

EQUATION 3 ESTIMATION OF THE TOTAL RISK

$$EQ3 \quad Risk_{Tot} = \sum (Risk_{Flood} + Risk_{Earthquake} + Risk_{Volcano} + Risk_{Cyclone} + \dots Risk_n)^b$$

Information System (GIS). The population affected multiplied by the frequency of a hazard event for a specified magnitude provided the measure for physical exposure.

Socio-economic variables that could be statistically associated with risk were identified by replacing the risk in the equation with deaths reported in EM-DAT. A statistical analysis was then run to identify links between socio-economic and environmental variables, physical exposure and observed deaths.

The magnitude of events was taken into account by drawing a threshold above which an event is included. In the case of earthquakes, the threshold was placed at 5.5 on the Richter scale. Then the magnitude was partially taken into account by approaching the size of the area affected in relation to the magnitude, for the computation of physical exposure. Estimating event magnitude for use in global assessments is an area where there is great scope for improvement.

Scores for aggregated hazard deaths were calculated at the national level. Expected losses due to natural hazards were equal to the sum of all types of risk faced by a population in a given area. This is summarised in Equation 3 above.

The multi-hazard risk for a country required calculating an estimate of the probability of the occurrence and severity of each hazard, the number of persons affected by it, and the identification of the population's vulnerability and coping capacities. This is very ambitious and not achievable with present data constraints. However the aim is to provide an approach built on existing data that will be refined in subsequent runs of the DRI.

T.3 Choice of Indicators

T.3.1 Spatial and temporal scales

The DRI exercise was performed on a country-by-country basis for the 249 countries defined in the GEO reports.⁶

The socio-economic variables used in the analysis of risk needed to be available to cover the 21-year period under analysis. This period was from 1980 to 2000. The starting date was set at 1980 because access to information (especially on victims) was not considered reliable or comparable before this year. The variables introduced in Equation 2 were aggregate figures (sum or average) of the available data for that period, with the following major exceptions:

- Earthquake frequencies were calculated over a 36-year period, due to the longer return period of this type of disaster. The starting date for the first global coverage on earthquakes measurement is 1964.
- Cyclones frequencies were based on annual probabilities provided by the Carbon Dioxide Information Analysis Center (CDIAC).⁷
- HDI was available for the following years: 1980, 1985, 1990, 1995 and 2000. However, algorithms were applied for computation of every year between 1980 and 2000.
- Population by grid cell (for physical exposure calculations) was available for 1990 and 1995.
- The Corruption Perception Index (CPI) was available for 1995 to 2000.

T.3.2 Risk indicators

Risk can be expressed in different ways (for example by the number of people killed, percentage killed or percentage killed as compared to the exposed population). Each measure has advantages and inconveniences (see Table T.1 on the following page).

The DRI work used two indicators for each hazard type: the number of killed and killed per population. The third indicator is used to indicate relative vulnerability. Exposed populations to different hazards should not be compared as stated in the Report without standardisation.

T.3.3 Vulnerability indicators

Table T.2 (see following page) shows those socio-economic and environmental variables chosen to represent eight separate categories of vulnerability.

b. In the case of countries marginally affected by a hazard type, the risk was replaced by zero if the model could not be computed for this hazard.

Indicators for risk	Advantages	Inconveniences
Number of killed	Each human being has the same 'weight.'	10,000 people killed split between 10 small countries does not appear in the same way as 10,000 killed in one country. Smaller countries are disadvantaged.
Killed/Population	Allows for comparisons between countries. Less populated countries have the same weight as more populated countries.	The 'weight' of each human being is not equal, e.g. one person killed in Honduras equals 160 killed in China.
Killed/Population exposed	Regional risk is highlighted, even though the population affected is a smaller portion of the total national population.	This may highlight local problems that are not of national significance and give the wrong priority for a selected country.

Categories of Vulnerability	Indicators	Drought	Flood Earthquakes Cyclones	Source ^c
Economic	Gross Domestic Product per inhabitant at purchasing power parity	X	X	WB
	Human Poverty Index (HPI)	X		UNDP
	Total debt service (% of the exports of goods and services)		X	WB
	Inflation, food prices (annual %)		X	WB
	Unemployment, total (% of total labour force)		X	ILO
Type of economic activities	Arable land (in thousand hectares)		X	FAO
	% of arable land and permanent crops		X	FAO
	% of urban population		X	UNPOP
	% of agriculture's dependency for GDP	X		WB
	% of labour force in agricultural sector	X		FAO
Dependency and quality of the environment	Forests and woodland (in % of land area)		X	FAO
	Human-Induced Soil Degradation (GLASOD)	X	X	FAO/UNEP
Demography	Population growth		X	UNDESA
	Urban growth		X	GRID ^d
	Population density		X	GRID ^e
	Age dependency ratio		X	WB
Health and sanitation	% of people with access to improved water supply (total, urban, rural)	XXX		WHO/UNICEF
	Number of physicians (per 1,000 inhabitants)		X	WB
	Number of hospital beds		X	WB
	Life expectancy at birth for both sexes		X	UNDESA
	Under-five-years-old mortality rate	X		UNDESA
Early warning capacity	Number of radios (per 1,000 inhabitants)		X	WB
Education	Illiteracy rate		X	WB
Development	Human Development Index (HDI)	X	X	UNDP

