In order to take both risk indicators (killed and killed per inhabitant) into account, a Principal Component Analysis (PCA) was performed to combine the two. Then a distinction was made between countries smaller than 30,000 km squared and with population density higher than 100 inhabitants per km squared.

T.6.2 Results

Modelled countries without reported deaths
The multi-hazard DRI was computed for 210 countries. This includes 14 countries where no recorded deaths were reported in the last two decades from EM-DAT: Barbados, Croatia, Eritrea, Gabon, Guyana, Iceland, Luxembourg, Namibia, Slovenia, Sweden, Syrian Arab Republic, The former Yugoslav Republic of Macedonia, Turkmenistan and Zambia.

No data, abnormal values and specific cases
Through the Principal Component Analysis transformation, inferior and superior thresholds were identified. This was performed on both observed and modelled deaths. For 14 countries, a value was calculated in the multi-hazard risk model even though no deaths had been recorded by EM-DAT in the 1980-2000 period. On the other hand, 37 countries where deaths were recorded could not be modelled, either because of a lack of data or because they did not fit with the model assumptions. These countries were: Afghanistan, Azerbaijan, Cuba, Democratic People's Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominica, France, Greece, Liberia, Malaysia, Montserrat, Myanmar, New Caledonia, Portugal, Solomon Islands, Somalia, Spain, Sudan, Swaziland, Taiwan, Tajikistan, Vanuatu, Yugoslavia, Antigua and Barbuda, Armenia, Guadeloupe, Guam, Israel, Martinique, Micronesia (Federated States of), Netherlands Antilles, Puerto Rico, Reunion, Saint Kitts and Nevis, Saint Lucia, United States Virgin Islands.

Countries absent of both EM-DAT and Model
Two countries were absent from both EM-DAT and the model: Anguilla (a dependency of the United Kingdom) and Bosnia-Herzegovina.

EM-DAT-DRI multi-hazard risk comparison results
The results of the comparison of modelled and EM-DAT multi-hazard deaths are presented and discussed in Chapter 2. For more information, including country specific variables, researchers are encouraged to visit the Report website.

T.7 Technical Conclusions and Recommendations

T.7.1 The DRI – A work in progress

The DRI is a statistically robust tool
The results generated by the DRI method were statistically robust with a high level of confidence. This is especially the case considering the independence of the data sources and the coarse resolution of the data available at the global scale. The statistically strong links — both between observed and modeled deaths and between socio-economic variables associated with human vulnerability and levels of risk — that were found in the DRI study are not often found in similar studies that analyse geophysical datasets and socio-economic data. The model has succeeded in opening the great potential for future national level disaster risk assessments. It provides the first, solid statistical base for understanding and comparing countries' disaster risk and human vulnerability.

The DRI is not a predictive model
This is partly a function of a lack of precision in the available data. But it also shows the influence of local context. The risk maps provided in this research allow a comparison of relative risk between countries, but cannot be used to depict actual risk for any one country. Sub-national risk analysis would be required to inform development and land-use planning at the national level.

How to link extreme and everyday risk?
Extraordinary events by their very nature do not follow the normal trend. Hurricane Mitch in 1998, the rains causing landslides in Venezuela in 1999 or the 1988 earthquake in Armenia were off the regression line. This is due to the abnormal intensity of such events. These events are (hopefully) too rare to be usefully included in a two-decade period of study. Incorporating this level of intensity can only be done on an event-per-event approach.

T.7.2 Ways forward

Socio-economic variables
Results showed that global datasets can still be improved both in terms of precision and completeness. However, they already allow the comparison of countries. Other indicators — such as a corruption, armed conflict or

political events — would be interesting to test in the model in the future.

Floods

Geophysical data can be improved. The watersheds used to estimate flood physical exposure were based on a 1 km cell resolution for elevation. A new global dataset on elevation from radar measures taken from a National Aeronautics and Space Administration (NASA) space shuttle is expected in 2004. It consists of a 30m resolution grid for the USA and 90m resolution for global coverage. This dataset will allow the refining of estimated areas exposed to flood risk. This advance will be especially welcome for the central Asian countries, where the quality of globally accessible available data was low.

Earthquakes

If information on soil (i.e. Quaternary rocks) and fault orientations can be generated, it would be possible to compute intensity using a modified Mercali scale, with much higher precision for delineating the affected area. Alternatively, a method for deriving frequency based on the Global Seismic Hazard Map from the GSHAP[13] could be used.

