

## **Appendix 2: Risk and Poverty**

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## Note 2.1: Poverty definitions

In general terms an individual, household or community is said to be poor when it falls, in absolute or relative terms, short of a minimum level of welfare, often referred to as the poverty line.<sup>1</sup> Absolute poverty is usually measured as the proportion of the population eating fewer calories than is required to sustain health. In most nations, there are two poverty lines, the food poverty line based only on the income needed for sufficient calories (sometimes called the extreme poverty line) and another that makes a small allowance for the costs of non-food needs. From the early 1990s, the 'dollar a day' poverty line was introduced although this is known to considerably understate the scale of poverty, as food and non-food needs cost far more than this in many locations. The dollar a day poverty line was recently reset at \$1.25 for 2005.

Relative poverty could be expressed as the proportion of the population falling below a socially defined level of consumption or welfare considered to be a reasonable minimum in a given society. The report recognises that the choice of a poverty line is ultimately arbitrary.

In this report, the term *monetary poverty* will be used generically to refer to income or consumption poverty, where a lack of assets, income, endowments and capital means that people are unable to satisfy minimum required expenditures on food, housing, health, education, energy and transport etc. In this sense, monetary poverty can be assessed in terms of its *incidence* (the proportion of a given population falling below the poverty line), in terms of its *depth* (the distance below the poverty line at which different groups of households find themselves, often described as the 'poverty gap' or in some cases as 'poverty severity' to measure inequalities), or in terms of its *duration*, which distinguishes between the transitory poor (those who temporarily move in and out of poverty) and the chronically poor (those who are permanently below the poverty line).

Monetary poverty, however, only partially describes the experience of poverty. It is usually accompanied by lack of access to health, education and other services, powerlessness and isolation, gender discrimination, social exclusion, illiteracy, poor sanitation, livelihood vulnerability and others. The World Bank<sup>2</sup> documented a range of attributes which poor people identify as part of poverty. These include: precarious livelihoods; excluded locations; physical limitations; gender relationships; problems in social relationships; lack of security; abuse by those in power; disempowering institutions; limited capabilities and weak community organizations. Viewed holistically, monetary, social, physical and political factors such as described above, will be referred to as 'human poverty' where relevant.

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<sup>1</sup> Lipton and Ravallion, 1995

<sup>2</sup> Voices of the Poor World Bank, accessed December 2008 at: <http://go.worldbank.org/H1N8746X10>

## Note 2.2: Establishment of the threshold between intensive and extensive risk

Previous studies undertaken by Ramirez et. al in 2002 for the ISDR Working Group 3 on Risk, Vulnerability and Disaster Impacts<sup>3</sup> and in 2005 by Marulanda, Cardona et. al. at the National University of Colombia<sup>4</sup> applied different methodologies to identify losses at different scales using DesInventar. These methods were reviewed in order to see if they provided a viable approach for the identification of extensive risk.

The Working Group 3 study compared losses reported in DesInventar with those in EM-DAT in four countries: Chile, Colombia, Jamaica and Panama. DesInventar registers losses in local administrative areas (normally municipalities or equivalent in each country). In contrast, EM-DAT registers the losses associated with hazard events, which can affect a large number of different local administrative areas, and above a threshold of 10 deaths, 100 people affected or a call for international assistance. The different architecture of the two databases poses challenges to compare losses. Nevertheless, by matching loss reports it was possible to identify sets of individual or aggregated DesInventar loss reports that corresponded to EM DAT events, as well as those reports that neither individually nor aggregated surpassed the EM DAT threshold.

This, however, did not prove to be a valid approach to identify manifestations of intensive and extensive risk. The EM-DAT threshold was not established as a measure of intensive risk but rather to identify what EM DAT considers to be disasters from other more idiosyncratic losses. For example, a large number of localised losses, in spatially discontinuous areas, but associated for example with a common weather system, when aggregated might surpass the EM DAT threshold, and would thus be registered as a disaster. However, this does not impute a manifestation of intensive risk in any of the areas affected.

The second study, which examined the impact of small disasters in Colombia, used a statistical procedure to calculate outlier events which exceeded 3.5 standard distributions from the mean distribution of DesInventar reports in Colombia. While this approach has a transparent statistical procedure, the definition of the number of standard deviations from the mean is by definition arbitrary and relative. To use this method to identify reports which manifest intensive risk therefore poses a problem of how to calculate an appropriate standard deviation. If the number of standard deviations increases or decreases then the number of outliers would increase or decrease and the threshold between intensive and extensive risk would change.

After reviewing the above methods, the approach chosen was to compare the distribution of DesInventar reports across the dataset of 126,620 disaster reports in the 12 countries between 1970-2007 with the numbers of deaths and of houses destroyed. As Figure 2.2 and Table 2.2 a show the number of deaths per loss report were grouped together in fatality classes. A statistical analysis was carried out to identify the point where the maximum percentage of losses is concentrated in the minimum number of reports for both the variables, in this case where the fatality slope fell below a gradient of 0.1%. A similar exercise was carried out for destroyed houses. 50 deaths and 500 destroyed houses were considered to represent a reasonable threshold between extensive and intensive risk that was both easy to understand and met the above criteria.

Table 2.2b shows the application of the threshold to the universe of loss reports in the 12 countries and for both geological and hydro-meteorological hazard. In all individual countries or states more than 95% of all loss reports were in the extensive risk category, indicating that the threshold was also reasonable across individual countries.

Nevertheless, it is important to stress that the threshold is only statistically valid for this group of 12 countries and with losses aggregated in local administrative areas (mostly third tier administrative areas). If the losses were aggregated at a higher level (for example in first or second tier administrative areas) the threshold would increase. If the losses were disaggregated to a lower level (for example neighbourhoods) the threshold would decrease. To illustrate this with an example, Table 2.2c shows that if the methodology were applied to the EM DAT database using countries as the spatial unit, the mortality threshold would be approximately 10,000 deaths.

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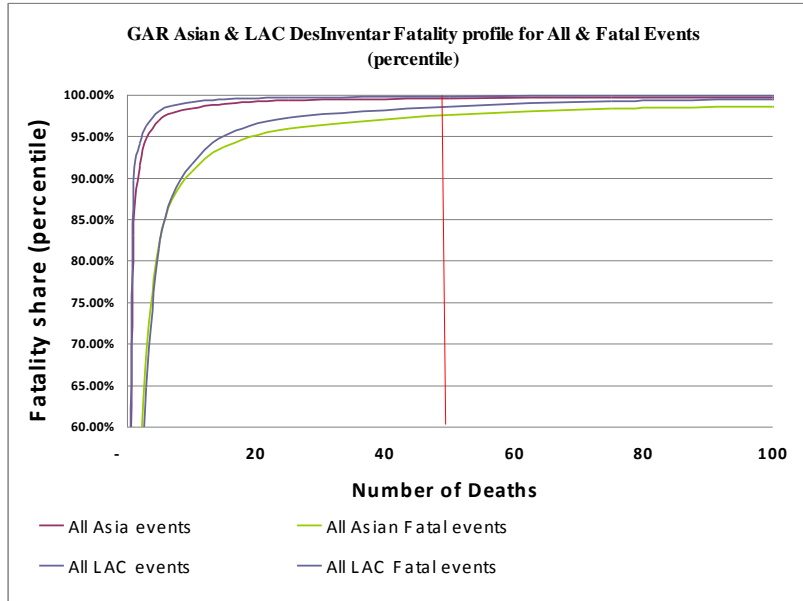
<sup>3</sup> Observatorio Sismológico del Sur-Occidente (OSSO) and LA RED, 2002

<sup>4</sup> Marulanda, M.C. and Cardona, O.D. (2006) 'Analysis of the impact of small and moderate disasters at local level in Colombia'. *ProVention Consortium. La RED*. Available at: <http://www.desin-ventar.org/sp/pro-yectos/ar-ticulos/>

Marulanda, M.C., Cardona, O.D. & A. H. Barbat, (2008). "The Economic and Social Effects of Small Disasters: Revision of the Local Disaster Index and the Case Study of Colombia", in *Megacities: Resilience and Social Vulnerability*, Bohle, H.G., Warner, K. (Eds.), SOURCE No. 10, United Nations University (EHS), Munich Re Foundation, Bonn.

