

Appendix

TABLE T.2 VULNERABILITY INDICATORS				
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

DRI Regression Models

Hazards	Multiple logarithmic regression model	Variables
Earthquake	$\ln(K) = 1.26 \ln(\text{PhExp}) + 12.27 \cdot U_g - 16.22$	K is the number of killed from earthquakes PhExp is the Physical Exposure to earthquakes U_g is the rate of urban growth
Flood	$\ln(K) = 0.78 \ln(\text{PhExp}) + 0.45 \ln(\text{GDP}_{\text{cap}}) - 0.15(D) - 5.22$	K is the number of killed from floods PhExp is the Physical Exposure to floods GDP_{cap} is the normalized Gross Domestic Product per capita D is the local population density
Cyclone	$\ln(K) = 0.63 \ln(\text{PhExp}) + 0.66 \ln(\text{Pal}) - 2.03(\text{HDI}) - 15.86$	K is the number of killed from cyclones PhExp is the Physical Exposure to cyclones Pal is the transformed value of percentage of arable land HDI is the transformed value of the Human Development Index
Drought	$\ln(K) = 1.26 \ln(\text{PhExp}_{3_50}) + 7.58 \ln(\text{WAT}_{\text{TOT}}) + 14.4$	PhExp_3_50 is the number of people exposed per year to droughts. A drought is defined as a period of at least 3 months $\leq 50\%$ of the average precipitation level (IRI 2002; CIESIN/FPRI/WRI 2000) WAT_{TOT} is the percent of population with access to improved water supply

EQUATION 15 COMPUTATION OF MULTIPLE RISK BY SUMMING CALCULATED DEATHS AS MODELLED FOR RISK FOR CYCLONE, FLOOD, EARTHQUAKE AND DROUGHT

$$\text{EQ15 } K_{\text{cyclones}} (\text{PhExp}_{\text{cyclones}}^{0.63} \cdot \text{Pal}^{0.66} \cdot \text{HDI}^{-2.03} \cdot e^{-15.86}) + K_{\text{floods}} (\text{PhExp}_{\text{floods}}^{0.78} \cdot \text{GDP}_{\text{cap}}^{0.45} \cdot D^{-0.15} \cdot e^{-5.22}) + K_{\text{earthquakes}} (\text{PhExp}_{\text{earthquakes}}^{1.26} \cdot U_g^{12.27} \cdot e^{-16.22}) + K_{\text{droughts}} (\text{PhExp}_{3_50}^{1.26} \cdot \text{WAT}_{\text{TOT}}^{-7.58} \cdot e^{14.4})$$

Where		GDP_{cap}	is the Gross Domestic Product per capita at purchasing power parity
e	is the Euler constant (=2.718...)	D	is the local density (density of population in the flooded area)
PhExp	is the physical exposure of selected hazard	U_g	is the Urban growth (computed over three-year period)
HDI	is the Human Development Index	WAT_{TOT}	is the access to safe drinking water

Table 2: Summary of data sources for each Hotspot Hazard

Hazard	Parameter	Period	Resolution	Source(s)
Cyclones	Frequency by wind strength	1980-2000	30"	UNEP/GRID-Geneva PreView
Drought	Weighted Anomaly of Standardized Precipitation (50% below normal precip. for a 3-month period)	1980-2000	2.5°	IRI Climate Data Library
Floods	Counts of extreme flood events	1985-2003*	1°	Dartmouth Flood Observatory, <i>World Atlas of Large Flood Events</i>
Earthquake	Expected pga > 2 m/s ² (10% probability of exceedance in 50 years)	n/a	sampled at 1'	Global Seismic Hazard Program
	Frequency of earthquakes > 4.5 on Richter Scale	1976-2002	sampled at 2.5'	Advanced National Seismic System Earthquake Catalog
Volcanoes	Counts of volcanic activity	79-2000	Sampled at 2.5'	UNEP/GRID-Geneva and NGDC
Landslides	Index of landslide and snow avalanche hazard	n/a	30"	NGI

* missing data for 1989, 1992, 1996, and 1997; quality of spatial data for 1990-91 and 1993-95 limited.

Table 3. Economic loss-related vulnerability coefficients.