Cyclones

Once data from the North Indian Ocean is available, a vector approach should be applied using the PreView Global Cyclone Asymmetric Windspeed Profile model developed by UNEP/GRID-Geneva. This method computes areas affected, based on central pressure and sustainable winds.

Drought

Other precipitation datasets with higher spatial resolution could be usefully tested. The use of geo-climatic zones might be useful in order to take into account the usual climate of a specific area. Indeed, a drop of 50 percent precipitation might not have the same consequence on a humid climate as on a semi-arid area. The use ofthe Global Humidity Index (from UNEP/GRID UEA/CRU) might help in differentiating these zones. Measuring food insecurity (by using information on conflict and political status) would be also a significant improvement as compared to meteorological drought. Alternatively, drought could be measured in terms of crop failure through use of satellite imagery. This will be closer to drought as it impacts on food security.

The case of small islands and archipelagos

In some cases, small islands and archipelagos were too small to be considered by the GIS-automated algorithms. This was typically the case for population data. The raster information layer for population could not be used to extract the population of small islands. For single island countries, the problem might be overcome by using the population of the country, but for others this was not possible. Indeed, when superimposing cyclone tracks on top of archipelagos, the population is needed for each island. A manual correction is needed, but could not be performed due to the time-frame of the study. The compilation of socio-economic variables was also not complete for the islands. This might be improved by collaborating with agencies such as the South Pacific Applied Geoscience Commission (SOPAC) and Economic Commission for Latin America and the Caribbean (ECLAC) as both agencies are currently working on indicators for island vulnerability.

For all these reasons, the case of small island states and archipelagos would need a separate study.

Death as an indicator for risk

To what extend are deaths proportional to the significance of total losses, including losses of livelihood? In the case of earthquakes, where no early warning exists, this might be a good proxy. But it will depend on whether the earthquake epicentre is located in a rural or urban area. For tropical cyclone and flood, deaths are usually much smaller in relation to losses of houses, infrastructures and crops. In drought, the relationship is even more exaggerated. A much higher number of people are affected through the slow erosion of rural livelihoods and the possible influence of intervening factors, such as armed conflict, economic or political crisis, or epidemic disease such as HIV/AIDS. This makes separating the impact of drought from other factors a big challenge.

The ideal would be to have access to records of livelihood losses in order to calibrate the severity of one hazard type as compared to another (while considering the magnitude of a hazard). Other approaches for obtaining a structured assessment of comparative risk by country could include an assessment on the comparative severity of hazard using local and expert knowledge, or using relief and aid organisation budget data as a proxy for risk severity.

Extending to other hazards

Volcanic eruptions. The variability of volcanic hazards was too complex to be entered into a general model. Volcanic hazard ranges from lahars linked with precipitation level, seismicity, topography and soils characteristics, to tephra falls influenced by the prevailing wind direction and strength, and phreatomagmatic eruption. Despite this complexity, much data is available for volcanic hazard and each active volcano is well described. Data needed for a global assessment of volcanic risk probably exists. But a finer resolution for elevation is needed. It would be necessary to include data on the shape and relief of volcanoes, computing slopes and hazard from lahars. Remote sensing analysis for local assessment of danger and population distribution would also be required.

Tsunamis and landslides. Some countries are not well represented by the model because they are affected by hazards that are not of global significance. This is the case of Papua New Guinea and Ecuador, both affected by tsunamis, respectively 67.8 percent and 14.3 percent of national deaths. Landslides also cause significant losses in Indonesia (13 percent), Peru (33 percent) and Ecuador (10 percent) of recorded disaster-related deaths. As a result, the multi-hazard DRI is under evaluated for these countries.

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1. Burton et al. 1993, p.34.
2. Coburn et al. 1991, p. 49.
3. Guha-Sapir, Debatathi and Below, Regina (2002) "Quality and Accuracy of Disaster Data: A Comparative Study of 3 Global Datasets," WHO Centre for Research on the Epidemiology of Disasters, University of Louvain School of Medicine for the Disaster Management Facility of the World Bank, Brussels.
4. Idem, p.14.
5. For a more detailed argument see the CRED-EM-DAT database http://www.cred.be/ and IFRC World Disaster Reports.
6. UNEP, 2002.
7. Birdwell & Daniel, 1991.
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12. Giardini, 1999.