intensively farmed animal products (includes aquaculture, pigs, poultry) produced over the last five years per square kilometre land area.

Categories	Data sources
Hazards / Resources & services	FAO 1996-2000

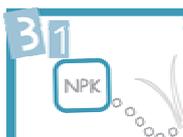
This indicator captures the risk of pollution, eutrophication, ecosystem loss or damage and the risk of diseases and plagues. It focuses on lands being used for intensive agriculture, which we define as those in which the wastes produced over the land are in excess of the ability of that same land area to attenuate them. Intensive farming includes the farming of poultry, pigs, aquaculture, and some farming of cattle and other animals where kept in feed lots. Intensive farming usually involves clearing of land, feeding, heavy use of pesticides and other medications and a concentrated production of wastes. It concentrates the environmental requirements of farmed animals into a small area, and wastes often find their way into the surrounding water table, waterways and land areas. Countries with a large production through intensive farming methods are also considered more at risk of inadvertent introductions of diseases, species and genetically modified organisms. The effects of intensive farming would be especially important if there are many endangered species, sensitive ecosystems that could be affected by key species, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, UNFCCC, Regional Strategies, National Plans, SOE

Reducing vulnerability: The main risks of intensive agriculture and aquaculture relate to use of medicines, pesticides and other chemicals and production of concentrated wastes. Mechanisms for reducing their use and/or impacts on the environment through better husbandry and treatment of wastes would reduce risks associated with this issue.

Indicator scaling: (cut-off values are tonnes / sq km of land area)





FERTILISERS

FERTILISERS

Average annual intensity of fertiliser use over the total land area over the last 5 years.

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001; OECD 1999

This indicator captures the risk to terrestrial, aquatic ecosystems and ground waters from the use of chemical NPK fertilisers. This indicator is a measure of damage to ecosystems, water and soil quality, coral reefs and other sensitive organisms through eutrophication, pollution, soil damage and salinisation. The effects of using NPK fertilisers depends on the intensity of application and time and space needed for natural attenuation. The effects of releasing large amounts of fertilisers into the environment would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, Regional Strategies, National Plans, SOE

Reducing vulnerability: Systems of agriculture that do not require large applications of NPK fertilisers should be explored, this might include mechanisms for recycling organic wastes. General resilience building would be through reducing other pressures on the receiving environments that could interact with large inputs of fertilisers.

Indicator scaling: (cut-off values are kg/yr/km² of land area)





PESTICIDES

PESTICIDES

Average annual pesticides used as kg/km²/year over total land area over last 5 years.

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001; OECD 1999

This indicator captures the risk to terrestrial, aquatic ecosystems and ground waters from heavy use of pesticides. The indicator focuses on damage and pollution of ecosystems, soil damage, damage to reproductive systems of organisms, loss of species, and damage to aquatic organisms including fisheries and coral reefs. Pesticides need time and a suitable area of land or volume of water for their attenuation. High loads of mobile pesticides present risks to all aspects of the environment. The effects of introducing pesticides into the environment where they can accumulate would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: Systems of agriculture that do not require large applications of pesticides should be explored, e.g. using integrated pest management. General resilience building would be through reducing other pressures on the receiving environments that could interact with large inputs of pesticides.

Indicator scaling: (cut-off values are kg/yr/km² of land area)





BIOTECHNOLOGY

BIOTECHNOLOGY

Cumulative number of deliberate field trials of genetically modified organisms conducted in the country since 1986.

Categories	Data sources
Hazards / Resources & services	OECD Sept 2000 database; ISAAA International Services for the acquisition of agribiotech applications, 1997, 2002; BINAS; BIOTECH 1991-1999; Information Systems for Biotechnology (ISB), 2002.

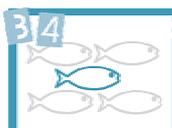
This indicator captures the risk to genetic diversity, genetic pollution and unpredictable ecosystem effects of introducing incompletely tested and/or unpredictable bioengineered organisms into the environment. This includes new toxin-producing organisms, terminators (the use of deliberately sterile organisms is often used as a biological control method for pests) or organisms with new ecological behaviours. This indicator operates under the precautionary principle. The effects of releasing organisms developed under laboratory conditions into the environment are unknown until they are tested in the environment. We have used data on deliberate field trials of GMOs for this indicator. It is likely that the risks of GMOs are less dependent on the *area* used, and more dependent on the *different types* of GMOs being either tested or grown. That is, we see risk increasing more with exposure to increasing numbers of GMOs, rather than the number of instances of any one type because of the capacity to spread once a gene ‘escapes’. Although operating at the genetic rather than species level, we see some of the risks of GMOs to ecosystems as being similar to those associated with introduced species.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, RAMSAR, Regional Strategies, National Plans, SOE

Reducing vulnerability: Deliberate introductions of organisms that may have unpredictable interactions with the environment should not be undertaken. Any single organism may have far-reaching effects that could not be reversed, in the same way that species introductions have in the past. Laboratory tests are not the same as field tests and cannot predict outcomes in the environment. Each GMO introduced into the environment carries a similar risk to an introduced species.