Marulanda, M.C., Cardona, O.D., Barbat A.H. (2009) *Revealing the Socio-Economic Impact of Small Disasters in Colombia using DesInventar database. Disasters*. In press.

**Figure 2.2: DesInventar fatality profile (by percentile of all reported & fatal events)**



**Table 2.2a: DesInventar fatality profile (by percentile of all reported & fatal events)**

Fatality class intervals	Asia					LAC				
	All Asian events	All Asian fatal events	All fatality slope	Cumulative deaths	% Cumulative death	All Latin American events	All Latin American fatal events	All fatality slope	Cumulative deaths	% Cumulative death
-	0.00%					0.00%				
1	83.00%	0.00%	0.000	3,851	1.89%	89.60%	0.00%	-	3,728	3.41%
2	91.50%	50.30%	0.503	6,663	3.27%	94.20%	44.20%	0.442	7,182	6.57%
3	94.70%	68.70%	0.184	10,084	4.95%	96.30%	64.70%	0.205	11,945	10.92%
5	96.90%	81.90%	0.066	12,294	6.04%	98.00%	81.50%	0.084	14,796	13.53%
7	97.80%	87.30%	0.027	14,346	7.05%	98.70%	87.70%	0.031	17,290	15.81%
10	98.40%	90.70%	0.011	16,959	8.33%	99.10%	91.60%	0.013	20,588	18.83%
15	98.90%	93.70%	0.006	20,139	9.89%	99.40%	95.00%	0.007	23,945	21.90%
25	99.30%	95.90%	0.002	24,495	12.03%	99.70%	97.20%	0.002	28,114	25.71%
50	99.60%	97.60%	0.001	27,637	13.58%	99.80%	98.60%	0.001	30,920	28.28%
75	99.70%	98.30%	0.000	29,365	14.43%	99.90%	99.20%	0.000	32,175	29.43%
100	99.70%	98.60%	0.000	37,525	18.44%	99.90%	99.40%	0.000	36,317	33.21%
250	99.80%	99.30%	0.000	43,633	21.44%	99.90%	99.80%	0.000	37,407	34.21%
500	99.90%	99.50%	0.000	53,646	26.36%	99.90%	99.80%	-	40,903	37.41%
1,000	99.90%	99.70%	0.000	63,486	31.19%	99.90%	99.90%	0.000	45,403	41.52%
2,500	99.90%	99.80%	0.000	75,220	36.96%	99.90%	99.90%	-	48,403	44.27%
5,000	99.90%	99.80%	0.000	112,265	55.16%	99.90%	99.90%	-	48,403	44.27%
7,500	99.90%	99.90%	0.000	112,265	55.16%	99.90%	99.90%	-	48,403	44.27%
10,000	99.90%	99.90%	0.000	112,265	55.16%	99.90%	99.90%	-	68,403	62.56%
15,000	99.90%	99.90%	0.000	112,265	55.16%	99.90%	99.90%	-	86,403	79.02%
25,000	99.90%	99.90%	0.000	203,536	100.00%	100.00%	100.00%	0.000	109,345	100.00%
50,000	100%	100%	0.000	203,536	100.00%	100.00%	100.00%	-	109,345	100.00%
n' value	45,217	7,652				81,399	8,431			
	No events									
	Fatal events with asymptotic fatality < 0.1% slope									

**Table 2.2b: Intensive and extensive risk in Asia and Latin America (1970 – 2007)**

Country	Risk Type	Hazard type	Disaster reports	%	Deaths	%	Houses Destroyed	%	Houses Damaged	%
<b>Argentina</b>	Extensive	Hydrometeorological	14,525	98.7	2,554	84.8	18,343	34.6	101,095	72.5
	Extensive	Geological	165	1.1	68	2.3	1,041	2.0	3,031	2.2
	Intensive	Hydrometeorological	25	0.2	360	12.0	24,775	46.8	28,600	20.5
	Intensive	Geological	4	0.0	30	1.0	8,800	16.6	6,643	4.8
<b>SUB TOTAL</b>			<b>14,719</b>	<b>100.0</b>	<b>3,012</b>	<b>100.0</b>	<b>52,959</b>	<b>100.0</b>	<b>139,369</b>	<b>100.0</b>
<b>Bolivia</b>	Extensive	Hydrometeorological	1,363	98.5	435	55.1	2,369	56.7	2,066	100.0
	Extensive	Geological	16	1.2	0	0.0	8	0.2	0	0.0
	Intensive	Hydrometeorological	4	0.3	249	31.6	0	0.0	0	0.0
	Intensive	Geological	1	0.1	105	13.3	1,800	43.1	0	0.0
<b>SUB TOTAL</b>			<b>1,384</b>	<b>100.0</b>	<b>789</b>	<b>100.0</b>	<b>4,177</b>	<b>100.0</b>	<b>2,066</b>	<b>100.0</b>
<b>Colombia</b>	Extensive	Hydrometeorological	21,316	97.2	6,645	18.5	86,655	50.5	397,968	83.8
	Extensive	Geological	548	2.5	221	0.6	6,489	3.8	35,386	7.4
	Intensive	Hydrometeorological	58	0.3	2,387	6.7	27,224	15.9	2,991	0.6
	Intensive	Geological	14	0.1	26,603	74.2	51,282	29.9	38,754	8.2
<b>SUB TOTAL</b>			<b>21,936</b>	<b>100.0</b>	<b>35,856</b>	<b>100.0</b>	<b>171,650</b>	<b>100.0</b>	<b>475,099</b>	<b>100.0</b>
<b>Costa Rica</b>	Extensive	Hydrometeorological	8,957	97.7	414	86.1	2,981	39.0	36,497	80.9
	Extensive	Geological	207	2.3	21	4.4	835	10.9	2,538	5.6
	Intensive	Hydrometeorological	0	0.0	0	0.0	0	0.0	0	0.0
	Intensive	Geological	3	0.0	46	9.6	3,830	50.1	6,068	13.5
<b>SUB TOTAL</b>			<b>9,167</b>	<b>100.0</b>	<b>481</b>	<b>100.0</b>	<b>7,646</b>	<b>100.0</b>	<b>45,103</b>	<b>100.0</b>
<b>Ecuador</b>	Extensive	Hydrometeorological	3,237	96.1	1,944	67.9	8,223	75.6	36,088	90.3
	Extensive	Geological	124	3.7	43	1.5	406	3.7	3,687	9.2
	Intensive	Hydrometeorological	4	0.1	550	19.2	663	6.1	178	0.4
	Intensive	Geological	2	0.1	327	11.4	1,590	14.6	0	0.0
<b>SUB TOTAL</b>			<b>3,367</b>	<b>100.0</b>	<b>2,864</b>	<b>100.0</b>	<b>10,882</b>	<b>100.0</b>	<b>39,953</b>	<b>100.0</b>
<b>Iran</b>	Extensive	Hydrometeorological	2,065	55.3	3,389	2.5	3,379	2.4	119,705	37.1
	Extensive	Geological	1,601	42.9	375	0.3	3,729	2.7	46,569	14.4
	Intensive	Hydrometeorological	29	0.8	2,099	1.5	29,420	21.3	2,800	0.9
	Intensive	Geological	36	1.0	131,430	95.7	101,485	73.5	153,606	47.6
<b>SUB TOTAL</b>			<b>3,731</b>	<b>100.0</b>	<b>137,293</b>	<b>100.0</b>	<b>138,013</b>	<b>100.0</b>	<b>322,680</b>	<b>100.0</b>
<b>Mexico</b>	Extensive	Hydrometeorological	11,978	96.8	7,692	32.5	28,198	8.1	1,387,289	71.5
	Extensive	Geological	317	2.6	242	1.0	1,312	0.4	81,220	4.2
	Intensive	Hydrometeorological	65	0.5	3,549	15.0	236,801	68.4	370,011	19.1
	Intensive	Geological	14	0.1	12,171	51.5	80,127	23.1	101,697	5.2
<b>SUB TOTAL</b>			<b>12,374</b>	<b>100.0</b>	<b>23,654</b>	<b>100.0</b>	<b>346,438</b>	<b>100.0</b>	<b>1,940,217</b>	<b>100.0</b>
<b>Nepal</b>	Extensive	Hydrometeorological	11,295	98.8	8,513	80.6	113,580	58.1	59,936	40.8
	Extensive	Geological	72	0.6	116	1.1	2,001	1.0	5,300	3.6
	Intensive	Hydrometeorological	49	0.4	1,180	11.2	48,062	24.6	31,811	21.6
	Intensive	Geological	19	0.2	757	7.2	31,709	16.2	50,023	34.0
<b>SUB TOTAL</b>			<b>11,435</b>	<b>100.0</b>	<b>10,566</b>	<b>100.0</b>	<b>195,352</b>	<b>100.0</b>	<b>147,070</b>	<b>100.0</b>
<b>Orissa, India</b>	Extensive	Hydrometeorological	7,298	94.8	6,572	22.0	281,154	23.4	398,913	15.2
	Extensive	Geological	6	0.1	0	0.0	3	0.0	11	0.0
	Intensive	Hydrometeorological	395	5.1	23,296	78.0	917,797	76.5	2,227,441	84.8
	Intensive	Geological	0	0.0	0	0.0	0	0.0	0	0.0
<b>SUB TOTAL</b>			<b>7,699</b>	<b>100.0</b>	<b>29,868</b>	<b>100.0</b>	<b>1,198,954</b>	<b>100.0</b>	<b>2,626,365</b>	<b>100.0</b>
<b>Peru</b>	Extensive	Hydrometeorological	13,134	92.1	5,191	13.0	39,860	9.2	244,275	67.1
	Extensive	Geological	1,062	7.4	876	2.2	19,847	4.6	43,865	12.0
	Intensive	Hydrometeorological	36	0.3	20,409	51.0	61,402	14.1	51,312	14.1