Source: UNDP/UNEP

- c. FAOSTAT, the database of the Food and Agriculture Organisation (FAO); GRID, the Global Resource Information Database of UNEP; WB, World Development Indicators of the World Bank; Human Development Report of UNDP; ILO, International Labour Office; UNDESA, the UN Dept. of Economic and Social Affairs/Population Division. Most of the data were reprocessed by the UNEP Global Environment Outlook Team. Figures are available at the GEO Data Portal (UNEP), <http://geodata.grid.unep.ch>
- d. Calculated from UN Dept. of Economic and Social Affairs data.
- e. Calculated from UNEP/GRID spatial modelling based on CIESIN population data.

TABLE T.3 DATA SOURCES FOR HAZARDS	
Hazard type	Data source
Earthquakes	Council of the National Seismic System (as of 2002), <i>Earthquake Catalog</i> , http://quake.geo.berkeley.edu/cnss/
Cyclones	Carbon Dioxide Information Analysis Centre (1991), <i>A Global Geographic Information System Data Base of Storm Occurrences and Other Climatic Phenomena Affecting Coastal Zones</i> , http://cdiac.esd.ornl.gov/
Floods	U.S. Geological Survey (1997), <i>HYDRO1k Elevation Derivative Database</i> , http://edcdaac.usgs.gov/gtopo30/hydro/
Droughts (physical drought)	IRI/Columbia University, National Centres for Environmental Prediction Climate Prediction Centre (as of 2002), <i>CPC Merged Analysis of Precipitation (CMAP)</i> , monthly gridded precipitation, http://iridl.ideo.columbia.edu/

TABLE T.4 DATA SOURCES FOR VICTIMS, POPULATION AND VULNERABILITY VARIABLES	
Theme	Data source
Victims (killed)	Université Catholique de Louvain (as of 2002), <i>EM-DAT: The OFDA/CRED International Disaster Database</i> , http://www.cred.be/ (for droughts, victims of famines were also included on a case by case basis by UNDP/BCPR)
Population (counts)	CIESIN, IFPRI, WRI (2000), <i>Gridded Population of the World (GPW), Version 2</i> , http://sedac.ciesin.org/plue/gpw/ ; UNEP, CGIAR, NCGIA (1996), <i>Human Population and Administrative Boundaries Database for Asia</i> , http://www.grid.unep.ch/data/grid/human.php
Vulnerability factors	
Human Development Index (HDI)	UNDP (2002), <i>Human Development Indicators</i> , http://www.undp.org/
Corruption Perceptions Index (CPI)	Transparency International (2001), <i>Global Corruption Report 2001</i> , http://www.transparency.org/
Soil degradation (% of area affected)	ISRIC, UNEP (1990), <i>Global Assessment of Human-Induced Soil Degradation (GLASOD)</i> , http://www.grid.unep.ch/data/grid/gnv18.php
Other socio-economic variables	UNEP/GRID (as of 2002), <i>GEO-3 Data portal</i> , http://geodata.grid.unep.ch/ (data compiled from World Bank, World Resources Institute, FAO databases)

The list of factors to be considered for the analysis was set on the basis of the following criteria:

- *Relevance.* Select vulnerability factors (outputs orientated, resulting from the observed status of the population) not based on mitigation factors (inputs, action taken). For example, school enrollment rather than education budget.
- *Data quality and availability.* Data should cover the 1980–2000 period and most of the 249 countries and territories.

Examples of variables that were rejected for these two reasons were the percentage of persons affected by AIDS, the level of corruption and the number of hospital beds per inhabitant.

T.3.4 Data sources

Data sources ranged from universities and national scientific institutions to international data series collected by international organisations. Table T.3 presents the data sources used to obtain data on hazards.

Table T.4 presents the data sources used to obtain data on victims, population and vulnerability variables.

T.4 The Computation of Physical Exposure

T.4.1 General description

Two methods are available for calculating physical exposure. First, by multiplying hazard frequency by the population living in each exposed area. The frequencies of hazards were calculated for different strengths of event, and physical exposure was computed as in Equation 4.

EQUATION 4 COMPUTATION OF PHYSICAL EXPOSURE

$$EQ \quad PhExp_{nat} = \sum F_i \cdot Pop_i$$

Where
 PhExp_{nat} is the physical exposure at national level
 F_i is the annual frequency of a specific magnitude event in one spatial unit
 Pop_i is the total population living in the spatial unit