Indicator scaling: (cut-off values are cumulative number of deliberate field trials)





**PRODUCTIVITY
OVERFISHING**

PRODUCTIVITY OVERFISHING

Average ratio of productivity : fisheries catch over the last 5 years

Categories	Data sources
Hazards / Resources & services	FAO 1993-1998 (fisheries); University of British Columbia (productivity)

This indicator captures the risk of damage to fisheries stocks by examining rates of extraction in relation to the potential for the environment to replenish those stocks (productivity). We term this “productivity overfishing” or fishing beyond the capacity of the environment to replenish stocks through primary production and biomass transfer. If the catch is high and productivity low, there is a higher risk that overall fisheries stocks can be depleted (all other factors being equal) than if the converse were the case. This indicator should be read in combination with Indicator 39 which focuses on catch per human effort. The effects of ecological overfishing would be especially important if there are interactions with other on-going human and natural impacts. A small P:C ratio means greater vulnerability of fisheries.

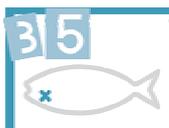
Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, Regional Strategies (e.g. Fisheries Agreements), National Plans, SOE

Reducing vulnerability: Fisheries policy that keeps catches within overall sustainable limits of the country’s productivity. General resilience can be built by creating marine reserves.

Indicator scaling: (cut-off values are tonnes carbon/km² EEZ/yr : tonnes fisheries/km² shelf / yr)



M=millions; K=thousands



FISHING
EFFORT

FISHING EFFORT

Average annual number of fishers per kilometre of coastline over the last 5 years

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001

This indicator captures the risk of damage to fisheries stocks through overcapacity of human effort. In this indicator we have tried to capture all fishers, not just the commercial fleet. Countries with large densities of fishers working their coastlines, including freshwater coasts such as lakes, are more likely to overfish their resources than those with lower densities. This indicator should be read in combination with Indicator 24, which focuses on ecological overfishing. The effects of overfishing would be especially important if there are interactions with other on-going human and natural impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CBD, Regional Strategies (e.g. Fisheries Agreements), National Plans, SOE

Reducing vulnerability: Fisheries policy that keeps catches within overall sustainable limits of the country's productivity. General resilience can be built by creating marine reserves.

Indicator scaling: (cut-off values are average number of fishers / km coastline)





RENEWABLE
WATER

RENEWABLE WATER

Average annual water usage as percentage of renewable water resources over the last 5 years

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001

This indicator captures the risk to terrestrial environments, aquatic ecosystems and ground waters from over-extraction of freshwater resources. It focuses on sustainable use of surface free water and groundwater and damage through salinisation, extraction of functionally non-renewable groundwater, and damage to rivers, lakes and other habitats. Renewable water is that which is caught in rain tanks and reservoirs, or collected from streams, rivers, lakes, ice or groundwater sources that are not being diminished or salinised as a result of the extraction. The effects of over-extraction would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, CCD, World Water Forum, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure extractions of water from the environment are within sustainable limits. Water usage should be from renewable sources and should not use all of the available renewable water so that other elements of the environment can function. General resilience can be built by managing watersheds, wetlands, groundwater and forests which are important elements of how ecosystems interact with the hydrological cycle.

Indicator scaling: (cut-off values are water usage as a percent of available renewable resources)





SO₂
EMISSIONS

SULPHUR DIOXIDE EMISSIONS

Average annual SO₂ emissions over the last 5 years

Categories	Data sources
Hazards / Resources & services	GEO-3 Data Compendium 2002; OECD 1999; WRI 2000-2001; HDR 1999; WDI 2001

This indicator captures the risk to ecosystem health from air pollution, including its downstream effects. High rates of emissions of gases from industry present risks to all aspects of the environment through diffuse pathways, including deposition by rain. The effects of air pollution (of which SO₂ is only one indicator and only one of the gases of concern) into the environment and beyond its capacity to attenuate them would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, UNFCC, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure managed emissions or clean industry should be examined and implemented. General resilience can be built by maintaining and restoring wetlands, forests and other ecosystems that encourage biodegradation of industrial wastes.

Indicator scaling: (cut-off values are tonnes/km²/year)





**WASTE
PRODUCTION**

WASTE PRODUCTION

Average annual net amount of generated and imported toxic, hazardous and municipal wastes per square kilometre land area over the last 5 years

Categories	Data sources
Hazards / Resources & services	EEA 2001 European Environment Agency; UNEP 1998; USA EPA; MZPSR Ministry of Environment of Slovak Republic 2000

This indicator captures the risk to terrestrial, aquatic ecosystems and ground waters from toxic and municipal wastes. All such wastes need a suitable area of land or volume of water for their eventual attenuation. High waste loads present risks to all aspects of the environment. The effects of dumping large amounts of wastes into the environment and beyond its capacity to attenuate them would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Basel Convention, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure wastes are minimised and used efficiently through recycling. Waste importation should be reduced or stopped. General resilience can be built by maintaining and restoring forests and other ecosystems that encourage biodegradation of wastes.

Indicator scaling: (cut-off values are tonnes/km²/year)





**WASTE
TREATMENT**

WASTE TREATMENT

Mean annual percent of hazardous, toxic and municipal waste effectively managed and treated over the past 5 years.