<b>SUB TOTAL</b>	Intensive	Geological	29	0.2	13,550	33.9	312,894	72.1	24,732	6.8
			<b>14,261</b>	<b>100.0</b>	<b>40,026</b>	<b>100.0</b>	<b>434,003</b>	<b>100.0</b>	<b>364,184</b>	<b>100.0</b>
<b>Sri Lanka</b>	Extensive	Hydrometeorological	9,745	98.8	1,801	8.7	30,416	13.0	242,128	55.3
	Extensive	Geological	35	0.4	221	1.1	1,836	0.8	3,000	0.7
	Intensive	Hydrometeorological	40	0.4	2,383	11.5	147,072	62.6	144,923	33.1
	Intensive	Geological	42	0.4	16,360	78.8	55,472	23.6	47,515	10.9
<b>SUB TOTAL</b>			<b>9,862</b>	<b>100.0</b>	<b>20,765</b>	<b>100.0</b>	<b>234,796</b>	<b>100.0</b>	<b>437,566</b>	<b>100.0</b>
<b>Tamil Nadu, India</b>	Extensive	Hydrometeorological	12,325	98.7	1,847	36.6	109,869	48.5	550,346	60.9
	Extensive	Geological	62	0.5	213	4.2	3,171	1.4	1,703	0.2
	Intensive	Hydrometeorological	81	0.6	839	16.6	90,511	40.0	326,994	36.2
	Intensive	Geological	23	0.2	2,145	42.5	22,991	10.1	24,056	2.7
<b>SUB TOTAL</b>			<b>12,491</b>	<b>100.0</b>	<b>5,044</b>	<b>100.0</b>	<b>226,542</b>	<b>100.0</b>	<b>903,099</b>	<b>100.0</b>
<b>Venezuela</b>	Extensive	Hydrometeorological	4,135	98.6	1,395	52.4	13,975	28.6	78,290	61.8
	Extensive	Geological	44	1.0	10	0.4	6	0.0	235	0.2
	Intensive	Hydrometeorological	15	0.4	1,258	47.2	34,955	71.4	48,115	38.0
	Intensive	Geological	0	0.0	0	0.0	0	0.0	0	0.0
<b>SUB TOTAL</b>			<b>4,194</b>	<b>100.0</b>	<b>2,663</b>	<b>100.0</b>	<b>48,936</b>	<b>100.0</b>	<b>126,640</b>	<b>100.0</b>
<b>All</b>	Extensive	Hydrometeorological	121,373	95.9	48,392	15.5	739,002	24.1	3,654,596	48.3
	Extensive	Geological	4,259	3.4	2,406	0.8	40,684	1.3	226,545	3.0
	Intensive	Hydrometeorological	801	0.6	58,559	18.7	1,618,682	52.7	3,235,176	42.7
	Intensive	Geological	187	0.1	203,524	65.0	671,980	21.9	453,094	6.0
<b>TOTAL</b>			<b>126,620</b>	<b>100.0</b>	<b>312,881</b>	<b>100.0</b>	<b>3,070,348</b>	<b>100.0</b>	<b>7,569,411</b>	<b>100.0</b>

**Table 2.2c: EM-DAT Fatality profile (by percentile of all reported & fatal events)**

Fatality Class Intervals	Em-Dat Fatal events	Fatality Slope	Cumulative deaths	Cumulative death %
-				
5	22.79%	4.5575%	3'498	0.15%
10	34.49%	2.3409%	9'130	0.39%
20	51.10%	1.6608%	23'898	1.02%
30	60.57%	0.9471%	38'230	1.63%
50	71.42%	0.5424%	64'021	2.73%
100	82.54%	0.2223%	112'252	4.79%
500	95.13%	0.0315%	277'503	11.85%
1'000	97.48%	0.0047%	377'365	16.11%
2'500	98.96%	0.0010%	515'888	22.02%
5'000	99.35%	0.0002%	594'873	25.39%
10'000	99.60%	0.0001%	709'464	30.28%
15'000	99.65%	0.0000%	753'215	32.15%
20'000	99.71%	0.0000%	825'731	35.25%
50'000	99.87%	0.0000%	1'072'731	45.79%
100'000	99.92%	0.0000%	1'346'069	57.46%
300'000	100.00%	0.0000%	2'342'643	100.00%
<b>n' value</b>	<b>5'955</b>			
	No events			
	Fatal events with asymptotic fatality <0.1% slope			