Region and wealth status	Cyclone	Drought	Earthquake	Flood	Landslide	Volcano
<i>Africa</i>						
Low	38.97	5.55		0.65	0.00	0.00
Lower middle	127.01	0.01		2.33	0.00	0.00
Upper middle	18.49	9.88		0.00		
High	5.24	0.00				0.00
<i>East Asia and the Pacific</i>						
Low	59.47	0.66	0.92	25.97	0.07	7.58
Lower middle	8.62	0.54	10.72	17.45	0.08	12.02
Upper middle	953.20	0.00		0.07	0.00	
High	4.02	8.54	47.97	1.53	0.17	0.00
<i>Europe and Central Asia</i>						
Low		4.52	16.34	5.56	3.80	
Lower middle	0.00	0.76	82.12	24.96	4.23	0.00
Upper middle		4.13	0.00	10.13	0.00	
High	24.04	3.29	19.23	4.23	4.65	0.31
<i>Latin America and the Caribbean</i>						
Low	71.65	7.50	2.23	0.36	0.00	0.17
Lower middle	48.84	2.74	8.82	7.04	3.97	22.94
Upper middle	14.48	1.28	11.72	5.88	1.04	0.37
High	104.27	0.00	0.00	0.00	0.00	0.00
<i>Middle East and North Africa</i>						
Low		0.00		168.87		0.00
Lower middle		9.35	38.98	5.90	0.00	
Upper middle	0.00	0.00	0.00	10.60	0.00	0.00
High		1.03	0.00	0.00		
<i>North America</i>						
High	13.00	0.97	30.82	2.84	0.00	0.00
<i>South Asia</i>						
Low	26.64	0.18	1.33	7.00	0.07	
Lower middle	0.00	0.00		5.26		
Upper middle						
High		0.00				

These are based on hazard-specific historical economic rates (economic losses per \$100,000 GDP in 2000 during 1981-2000) used to weight GDP exposure to obtain economic loss risks (blank cells indicate insignificant recorded historical losses; the number of historical events available to calculate each weight varies, with some weights based on as few as 5-10 events).

Table 4: Mortality-related Vulnerability Coeffi

Region and wealth status	Cyclone	Drought	Earthquake	Flood	Landslide	Volcano
<i>Africa</i>						
Low	5.06	118.97		1.51	0.95	79.10
Lower middle	59.35	1.10		3.10	0.00	0.00
Upper middle	0.57	0.00		2.18		
High	5.10	0.00				0.00
<i>East Asia and the Pacific</i>						
Low	10.17	0.42	2.60	2.24	2.08	0.79
Lower middle	5.03	0.15	3.17	2.22	4.74	13.20
Upper middle	39.22	0.00		0.51	23.31	
High	1.33	0.00	5.48	1.10	1.20	0.51
<i>Europe and Central Asia</i>						
Low		0.00	0.75	2.82	5.69	
Lower middle	2.50	0.00	62.16	0.67	1.46	0.00
Upper middle		0.00	0.00	0.33	0.00	
High	1.65	0.00	1.77	0.25	2.67	0.00
<i>Latin America and the Caribbean</i>						
Low	39.72	0.00	4.22	2.36	0.00	0.12
Lower middle	44.16	0.00	3.24	4.44	8.53	231.68
Upper middle	4.27	0.01	13.86	11.21	4.24	1.62
High	3.26	0.00	0.00	0.00	0.00	0.00
<i>Middle East and North Africa</i>						
Low		0.00		5.81		0.00
Lower middle		0.00	271.25	5.11	2.54	
Upper middle		0.00	0.00	0.54	1.91	0.00
High	0.00	0.00	0.00	0.19		
<i>North America</i>						
High	1.01	0.00	0.39	0.19	0.00	0.00
<i>South Asia</i>						
Low	64.52	0.04	8.04	3.90	7.04	
Lower middle	0.20	0.00				
Upper middle						
High		0.00				

These are based on hazard-specific historical mortality rates (persons killed during 1981-2000 per 100,000 persons in 2000) used to weight population exposure to estimate mortality risk (blank cells indicate insignificant recorded historical losses; the number of historical events available to calculate each weight varies, with some weights based on as few as 5-10 events).