Categories	Data sources
Hazards / Resources & services	Data are not generally available

This indicator captures the proportion of wastes rendered less harmful. Vulnerability is in relation to risk to terrestrial, aquatic ecosystems and ground waters from toxic and municipal wastes and how they are treated. All wastes need a suitable area of land or volume of water for their eventual attenuation, but treatment and recycling are effective means of reducing the overall waste load in a country. High waste loads present risks to all aspects of the environment. The effects of dumping large amounts of wastes into the environment and beyond its capacity to attenuate them would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Basel Convention, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure wastes are minimised and used efficiently through recycling. Waste importation should be reduced or stopped. General resilience can be built by maintaining and restoring forests and other ecosystems that encourage biodegradation of wastes.

Indicator scaling: (cut-off values are percent of waste treated)





INDUSTRY

INDUSTRY

Average annual use of electricity for industry over the last 5 years per square kilometre of land

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001

This indicator captures all major potential chemical and other industrial pollutants that could cause significant environmental damage from accidents and diffuse pollution, including acid rain, not normally recorded as part of waste streams. It also captures electricity generation and/or use specifically for purposes of industry, which in itself has ecological consequences. This indicator is used to take into account accidents such as the Bhopal chemical explosion in India, as well as incidents such as the Chernobyl and more recently the Japanese nuclear disaster. The effects of industrial accidents and diffuse pollution would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Basel Convention, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure clean industry with rapid and effective response to accidents, waste minimisation and recycling. General resilience can be built by maintaining and restoring forests and other ecosystems that encourage biodegradation of wastes.

Indicator scaling: (cut-off values are toe/km²/year)



toe=tonnes of oil equivalent



SPILLS

SPILLS

Total number of spills of oil and hazardous substances greater than 1000 litres on land, in rivers or within territorial waters per million km maritime coast during the last five years

Categories	Data sources
Hazards / Resources & services	ITOPF 2002 International Tanker Owners Federation; SPILLS 2000; CRED 2000; OFDA/CRED International disaster database

This indicator captures the risk to marine, estuarine, riverine, lake, ground water and terrestrial ecosystems from spills of hydrocarbons and other toxic fluids. Only spills greater than 1,000 litres are included. The effects of spills of toxic chemicals are of special significance for endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Basel Convention, MARPOL, GPA, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that promote safe handling of hazardous substances and ensure rapid and effective response to accidental spills. General resilience can be built by maintaining and restoring coasts, wetlands and forests as well as other ecosystems that encourage biodegradation of wastes.

Indicator scaling: (cut-off values are number of spills/million km)





MINING

MINING

Average annual mining production (include all surface and subsurface mining and quarrying) per km² of land area over the past 5 years.

Categories	Data sources
Hazards / Resources & services	USGS 1996-2000; World Nuclear Association 2003; Diamond Registry 2002; Salt Institute 2002

This indicator captures the risk to terrestrial, aquatic ecosystems and ground waters from the effects of ecosystem disturbance, accidents, oil spills and toxic leachates, and processing from mining of all kinds. All disturbance can lead to vulnerability to other processes, human and natural, and wastes need a suitable area of land or volume of water for their eventual attenuation or long term deposition. High levels of mining activity present risks to all aspects of the environment. The effects of mining would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Basel Convention, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure whole life management of mines, including waste minimisation, stabilisation and rehabilitation. Waste importation through bringing of ores should be minimised. General resilience can be built by maintaining and restoring forests and other ecosystems that encourage biodegradation of wastes.

Indicator scaling: (cut-off values are tonnes/km²/year)





SANITATION

SANITATION

Density of population without access to safe sanitation (WHO definitions)

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001

‘Safe sanitation’ is normally an issue seen from a human perspective. It deals with hygiene, disease control and direct quality of life for humans. We are using this information for the EVI from an environmental perspective. This indicator is a proxy measure for how human waste is treated before it enters the environment. We are taking safe sanitation as an indication of at least some pre-treatment of sewage before it enters stream, groundwater recharge, coastal and land areas. If sanitation is of a low standard, ecosystems downstream have a higher risk of being polluted with sewage that has not been broken down and which will contain high levels of urea, ammonia, nitrites, pharmaceuticals and pathogens. The WHO definition of safe sanitation used here is the percentage of the human population with sewage disposal facilities that can effectively prevent human, animal, and insect contact. This includes connections to public sewers, household systems such as pit and pour-flush latrines, septic tanks, communal toilets, and other such facilities.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, MDG, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that ensure human wastes are treated to secondary or higher levels before being released to the environment. Human wastes may not need such high levels of treatment if they can be disposed of into receiving environments that are large enough to attenuate them without damage (e.g. small island states with large ocean areas may be able to dispose of sewage into the ocean as dilution and attenuation can occur without significant damage to the environment). General resilience can be built by maintaining and restoring forests and other ecosystems that encourage biodegradation of wastes.

Indicator scaling: (cut-off values are human population without safe sanitation /km²)





VEHICLES

VEHICLES

Number of vehicles per square kilometre of land area (most recent data)

Categories	Data sources
Hazards / Resources & services	WRI 2000-2001, OECD 1999

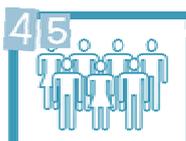
This indicator captures the risk to terrestrial ecosystems in the form of habitat damage, habitat fragmentation, loss of biodiversity, pollution hazardous wastes and industries, including air and lead pollution on land and in waterways. Of particular concern is fragmentation of the countryside which can interfere with normal movements and/or migration of terrestrial mammals. The definition of *vehicles* used here is from the World Bank. The effects would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: e.g. BPoA, WSSD, CSD, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that promote public and clean transport options and good waste management, including efficient use of wastes through recycling. General resilience can be built by maintaining and restoring forests and creating reserves.