## Note 2.3: Links between disaster risk and poverty: Summary of empirical analysis

**Table 2.3a: Case Studies: Disaster Risk and Poverty**

Commissioned Country Case Studies					
Country	Unit of observation	Impact	Natural events	Data	Method
<b>Bolivia</b>	Households	Changes in poverty and inequality between (2006-2007)	Floods in Trinidad (2006-2007)	Cross section	Ordinary Least Squares
<b>El Salvador</b>	Households	Changes in households' income	Earthquakes (2001)	Panel	Quasi experimental
<b>Ecuador</b>	Municipalities	Changes in poverty incidence between (1990-2001)	Landslides, earthquakes, droughts and floods	Geographical panel	Multivariate regression
<b>Mexico</b>	Municipalities	Changes in poverty levels and HDI	Hydrological, meteorological and geological	Geographical panel	Adjusted difference in difference
<b>Peru</b>	Households	Consumption-poverty transitions between (2002-2006)	Natural events incidence	Five-wave balanced panel	Multinomial regression
<b>Iran</b>	Provinces	Changes in urban households' expenditures (1991-2006)	Hydrological, meteorological and geological	Cross-sectional data	Ordinary Least Squares (elasticities)
<b>Nepal</b>	Ilaka (integration of lowest admin. Unit)	Changes in poverty incidence (2003/04)	Earthquakes, floods and landslides	Cross-section	Ordinary Least Squares
Other Relevant Literature					
Country	Unit of observation	Impact	Natural events	Data	Method
<b>Nicaragua</b>	Households	Consumption-poverty transitions and trajectories between (1998-2005)	Hurricane Mitch, drought, flood	Panel (3 rounds)	Probit Quasi experimental (matching estimates)
<b>Bangladesh</b>	Households	Changes in households' consumption in bottom quintile	Self-reported floods	Panel data	Multinomial logit and quantile regression
<b>Indonesia</b>	Districts	Changes in poverty incidence between 2004-2006	December 2004 tsunami	Cross-section and subsample panel data	Odds ratios
<b>India</b>	Households	Incidence of droughts on income-poverty spells (1975-1984)	Crop shocks due to deficient or delayed rain	Panel data (ICRISAT)	Counterfactual simulations on poverty Arellano-Bond GMM estimates.
<b>Burkina Faso</b>	Households	Changes in poverty incidence and inequality (1983-85)	1984-85 drought	Panel data	Poverty elasticities and inter-annual comparisons
<b>Ethiopia</b>	Households	Changes in poverty incidence (1999-2004)	1999 and 2002 droughts	Panel data	Consumption simulations (counterfactuals) from village FE for consumption
<b>Zimbabwe</b>	Households	Changes in poverty incidence (1992-96)	1994-95 drought	Panel data	Inter-annual comparisons

**Table 2.3b: Case Studies: Main findings on links between Disaster Risk and Poverty**

Country	Results
<b>Bolivia</b>	<ul style="list-style-type: none"> <li>- The 2006 flood in the city of Trinidad resulted in an increase in poverty the year after: poverty incidence increased 12%, poverty gap increased by almost 7% and the severity of poverty increased by 5%.</li> <li>- Isolating the effect of the flood on wellbeing it was found that less exposure to risk implies a return on income: 5% in 2006 and 7% in 2007.</li> </ul>
<b>El Salvador</b>	<ul style="list-style-type: none"> <li>- Earthquakes are associated with a reduction of \$1,760 <i>colones</i> –a third of pre-shock average per capita income. This decline in rural income amounts to gains achieved during the prosperous decade of the 1990s. Also, the decline contrasts with the gains in average household income per capita that was taking place in the country between 2000 and 2002 (from 5,449 to 6,957 <i>colones</i>).</li> <li>- Most dangerous effects are related to reductions in human and physical capital. In households exposed the probability of school enrollment decreased by 5%.</li> <li>- 9.3% of households had to sell animals or land and 7.5% stopped or cancelled investments in physical capital.</li> </ul>
<b>Peru</b>	<ul style="list-style-type: none"> <li>- The probability of being <i>always poor</i> is 2.3 - 4.8 times higher than to be <i>never poor</i> for those households that experienced a natural hazard. Results only hold if consumption, rather than assets, is used to measure poverty.</li> <li>- For households in the lower quartile of the distribution the occurrence of shocks reduces monthly per capita consumption by 3.85%, while for households in the richer quartile this reduction is only by 1.2%.</li> </ul>
<b>Ecuador</b>	<ul style="list-style-type: none"> <li>- Exposure to droughts increases the change in poverty by 2% on average.</li> <li>- There is no effect on the change in poverty gap and severity.</li> </ul>
<b>Mexico</b>	<ul style="list-style-type: none"> <li>- Hazards reduce by 0.006 on average the HDI. This is similar to going back about two years in terms of human development gains over the 5-year period reviewed for those municipalities affected by a natural hazard.</li> <li>- Food poverty increased 3.6 percentage points on average (which is about an eight % increase in their food poverty of those who experienced a disaster), capacities poverty (3 p.p.) and asset poverty (1.5 pp), with floods and droughts being the most significant events affecting poverty. Droughts reduce the HDI on 0.009 and rains about 0.8 % of the HDI. Floods and droughts increase food poverty in 3.5 and 4.2 pp respectively.</li> <li>- The impact of natural disasters is higher for those with lower levels of human development (0.006 loss for 20<sup>th</sup> percentile and non-significant loss for the 90<sup>th</sup> percentile)</li> </ul>
<b>Nicaragua</b>	<ul style="list-style-type: none"> <li>- Droughts are found to substantially increase the probability that households' exhibit downward trajectories. Droughts also have a particularly strong impact on the persistence of poverty for households initially at the bottom of the welfare distribution.</li> <li>- Reporting a drought increase the probability of downward trajectories between 10-15%, the strongest impact, and brings a probability higher by around 10% to remain at the bottom of the welfare distribution in 2005.</li> </ul>
<b>Bangladesh</b>	<ul style="list-style-type: none"> <li>- Floods felt on households whose head has less than four years of schooling and on households with less than median assets have a positive effect on per capita consumption. This seems consistent with finding on the positive impact of food assistance after the 1998 floods on households in the bottom quintile of asset distribution.</li> </ul>



<b>Indonesia</b>	<ul style="list-style-type: none"> <li>-The tsunami increased poverty from 28.4 % in 2004 to 32.6 % in 2005 in Aceh, while poverty in Indonesia declined as a whole from 16.7 % to 16 % in the same period.</li> <li>- Households in areas heavily affected by tsunami in Aceh were 44 % more likely to be poor than those residing in non-affected sub-districts.</li> <li>- Recovery of households was relatively rapid with significant difference in poverty likelihood across affected and non-affected areas. The receipt of government aid increased the likelihood of escaping poverty by 43 percent.</li> </ul>
<b>India</b>	<ul style="list-style-type: none"> <li>- As a consequence from negative crop shocks (due to deficient or delayed rainfall), there is an increase in proportions of households experiencing short (1-2 years) and relatively longer (3-5 years) spells of poverty: the proportion of households in poverty for 3-5 years jumps from 5.5 % when no crop shock is experienced to 14.8 % when a crop shock takes place for the first 3 years.</li> <li>- When crop shocks occur in consecutive years there is an increase in the proportions of always poor (6-7 years).</li> <li>- Even relatively affluent households (ie, owning large amounts of land, possessing a few years of education and affiliated to upper castes are highly vulnerable to persistent poverty under consecutive droughts).</li> </ul>
<b>Nepal</b>	<ul style="list-style-type: none"> <li>- Poverty rates have a statistically significant positive association with the occurrence of landslides in the past, while those areas affected by floods have lower rates of poverty.</li> </ul>
<b>Burkina Faso</b>	<ul style="list-style-type: none"> <li>- Poverty increased in Sahelian (2 to 19%) and Sudanian (12 to 15%) agro-ecological zones of the country in the aftermath of the 1984-1985 droughts.</li> <li>- Drought affected the lowest tercile of the population more than 10% harder than the top tercile: the former experienced crop-income losses of 69% versus 58% drop for the latter.</li> </ul>
<b>Ethiopia</b>	<ul style="list-style-type: none"> <li>- Uninsured 1999 and 2002 droughts increased consumption poverty for about 14% by 2004.</li> </ul>
<b>Zimbabwe</b>	<ul style="list-style-type: none"> <li>- The incidence and severity of poverty increased overall from 58 % in 1993/94 to 74.5 in 1994/95 (the drought years).</li> <li>- Out of three resettlement schemes, the most reliant on crop production for income experienced significant increases in poverty (from 48.4pp to 76.5pp), whereas the more reliant scheme on income from non-agricultural activities was slightly buffered from drought (poverty dropped from 67.4 to 64.1 pp).</li> </ul>

**Table 2.3c: Africa: Disasters, growth and poverty<sup>5</sup>**

	Short Term Effects	Long Term Effects
<b>Income /Consumption</b>	<ul style="list-style-type: none"> <li>• In Burkina Faso poverty increased in Sahelian (2-19%) and Sudanian (12-15%) areas in the aftermath of the 1984-1985 drought.</li> <li>• During 1998-2000 natural disasters in Madagascar explain about 46% of the limitation of financial access to food.</li> <li>• In Burkina Faso aggregate income shocks during drought period from 1981-85 passed onto consumption, and only a quarter was smoothed via stored grains.</li> <li>• Farmers in Kilimanjaro, Tanzania who reported receiving much below normal rainfall (21%) on their plots in 2003 experienced a reduction of consumption of 10% per acre cultivated per adult equivalent. The total gross loss in personal consumption among rural households attributed to drought was estimated at 5.3 billion.</li> <li>• A high rainfall sensitivity of consumption is found in Ethiopia, where 10% lower rainfall translates immediately into about 2% lower consumption. The effect is smaller for those with lower livestock holdings.</li> </ul>	<ul style="list-style-type: none"> <li>• In Ethiopia, experiencing a drought at least once in the period 1999-2004, lowered per capita consumption by about 20% in 2004. Those households reporting a serious drought shock in the last two years correlated with 16% lower consumption, while a shock in the preceding two years still reduced consumption by 14%.</li> <li>• In Ethiopia uninsured droughts in 1999 and 2002 increased consumption poverty by about 14%.</li> <li>• In Tanzania crop shocks going back to 1991-1995 lead to consumption growth losses with point estimates of between 17-40% in 2004.</li> </ul>
<b>Assets</b>	<ul style="list-style-type: none"> <li>• In Ethiopia having a large herd of 45-75 cattle at the beginning of a drought during 1980-1997 helped to smooth consumption and ensured a reasonable herd size after a drought, but having below 45 prevents households from diversifying income sources rendering them vulnerable to shocks.</li> <li>• For pastoralists in northern Kenya the variability of household expenditures exceeds that of income below a dynamic asset poverty threshold, but not above it. This shows the poor manage their herds to smooth assets, not consumption.</li> <li>• Selling-off livestock partially compensates for the impoverishing and un-equalizing effect of the 1984-1985 drought in Burkina Faso primarily due to distress sales of livestock by the poor. For the same country and shock livestock compensate for 20-30% of crop income shortfalls.</li> <li>• In Burkina Faso changes in livestock holdings and within-village risk sharing during drought periods from 1981-1985 were not used to smooth consumption suggesting an intentional destabilization in</li> </ul>	<ul style="list-style-type: none"> <li>• In north-eastern Ethiopia, the 1999-2000 drought increased asset poor households from 60% in 1997 to 78% in 2003. As a consequence of this shock, 95% of asset destitute households in the study sample remained poor after 6 years.</li> <li>• Also in Ethiopia, after the 1984-1985 famine it took on average 10 years for asset poor households to recover their livestock holdings to pre-famine levels.</li> <li>• In Tanzania, a household with an average livestock holding allocates 20% less of its land to sweet potatoes (low drought-risk low return crop) than a household with no liquid assets (livestock). As a result, the crop portfolio of the wealthiest quintile yields 25% more per adult than that of the poorest quintile.</li> <li>• In Zimbabwe a growth model that accounts for risk and risk responses using 50 randomly drawn shocks one for each year has been calibrated. It has been found that exposure to risk reduces growth and capital stock is reduced by more than 40%. Two-thirds of this loss is due to ex-ante strategies by which households try to minimize the impact of risk (build up of livestock holdings to cope with consumption risk).</li> </ul>

<sup>5</sup> Fuente, A. d. I. & Dercon, S. (2008) *Disasters, Growth and Poverty in Africa: Revisiting the Microeconomic Evidence*. Background paper for the 2009 Global Assessment Report.

	consumption to conserve livestock through the drought period.	<ul style="list-style-type: none"> <li>In Ethiopia, a study on the impact of village-level rainfall during 1994-1999 on consumption outcomes found that the adoption and use of fertiliser was significantly lower for those with higher consumption risk due to drought. Moving households up in the consumption distribution at the 10th%ile by one standard deviation would result in 44% more intake of fertiliser.</li> </ul>
<b>Education</b>	<ul style="list-style-type: none"> <li>In Cote d' Ivoire school enrolment rates declined by 14% and 11% among boys and girls (respectively) in areas that experienced excessive rainfall in 1986-1987. Overall school enrolment rates declined 20% in the shock regions relative to the non-shock regions.</li> </ul>	<ul style="list-style-type: none"> <li>In Zimbabwe children affected by the 1982-1984 droughts showed delays in school enrolment of 3.7 months and reduction in grade completion of 0.4 grades, 13-16 years after the shock, this could imply 14% loss of their lifetime earnings.</li> </ul>
<b>Health</b>	<ul style="list-style-type: none"> <li>Children aged between 6-24 months lost about 0.9 cm growth over a six month interval (1995-1996) compared to those residing in communities where drought-damaged crop area was 50% lower.</li> <li>In Zimbabwe preservation of physical assets during the 1994-1995 drought appeared to cause women's body mass to fall by about 3%, although they appeared to recover quite quickly after the shock.</li> <li>For Cote d' Ivoire the percentage of sick children taken for consultation after a rainfall shock in 1986-1987 declined by around one third for those who received the negative shock and increased slightly for boys in regions with normal rainfall.</li> </ul>	<ul style="list-style-type: none"> <li>In Ethiopia children in utero or less than 36 months of age at the time of the 1984 famine and living in a drought shock village were significantly shorter (almost 3 cm) ten years after the shock than their counterparts.</li> <li>In Zimbabwe children (12-24 months of age) affected by the droughts in 1982-1984 experienced a loss of stature of 2.3 cm in late adolescence.</li> <li>In Zimbabwe the 1994-1995 drought lowered annual height growth rates in children between 12-24 months by 15-20% (1.73 cm) relative to control group.</li> <li>For the same country and shock the drought shock had permanent consequences for children aged 12-24 months. 4 years after the climatic shock children remained shorter than their counterparts who did not experience the drought. The impact was greater for children living in households with holdings of livestock below the median (poorer households).</li> </ul>

## **Note 2.4: Case Studies: Urbanisation, Environmental change and territorial occupation**

### **Urbanisation, environmental change and territorial occupation**

It is likely, therefore, that improved disaster reporting and climate variability and change, are partly responsible for the increase in the number of weather related extensive loss reports in general and flood and rain related reports in particular, though it is impossible to estimate by how much and in which regions.

They are insufficient, however, to explain the geographic expansion of extensive risk, described above. Aggregate national statistics on variables such as deforestation and urban growth similarly provide little insight. Continuing with the example of Costa Rica, for example, forest cover has increased, due to environmental protection policies and the application of a system of payment for ecosystem services, in the same period that the dramatic increase in flood and rain loss reports has occurred.

In contrast, case study evidence, from Latin America, Asia and Africa does demonstrate how drivers such as urbanisation, environmental change and territorial occupation are fundamentally shaping the geography and trends of extensive risk in both regions.

### ***Latin America***

In Latin America, more than 80% of the total population is now “urban” although definitions of what constitutes urban and rural vary from country to country. Case studies from the region indicate two different but complementary processes of expansion of extensive risk.

#### **Urban growth in metropolitan areas**

Case studies from Buenos Aires, Argentina, Cali, Colombia, Mexico City and Costa Rica indicate how extensive risk is generated through processes of urban expansion. Extensive flood risk is closely linked to the increased run-off caused by new urban development, a chronic underinvestment in city-wide pluvial drainage, the location of informal settlements and social housing projects in low-lying flood prone areas and inadequate water management in the surrounding watersheds. In other words, the urbanisation process not only leads to increasing exposure of vulnerable people and assets in hazard prone areas but is also responsible for magnifying hazards themselves, particularly floods.