Indicator scaling: (cut-off values are vehicles/km²)





POPULATION

POPULATION

Total human population density (number per km² land area)

Categories	Data sources
Damage / Human populations	WRI 2000-2001; CIA Fact sheets 2001

This is a proxy measure for pressure on the environment resulting from the number of humans being supported per unit of land. The greater numbers of people increases pressure on the environment for resources, for the attenuation of wastes and physical disturbance of the environment.

Policy / reporting relevance: e.g. BPoA, WSSD, MDG, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that keep human population pressures within sustainable limits. This includes lifestyle choices and minimising the ecological footprint and levels of consumption. General resilience can be built by maintaining and restoring damaged ecosystems, minimising wastes and creating terrestrial and aquatic reserves.

Indicator scaling: (cut-off values are people/km²)





POPULATION GROWTH

POPULATION GROWTH

Annual human population growth rate over the last 5 years

Categories	Data sources
Hazards / Human populations	WRI 2000-2001; U.S. Bureau of Census International Data Base

This indicator focuses on the potential for damage relating to expanding human populations. It signals increasing rates of habitat damage, exploitation of natural resources and disposal of wastes that will need to be assimilated into the environment. It also captures the risk of infrastructure not being able to keep up with demand for issues such as waste treatment.

Policy / reporting relevance: e.g. BPoA, WSSD, MDG, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that keep human population pressures within sustainable limits. This includes lifestyle choices and minimising the ecological footprint and levels of consumption. General resilience can be built by maintaining and restoring damaged ecosystems, minimising wastes and creating terrestrial and aquatic reserves.

Indicator scaling: (cut-off values are average yearly % change in population)





TOURISTS

TOURISTS

Average annual number of international tourists per km² land over the past 5 years.

Categories	Data sources
Hazards / Human populations	WTO

The correct form of this indicator when data become generally available: *Average annual number of international tourist-days per km² of land over the last five years.*

This is a measure for the additional load of all human impacts associated with international visitors and not reported in human population statistics. Tourists place additional pressure on the environment through increasing demands on local resources and through creation of pollution as well as physical disturbances of the environment. It is possible that their environmental burden is greater than that of residents.

Policy / reporting relevance: e.g. BPoA, WSSD, MDG, Regional Strategies, National Plans, SOE

Reducing vulnerability: Options for ecotourism could be examined. Policies that ensure that capital damage to the environment and wastes are minimised. General resilience can be built by maintaining and restoring forests and other ecosystems and creating terrestrial and aquatic reserves.

Indicator scaling: (cut-off values are tourists/km²/year)





COASTAL SETTLEMENTS

COASTAL SETTLEMENTS

Density of people living in coastal settlements (i.e. with a city centre within 100km of any maritime or lake* coast).

(* To be included, lakes must have an area of at least 100 sq km)

Categories	Data sources
Damage / Human populations	WRI 2000-2001; CIA Fact sheets 2001

This indicator captures the focus of stress on coastal ecosystems, often the most productive living areas in a country, through pollution, eutrophication, resource depletion and habitat degradation. The adjacent water areas are capable of spreading pollution widely in aquatic habitats and will not tend to allow for attenuation over upland areas. Countries with heavy densities of human populations living on their coastal areas are likely to be damaging some of their most productive and diverse areas and negatively affecting the resilience of the country to natural disasters such as cyclones, tsunamis etc.

Policy / reporting relevance: e.g. BPoA, WSSD, MDG, UNFCC, Regional Strategies, National Plans, SOE

Reducing vulnerability: Policies that manage ecosystems and their use at the interface between land and sea, lakes or rivers. Emphasis should be on fragile habitats such as swamps, mangroves, estuaries, lakes. General resilience can be built by maintaining and restoring damaged ecosystems and creating reserves.

Indicator scaling: (cut-off values are people/km² coastal land)





ENVIRONMENTAL AGREEMENTS

ENVIRONMENTAL AGREEMENTS

Number of environmental treaties in force in a country.

Categories	Data sources
Hazards / Human populations	SEDAC / CIESIN 2003

This indicator captures the level of management and stewardship of the environment in a country. Two aspects of legislation are needed: the message to the public that environmental management is essential, and the effectiveness of controls. The benefits of good management would be especially important if there are many endangered species, sensitive ecosystems, and interactions with on-going human impacts.

Policy / reporting relevance: None

Reducing vulnerability: Becoming party to agreements that help the country to address its most significant issues as identified by the EVI. Use assistance in the form of information, technology, and others to formulate and implement national-level actions to address environmental concerns.

Indicator scaling: (cut-off values are number of treaties in force)





CONFLICTS

CONFLICTS

Average number of conflict years per decade within the country over the past 50 years.

Categories	Data sources
Hazards / Human populations	EM-DAT: The OFDA/CRED International Disaster Database

This indicator captures the risk to terrestrial, aquatic ecosystems and ground waters related to human conflicts. Conflicts can result in habitat disturbance and degradation, pollution and a complete breakdown in environmental management. The direct effects include degradation through bombing, land mines, and chemicals left in the environment, temporary camps and vehicle disturbances, and damage caused by displaced people who need to support themselves under emergency conditions. This is also a proxy for the lack of environmental management during those years. The effects of civil unrest would be especially important if they were on-going, repeated, or occurring as separate events in more than one part of a country. Effects would be amplified if there are many endangered species, sensitive ecosystems, and interactions with other on-going human impacts. The time frame used reflects the long term nature of conflict-related damage to the environmental support system.

Policy / reporting relevance: e.g. BPoA, CSD, WSSD, CCD, CBD

Reducing vulnerability: Policies that reduce and clean up pollution and war-related hazards, rehabilitate damaged areas and ensure people in affected areas are given relief so that they do not need to make inefficient emergency use of resources and services.

Indicator scaling: (cut-off values are conflict years/decade)



ACRONYMS

AGL	FAO Land and Water Development Division
BINAS	Biosafety Information Network and Advisory Service
BPoA	Barbados Programme of Action
CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification
CIA	US Central Intelligence Agency Fact Book
CIESIN	Centre for International Earth Science Information Network
CO ₂	Carbon dioxide
CRED	Centre for Research on Epidemiology of Disasters
CSD	UN Commission on Sustainable Development
EEZ	Exclusive Economic Zone
EMDAT	Emergency Events Database (CRED, OFDA, OECD, WHO)
ENSO	El Nino / Southern Oscillation
EVI	Environmental Vulnerability Index and Profiles
FAO	UN Food & Agricultural Organisation
GEO3	Global Environment Outlook 3
GHCN	NOAA Global Historical Climatology Network
GMO	Genetically-Modified Organism
GOOS	Global Oceans Observing System
GPA	UN Global Programme of Action on Land Based Sources of Pollution in the marine Environment
GROMS	Global Register of Migratory Species
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
ISDR	International Strategy for Disaster Reduction
ITOPF	International Tanker-Owners Pollution Federation Ltd
IUCN	World Conservation Union
MARPOL	International Convention for the Prevention of Pollution from Ships
MDG	Millennium Development Goals
MHWS	Mean High Water Spring (tides)
NESDIS	NOAA National Environmental Satellite Data and Information Service
NOAA	US National Oceanic & Atmospheric Administration
NPK	Nitrogen, Phosphate, Potassium
OECD	Organisation for Economic Cooperation & Development
RAMSAR	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat
SEDAC	Social Economic Data Applications Centre
SIDS	Small Island Developing States
SIS	Small Island States
SO ₂	Sulphur dioxide
SOE	State of the Environment
SOPAC	South Pacific Applied Geoscience Commission
SPILLS	Worldwide Tanker Spill Database (etcentre.org)
SST	Sea Surface Temperature
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
USGS	US Geological Survey
VEI	Volcanic Explosivity Index (see definitions)
WCMC	World Conservation Monitoring Centre
WDI	World Development Indicators
WHO	UN World Health Organisation
WMO	World Meteorological Organisation
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development
WTO	World Tourism Organisation

INDICATOR DEFINITIONS



HIGH WINDS

Wind Speed refers to the rate at which air is moving horizontally past a given point. It may be a 2-minute average speed (reported as wind speed) or an instantaneous speed (reported as a peak wind speed, wind gust, or squall).

<http://weather.gov/glossary/index.php?word=wind+speed>



DRY PERIODS

Rainfall refers to the amount of precipitation of any type, primarily liquid. It is usually the amount that is measured by a rain gauge.

<http://weather.gov/glossary/index.php?word=rainfall>



HOT PERIODS

Maximum Temperature: The highest temperature recorded during a specified period of time. Common time periods include 6, 12 and 24 hours. The measure used here refers to the daily maximum temperature, or "high."

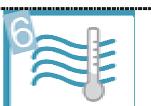
<http://weather.gov/glossary/index.php?word=temperature> Values used in the EVI are referenced against 30-year means of daily maxima calculated separately for different months and climate stations.



COLD PERIODS

Minimum Temperature: This is the lowest temperature recorded during a specified period of time. The time period can be 6, 12 or 24 hours. The measure used here refers to the daily minimum temperature, or "low."

<http://weather.gov/glossary/index.php?word=temperature> Values used in the EVI are referenced against 30-year means of daily maxima calculated separately for different months and climate stations.



SEA TEMPERATURES

Sea Surface Temperatures: The term refers to the mean temperature of the ocean in the upper few meters. <http://weather.gov/glossary/index.php?word=temperature>



VOLCANOES

The Volcanic Explosivity Index or VEI - is based on a number of things that can be observed during an eruption. VEI scores can vary between 0 and 8, with VEI=0 being non-explosive small volcanoes, and VEI=8 being large and very destructive.

http://volcano.und.nodak.edu/vwdocs/eruption_scale.html



EARTHQUAKES

ML = Local ("Richter") Magnitude $ML = \log A - \log A_0$ defined by Richter (1935) where A is the maximum trace amplitude in mm recorded on a standard short-period seismometer and $\log A_0$ is a standard value as a function of distance where distance ≤ 600 km.

http://wwwneic.cr.usgs.gov/neis/phase_data/mag_formulas.html



TSUNAMIS

A tsunami is a series of waves generated by an impulsive disturbance in the ocean or in a small, connected body of water.