In a different study in the metropolitan area of San Salvador, for example both frequent loss reports and high levels of housing damage and destruction were found to be closely correlated with urban growth. The municipalities with recurrent extensive loss reports were those with the most rapid urban growth,<sup>6</sup> in some cases up to 16% per year.

At the same time, the cases illustrate how extensive risk in cities is reduced over time through investment in public infrastructure as urban areas are consolidated. In some cities, this means that extensive risk patterns expands concentrically from the centre towards the periphery of the city following the logic of informal settlement, while at the same time being progressively reducing in the centre. In other cases extensive risk is concentrated in pockets of land ignored by formal urbanisation, for example in ravines or river banks.

#### **Floods in Mexico city**

The area now occupied by Mexico’s mega-capital was originally a series of lakes in a large basin surrounded by high mountains. Tenochtitlan, capital of the Aztecs, was founded on an island in these lakes and after the Spanish conquest became the capital of Nueva Espana and later Mexico City. Given the geography and hydrology of the basin floods occurred both in the pre-hispanic period and with increasing intensity in the colonial period. One flood between 1629 and 1635 may have caused 30,000 deaths. The problem was addressed by the government of Porfirio Diaz which drained the basin through the construction of a 50km long canal and a tunnel through the

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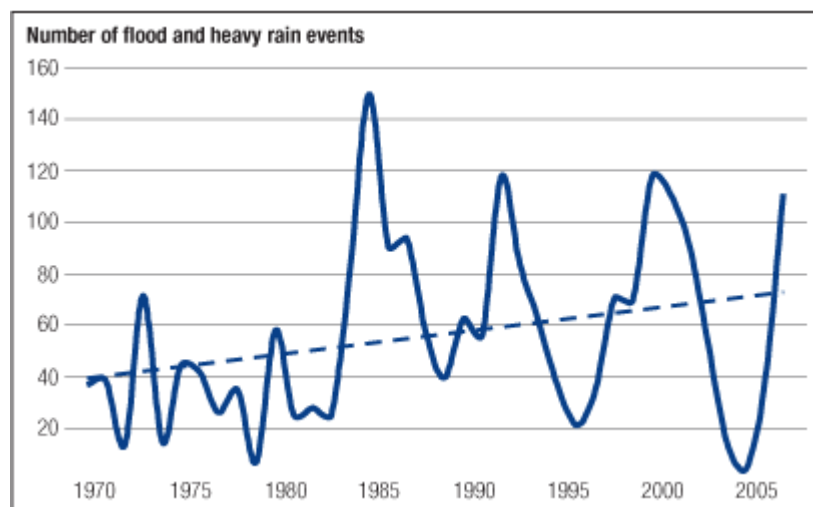
<sup>6</sup> Mansilla, 2008b

mountains of Tequiquiac allowing the waters of the basin to drain into the Gulf of Mexico. While this monumental example of civil engineering initially greatly reduced flooding, the exponential growth of the city and its subsidence due to the drainage and urbanisation of wetlands have progressively increased hazard levels and increased the frequency of urban flooding. Further engineering works, such as the construction of a deep drainage system between 1967 and 1975, have partially addressed the problem. However, the subsidence has reduced the gradient of the canal of Porfirio Diaz and even threatens to invert it, which would mean even more destructive floods in the future.

### Buenos Aires, Argentina

In Argentina, floods and rains account for approximately 45% of extensive weather-related loss reports. At the national level, unlike in other countries in the sample, the annual average number of loss reports is actually declining. However, no less than 32% of loss reports are from the Province of Buenos Aires or in the Federal Capital. In contrast to the country as a whole, the number of loss reports associated with extensive flood and rain risk in the urban area has increased between 1970 and 2007 as illustrated in the figure below. This increase is closely related with the increased run-off caused by the paving of the land area and the reduction in woodland and parks, as well as by under-investment in drainage. Whereas in the 1970s the average annual investment in urban infrastructure in Buenos Aires was US\$ 350 million per year, by 1989 this figure had fallen to US\$ 69.9 million. The city's drainage system was completed in 1953 for a calculated population of 800,000. The city proper of Buenos Aires had a population of 2,776,138 in 2001, while the Greater Buenos Aires area had a population of 11.4 million people. The greatest impact of the floods is in neighbourhoods such as La Boca and Barracas, which were traditionally inhabited by low-income groups.<sup>7</sup> The problem is now being addressed by a major World Bank programme, designed to increase the city's resilience to flooding, through the protection of its critical infrastructure and through the introduction of a risk management approach in government investment.<sup>8</sup>

**Extensive flood and rain loss reports in the province of Buenos Aires and the Federal Capital (1970-2007)**



<sup>7</sup> Herzer and Clichevsky, 2000

<sup>8</sup> The World Bank Urban Flood Prevention and Drainage Project, Phase 1 for the City of Buenos Aires:

<http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P088220>

## Costa Rica

In Costa Rica, floods, heavy rains and flash floods were associated with 63% of the extensive risk loss reports reported since 1996 and 83% of the housing damage. Since 1996, the number of loss reports has increased 10-fold, while the number of houses damaged has increased more than 3 -fold. In contrast, the number of deaths and destroyed houses has actually decreased, reflecting relatively efficient emergency management and an overall improvement in housing conditions, except in the case of informal *precario* settlements.

According to the Municipality of San Jose, more than 80% of the floods occurring in the country's capital are caused by either inadequate drainage to cope with the increased run-off caused by urban growth or by the accumulation of garbage and waste in drainage channels. Most housing damage is concentrated in *precarios* occupying marginal land adjacent to the streams and torrents that drain the city. Some cities such as Turrialba have historically prohibited construction within 15 metres of a river bank. This kind of urban zoning paradoxically guides formal urban development to safe areas, while leaving hazard prone areas for illegal or informal occupation by poor households.

According to the World Bank<sup>9</sup>, Costa Rica has one of the lowest poverty headcounts in Latin America. Using a US\$ 2 per day poverty line, Costa Rica has a headcount of only 9% compared to a regional average of 25%. Key socio-economic indicators are considerably better than the average in upper-middle-income countries. However, since the mid 1990s, while the country experienced relatively consistent economic growth, income inequality rose, per capita household income of the poor fell and the decline in poverty experienced in previous decades stagnated. In the same period, the number of poor people living in *precarios* has almost doubled to 8% of the population. This period coincides with the increase in flood events and damage to housing.

The rapid increase in the number of extensive flood loss reports in Costa Rica, therefore, would appear to be linked to urban growth, inadequate water management, a lack of investment in drainage and an increase in *precario* housing. The latter is a symptom of the lack of progress made in addressing poverty and inequality over the last decade.

## Cali, Colombia

In Cali floods related with the growth of informal settlements accounts for a large number of the extensive loss reports. The city of Cali reported 179 cases of flood loss between 1970 and 2007, representing 53% of all extensive weather-related loss reports and 96% of the housing damage. Between 1950 and 2000, manifestations of extensive risk associated with flood occurred in different areas of the city as informal settlements were created through land invasions by poor families and with inadequate drainage. In other areas of the city they gradually were reduced following public investment in drainage.

In the 1950s and 1960s flood losses were concentrated in informal settlements along the flood plains of the Cali and Cauca rivers, with inadequate or non-existent storm drains. In the 1970s, the focus of flood losses shifted to the right bank of the river Cali and the flood plain of the river Canavieles. The incapacity of the drainage system to deal with the increased run-off posed by urban growth was responsible for the flooding.