<http://www.ngdc.noaa.gov/seg/hazard/tsu.html> Mean High Water Springs (MHWS): the average height of the high waters of spring tides. Also called spring high water. (IHO Dictionary, S-32, 5th Edition, 3144) (<http://www.caris.com/S-57/attribut/def/d-verdat.htm>). Coast: The place where the waters of the seas meet the land. (http://icm.noaa.gov/story/icm_coast.html)



SLIDES

Slide: Disaster type term used in EM-DAT comprising the two disaster subsets - avalanche and landslide (<http://www.em-dat.net/glossary.htm>). Avalanche: Rapid and sudden sliding and flowage of masses of usually unsorted mixtures of snow/ice/rock material (<http://www.em-dat.net/glossary.htm>). Landslide: 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. (<http://www.em-dat.net/glossary.htm>)



LAND AREA

Land Area: Is the aggregate of all surfaces delimited by international boundaries and/or coastlines, excluding inland water bodies (lakes, reservoirs, rivers) (<http://www.cia.gov/cia/publications/factbook/docs/notesanddefs.html>)



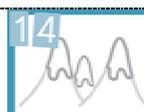
COUNTRY DISPERSION

Land Boundary: This entry contains the total length of all land boundaries and the individual lengths for each of the contiguous border countries. (<http://www.cia.gov/cia/publications/factbook/docs/notesanddefs.html>)



ISOLATION

Continent - land mass: any one of the seven large continuous land masses that constitute most of the dry land on the surface of the earth. They are Africa, Antarctica, Asia, Australia, Europe, North America, and South America. (Microsoft® Encarta® Premium Suite 2003. ©).



RELIEF

Space extended upward; height; the perpendicular elevation of an object above sea level. Values may be negative (below sea level) or positive. The difference between the highest and lowest points in a country is relief.



LOWLANDS

Lowland: low-lying or flat land: land that is less than or equal to a certain height above sea level. This indicator refers to heights of 10 and 50m above sea level



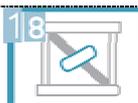
BORDERS

Border: line dividing two areas: the line that officially separates two countries or regions. For the EVI this definition includes land and sea borders, where sea borders are defined as the line between two or more EEZs (200 nautical mile exclusive economic zones).



ECOSYSTEM IMBALANCE

Ecosystem imbalance refers to the loss of or damage to any of the elements of ecosystems that are required for proper function. Elements may include species, changes in biomass or trophic relationships, productivity, reproduction or other aspects. This indicator shows a positive or negative change in trophic level calculated by weighting each trophic level present in the national fish catch by the tonnes reported. This indicator includes only those species with a trophic level of 3.35 or below. This constitutes a trophic slice, intended to exclude large pelagic fisheries usually caught offshore. A positive (+) change indicates an increase in trophic level present in the catch, which would be consistent with an increase in the larger fish-eating fishes. This is usually associated with an expansion of the fishery and a move to greater use of large pelagic species. A negative (-) change is usually associated with loss of fishes in the higher trophic levels and indicates fishing down of the food web, ecosystem damage and overfishing.

ENVIRONMENTAL
OPENNESS

Freight Imports refer to imports of goods and services represented by the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude labor and property income (formerly called factor services) as well as transfer payments. Data are in million current US dollars.

(http://earthtrends.wri.org/searchable_db/index.cfm?theme=5)



MIGRATIONS

The entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.

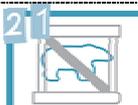
(http://www.biologie.uni-freiburg.de/data/zoology/riede/groms/Getting_started/)

(Convention on the conservation of Migratory Species of Wild Animals)



ENDEMIC

Endemic species : A species which is found in a given region or location and nowhere else in the world.



INTRODUCTIONS

Introduced species: Means the movement, by human agency, of a species, subspecies, or lower taxon (including any part, gametes or propagule that might survive and subsequently reproduce) outside its natural range (past or present).

This movement can be either within a country or between countries.

<http://iucn.org/themes/ssc/pubs/policy/invasivesEng.htm>

ENDANGERED
SPECIES

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild. (IUCN, 2001-

<http://www.iucn.org/themes/ssc/red-lists.htm>)



EXTINCTIONS

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form. (IUCN, 2001-

<http://www.iucn.org/themes/ssc/red-lists.htm>)

VEGETATION
COVER

Natural Forest: A forest composed of indigenous trees, and not classified as forest plantation. <http://www.fao.org/docrep/003/y0900e/y0900e11.htm>. Data from WRI (WRI 2000-2001) refer to original forest cover about 8,000 years ago assuming current climatic conditions. The definition of regrowth forest is one in which regrowth is unsupported by human (other than in allowing natural regeneration) and results in a forest community that is self-sustaining indefinitely (not withstanding climatic changes).



LOSS OF COVER

Total forest area, average annual percent change, as defined by the Food and Agriculture Organization of the United Nations, is the average annual percent change in both natural forests and plantations between 1990 and 2000. Total Forest is defined as land with tree crown cover of more than 10 percent of the ground and area of more than 0.5 hectares. Tree height at maturity should exceed 5 meters.

(<http://earthtrends.wri.org/>)



Fragmentation refers to the division of habitats or ecosystems into discontinuous pieces. It also relates to habitat disturbance and degradation. Fragmentation is likely to affect biodiversity, affecting species with variability in population numbers, keystones, those susceptible to local extinctions, those that use migration corridors and the persistence of species with large home ranges. For many large mammals and some birds, viable fragments of habitat are size-dependent, despite the fact that the overall area available in a country may still sum to a relatively large area. This indicator measures a specific aspect of habitat availability that relates to size and quality of patches.



The degrees of degradation are defined in terms of reduction in land productivity. In abbreviated form, these definitions are as follows: (i) Light: somewhat reduced agricultural suitability. (ii) Moderate: greatly reduced agricultural productivity. (iii) Strong: biotic functions largely destroyed; non-reclaimable at farm level. (iv) Extreme: biotic functions fully destroyed, non-reclaimable. The severity of land degradation is then obtained by combining the degree of degradation with its spatial extent. With four classes for degree, and five for extent, twenty combinations are possible. These were grouped into four *degradation severity classes*: light, moderate, severe, and very severe (Figure 13). A very severely degraded area can mean, for example, either that extreme degradation affects 10-25% of a mapping unit, or that moderate degradation affects 50-100% of the unit. FAO Terrastat <http://www.fao.org/ag/aql/aql/terrastat/>



An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural associated cultural resources, and managed through legal or other effective means. (IUCN World Commission on Protected Areas, 1994).



Any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment. (<http://www.mpa.gov/mpadescriptive/whatis.html>) (IUCN, 1988; Kelleher, 1999).



Farming characterised by high input use and that strives for maximum production. http://glossary.eea.eu.int/EEAGlossary//intensive_farming. For the EVI we define intensive farming as any farming that either uses inputs or produces pollution that cannot be obtained or attenuated over the land or water area over which the farming occurs.



Fertiliser use refers to nutrients in terms of nitrogen (N), potash (K₂O), and phosphate (P₂O₅). Food and Agriculture Organization of the United Nations (FAO). 2004. FAOSTAT on-line statistical service. <http://apps.fao.org>.



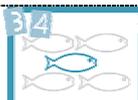
Refers to the per hectare use / sale to the agricultural sector of substances that reduce or eliminate unwanted plants or animals, especially insects. They include major groups of pesticides such as insecticides, mineral oils, herbicides, plant growth regulators, bacteria and seed treatments, and other active ingredients (WRI 2000-2001). See also Food and Agriculture Organization of the United Nations (FAO). 2004. FAOSTAT <http://apps.fao.org>.



BIOTECHNOLOGY

Genetic modification is a process whereby a gene for a desired trait or characteristic is inserted into a plant instead of acquiring it through the natural process of pollination. The inserted gene may come from another unrelated plant or from a different species. (http://www.searca.org/~bic/FAQs/FA_Questions.htm) (Bi Tech Information Center). Genetically modified organism - an organism whose genetic make-up has been changed by any method, including natural processes, genetic engineering, cloning or mutagenesis.

http://www.nature.ca/genome/02/022_efg_e.cfm

PRODUCTIVITY
OVERFISHING

Overfishing refers to the taking out of the sea more than natural population growth can sustain. Overfishing has a number of causes, including 'chronic over capacity' of modern fishing fleets to effectively take far more fish than can be replaced.

(<http://glossary.eea.eu.int/EEAGlossary/O/overfishing>). See also

(<http://www.seafoodchoices.com/resources/glossary.shtml>)

FISHING
EFFORT

Fishers include people employed in commercial and subsistence fishing (both, personnel on fishing vessels and on shore), operating in freshwater, brackish and marine areas, and in aquaculture production activities. "Fishery vessel" refers to "mobile floating objects of any kind and size, operating in freshwater, brackish and marine areas, and used for catching, harvesting, searching, transporting, landing, preserving and/or processing fish, shellfish and other aquatic animals, residues and plants." Food and Agriculture Organization of the United Nations (FAO). Fishers

<http://www.fao.org/fi/statist/fisoft/fishers.asp>

RENEWABLE
WATER

Average annual water usage as percentage of renewable water resources over the last 5 years. (i) Internal renewable water resources (IRWR) include the average annual flow of rivers and the recharge of groundwater (aquifers) generated from endogenous precipitation (occurring within a country's borders). IRWR are measured in km³/year. Data may have been collected in different years for different countries. (ii) Total internal renewable water resources is the sum of surface and groundwater resources minus overlap; in other words IRWR = Surface water resources + Groundwater recharge – Overlap. Natural incoming flow, originating outside a country's borders are not included in the total. (iii) Annual water withdrawals, measured in million m³ refers to total water removed for human uses in a single year, not counting evaporative losses from storage basins. Water withdrawals also include water from non-renewable groundwater sources, river flows from other countries, and desalination plants (<http://earthtrends.wri.org>). (iv) Actual Renewable Water Resources gives the maximum theoretical amount of water actually available for each country, although in reality a portion of this water may be inaccessible to humans. Actual renewable water resources are defined as the sum of internal renewable resources (IRWR) and external renewable resources (ERWR), taking into consideration the quantity of flow reserved to upstream and downstream countries through formal or informal agreements or treaties and possible reduction of external flow due to upstream water abstraction. Average annual groundwater recharge is the amount of water that is estimated to annually infiltrate soils, including water from rivers and streams that lose it to underlying strata. In general, this figure would represent the maximum amount of water that could be withdrawn annually without ultimately depleting the groundwater resource. Annual Total Water Withdrawals is the gross amount of water extracted from any

source, either permanently or temporarily, for a given use. It can be either diverted towards distribution networks or directly used. It includes consumptive use, conveyance losses, and return flow.