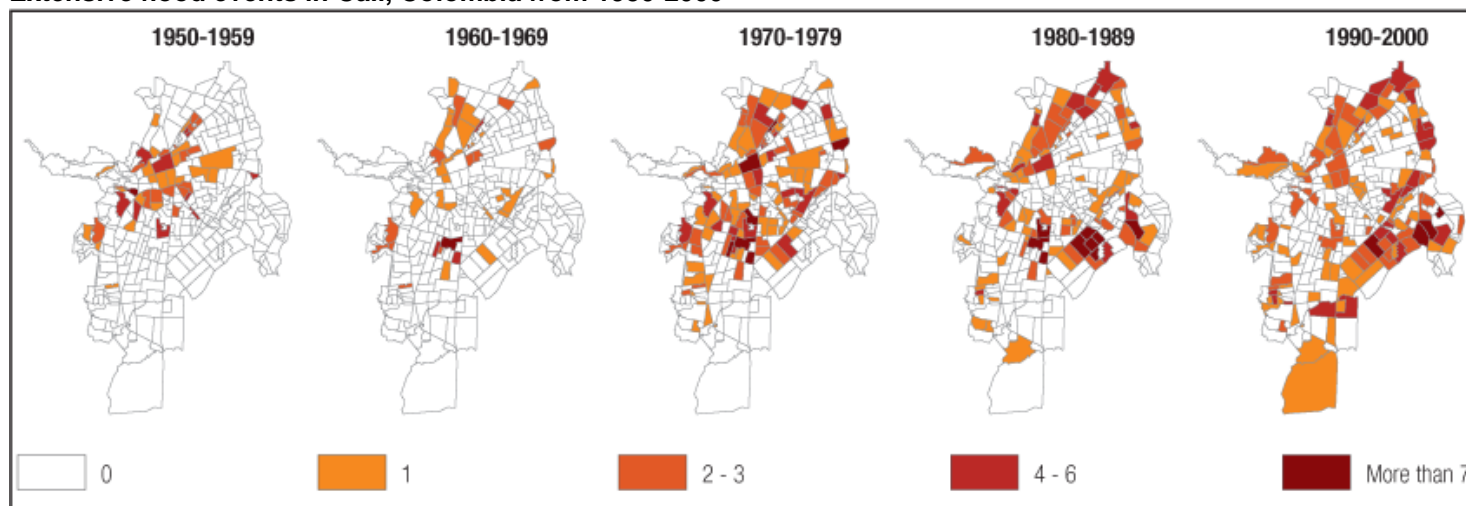
In the 1980s and 1990s, the focus of flood disasters shifted again to Aguablanca, an area which had been subject to major investments in hydraulic infrastructure to rehabilitate 640 hectares of land for agricultural use. In the 1980s this area was occupied by informal settlements and by social interest housing promoted by the city Government. 29 neighbourhoods and 24,000 houses sprung up on an area intended for agriculture and where the construction of drainage infrastructure was costly and difficult. The draining of lakes, intended to regulate flood waters, the levelling of dykes for urbanisation and the obstruction of natural drainage channels with garbage were additional causes of flooding in newly urbanised areas in the east of the city since the 1990s.

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<sup>9</sup> World Bank, 2007

The figure below shows how many areas experiencing flood loss in the 1950s no longer reported losses in the 1990s following investment in public infrastructure and urban consolidation.

#### Extensive flood events in Cali, Colombia from 1950-2000



#### Territorial occupation and environmental change

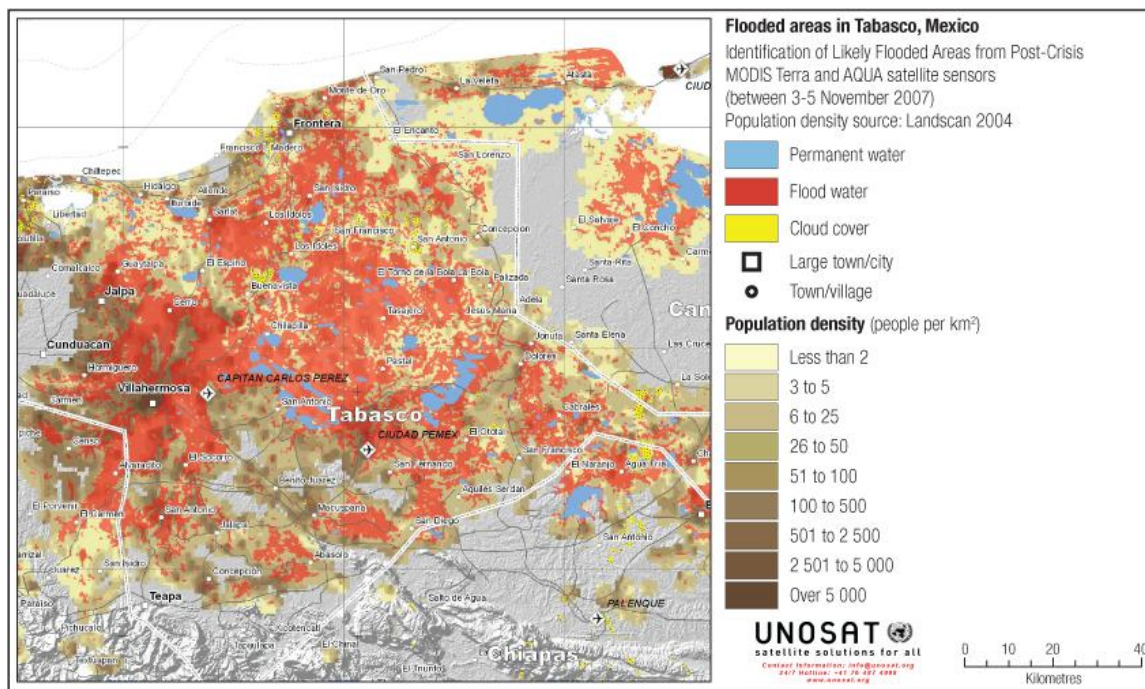
Case studies from Peru, Mexico and Ecuador, show how in parallel to mirroring the growth of large cities, extensive risk also expands concentrically in a country's territory, following the opening or improvement of roads, the opening of the agricultural frontier and the growth of small and medium urban centres. Increasing extensive risk associated with floods, for example, is often related to a combination of factors including a decline in the regulatory services provided by ecosystems, inadequate water management, land-use changes, rural-urban migration, unplanned urban growth which increases run-off, the expansion of informal settlements in low-lying areas and an under-investment in drainage infrastructure.

#### Flooding in Tabasco, Mexico<sup>10</sup>

In 2007, 62% of the area of the state of Tabasco in Mexico and 40% of the city of Villahermosa were affected by the most severe floods in the history of the state. At least 1.2 million people were affected, 168,000 houses damaged, 570,000 hectares of crops lost as well as major damages to infrastructure and the economy. The exceptionally high rainfall that contributed to the flooding meant that climate change and variability were invoked as the principal culprit of the disaster. In reality, the causes were a combination of inadequate water management in a very complex watershed that covers 89,000 km<sup>2</sup> and a process of urbanisation of low-lying areas without a corresponding investment in drainage. The canalisation of rivers in the upper basin, through a series of isolated and uncoordinated civil engineering works, has tended to increase flooding in urban areas built on the floodplains of the Grijalva and Carrizal Rivers further downstream. Four of the six most devastating floods that have occurred in Villahermosa in the last 95 years have occurred since 1980 (see **Error! Reference source not found.**).