SO₂
EMISSIONS

Sulphur dioxide: Is an air pollutant produced when fossil fuels containing sulphur are burned. It contributes to acid rain and can damage human health, particularly that of the young and elderly. (World Development Indicators, 2001).



WASTE
PRODUCTION

Waste refer here to materials that are not prime products (i.e. products produced for the market) for which the generator has no further use for production, transformation or consumption, and which he discards, or intends, or is required to discard. Wastes may be generated during the extraction of raw materials during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity.

(<http://waste.eionet.eu.int/definitions/waste>) (European Environment Agency).



WASTE
TREATMENT

Effectively managed wastes are composted, reused, recycled, subjected to controlled incineration (including temperature control, retention time control and control of emissions), and/or placed in controlled landfill (involving treatment of leachate, containment, gas management, aftercare and rehabilitation i.e. recovery, planting and post management) Eurostat <http://www.waste.eionet.eu.int>



INDUSTRY

The industry sector is defined as the combination of all industrial sub-sectors, such as mining and quarrying, iron and steel, construction, etc. Energy used for transport by industry is not included here but is reported under transportation. Energy Consumption by Source refers to the total amount of primary energy consumed by each country in the year specified, and is reported in thousands of metric tons of oil equivalent (toe). Primary energy also includes losses from transportation, friction, heat loss, and other inefficiencies. Specifically, consumption equals indigenous production plus imports, minus exports plus stock changes, minus international marine bunkers. IEA calls this value Total Primary Energy Supply (TPES). (http://pdf.wri.org/wr2002fulltxt_230-283_datatables.pdf). toe = tonnes oil equivalent (includes energy from solid fuels, liquid fuels, gaseous fuels, nuclear fuels, other sources).



SPILLS

Total number of spills of oil and hazardous substances greater than 1000 litres on land, in rivers or within territorial waters per million km maritime coast during the last five years. (i) ITOPF 2002 International Tanker Owners Federation - Refers to oil spills at sea only. (ii) SPILLS 2000 www.etcentre.org/spills . The source of the spill must be a vessel, generally a tanker or barge on which a petroleum product was cargo, and must involve at least 1000 barrels (42,000 gallons). (iii) CRED 2000 The OFDA/CRED International disaster database: data source derived from LLOYDS CAS



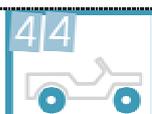
MINING

Average annual mining production (include all surface and subsurface mining and quarrying) per km² of land area over the past 5 years. Data are on average annual production between 1996-2000 for most products, except Uranium for which data for only the year 2000 were available. Data includes 81 types of mining, including clays, gravels, cement, gems, radioactive materials, metals, petroleum and gas. Data from USGS - US Geological Survey as mean annual production 1996-2000; World Nuclear Association 2003 web site - <http://www.world-nuclear.org/info/inf23.htm> ; Diamond Registry 2002 <http://www.diamondregistry.com/News/2002/production.htm> ; Salt Institute 2002 http://www.salt.org.il/frame_prod.html .



SANITATION

Density of population without access to safe sanitation (WHO definitions). Improved sanitation includes any of the following excreta disposal facilities: connection to a public sewer, connection to a septic tank, pour-flush latrine, simple pit latrine, and ventilated improved pit latrine. WHO emphasizes that these data measure access to an *improved* excreta disposal system - access to a sanitary system cannot be adequately measured on a global scale. A poor water supply and sanitation system can lead to a number of diseases, including diarrhoea, intestinal worms, and cholera. Examples of an unimproved sanitation system include: open pit latrines, public or shared latrines, and service or bucket latrines (where excreta are manually removed).



VEHICLES

Refers to the number of individual four-wheel vehicles per 1,000 people. These numbers exclude buses, freight vehicles and two-wheelers such as mopeds and motor-cycles. (WRI, 2000-2001)



CONFLICTS

Average number of conflict years per decade within the country over the past 50 years. Conflict: Use of armed force between the military forces of two or more governments, or of government and at least one organized armed group, resulting in the battle-related deaths of at least 10 deaths or 100 affected in one year. EM-DAT, conflict includes the disaster types intrastate conflict and international conflict. Intrastate conflict: CRED has adopted the simple Project Ploughshares typology of modern armed conflict based on three overlapping types of intrastate conflict: *state control*, *state formation* and *state failure*. (i) *State control conflicts* obviously centre on struggles for control of the governing apparatus of the state. State control struggles have typically been driven by ideologically defined revolutionary movements, decolonization campaigns or one set of elites seeking power in place of another. (ii) *State formation conflicts* centre on the form or shape of the state itself and generally involve particular regions of a country fighting for a greater measure of autonomy or for outright secession. Ethnicity, communal identity and religion are prominent in state formation conflicts. (iii) *Failed state conflicts* are conflicts about local issues and disputes involving violence in the absence of effective government control. The primary failure is an incapacity to provide minimal human security for individual citizens, compounded by weak governance and politics of exclusion that deny the majority of citizens any significant engagement in the political process. In the emerging chaos and lost confidence in public institutions, individuals and groups seek new political entities or social groupings,

often regionally or ethnically based, sometimes ideologically defined, through which to pursue their interests and to try to ensure the well-being of their particular families and communities. International conflict: It include border disputes, foreign invasion and other cross-border attacks (Project Ploughshares). EM-DAT: The OFDA/CRED International Disaster Database. <http://www.cred.be/cedat/index.htm>