#### Density of population in the inundation area of Tabasco, Mexico<sup>11</sup>

<sup>10</sup> Contribution from Elizabeth Mansilla



## Ecuador

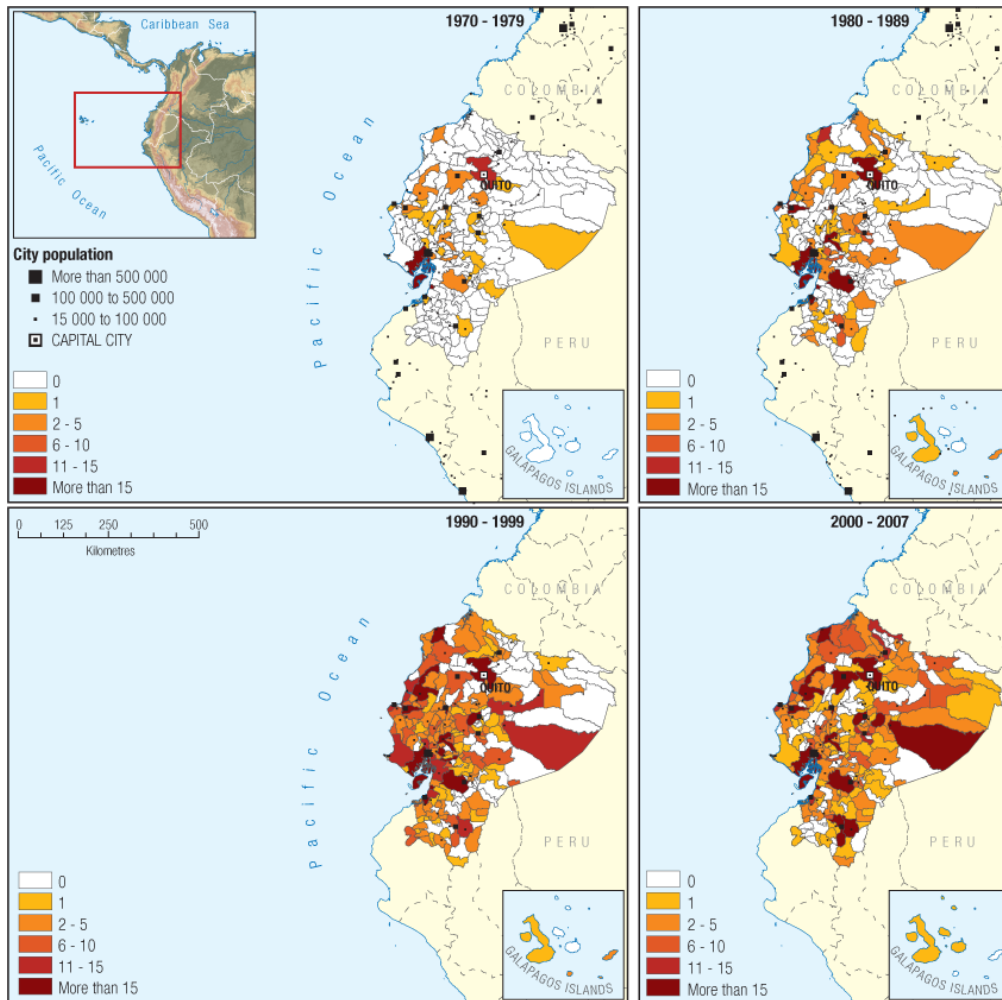
In Ecuador, 96.1% of the loss reports are extensive, accounting for 67.9% of the mortality, 75.6% of the destroyed housing and 90.3% of the damaged housing. Even the impacts of major climate events such as the 1997-1998 ENSO were extensive in Ecuador, given that they were spread over large areas of the country.

Extensive weather-related loss patterns are closely associated with the evolution of territorial occupation and urbanisation in the country. The figure below shows the spatial evolution of extensive weather-related disasters since 1970. In the 1970s, loss reports were concentrated in the metropolitan areas of Quito and Guayaquil. In successive decades, manifestations of extensive weather-related risk spread first along the country's Andean backbone, then into the tropical lowlands of the Pacific Coast and finally into the Amazon basin, closely reflecting the dynamics of territorial occupation in the country.

## Spatial evolution of extensive weather-related disasters in Ecuador from 1970-2007

<sup>11</sup> Contribution from the UN Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT)



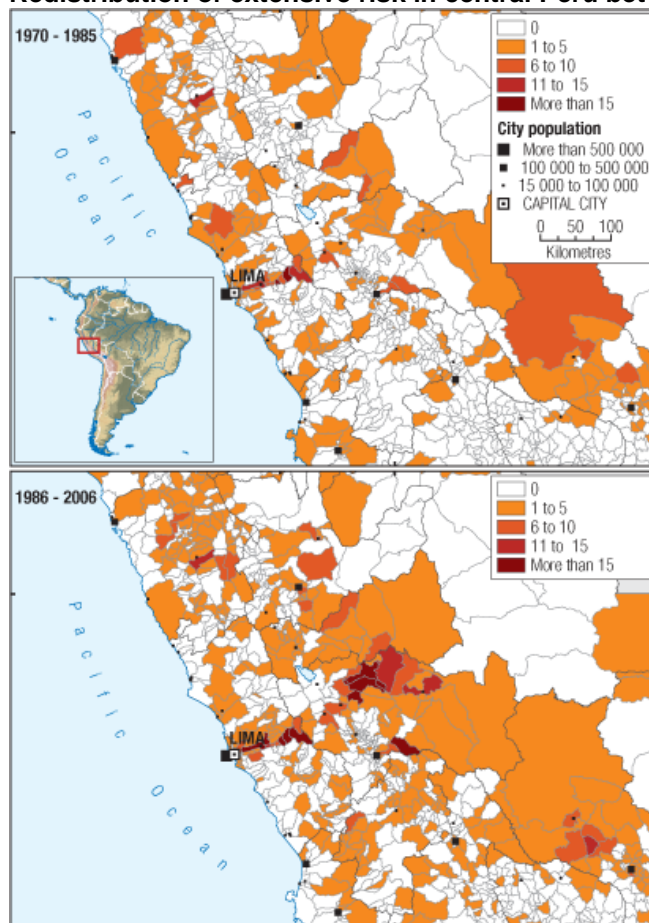


## Peru

Extensive weather-related risk in Peru is characterised by landslides and mudslides. Traditionally these hazards occurred in the coastal valleys on the Western slopes of the Andes. Over the last two decades there has been a drastic redistribution of hazard patterns as the opening of roads down the forested Eastern slopes of the Andes and into the Amazon basin led to the clearing of forest for agricultural purposes, including coca cultivation, and rapid urban growth. Given the topography and land cover of the area, this process of territorial occupation was accompanied by a rapid growth in the number of landslides and mudslides.

The figure below shows the redistribution of extensive loss reports associated with these hazards between 1970-1985 and 1986-2006. In the first period, the reports were concentrated in the coastal valleys, in the Andes and in the province of La Convention in Cuzco, an early area of territorial occupation in the Amazon. In the second period, concentrations of risk appear in the central jungle, along the upper Huallaga Valley and in the Northern Amazon, closely mirroring the process of territorial occupation.

#### Redistribution of extensive risk in central Peru between 1970-1985 and 1986-2006



#### An urban bias in disaster reporting?

Evidence from Peru and Colombia indicate that many more loss reports originate in major cities and from provincial capitals than from isolated rural areas.<sup>12</sup> This may reflect a bias in the reporting, given that losses occurring in centres of political administration are more likely to be reported than in remote rural areas. All the losses

<sup>12</sup> Glave, et al., 2009, Group of Analysis for Development (GRADE), 2008

reported from urban areas are documented and therefore did occur. While it is likely that many small scale losses in remote rural areas go unrecorded, it is unlikely that this includes nationally significant disasters. Therefore, while the bias certainly exists, it is unlikely to invalidate the two trends highlighted above.

## **Asia**

Interpreting the trend of expanding extensive risk in Asia poses a very different set of challenges. Firstly, the five databases from India (Orissa and Tamil Nadu), Iran, Nepal and Sri Lanka are not a representative sample of Asia as a region. They provide a North-south cross section of South Asia, and a glimpse of West Asia. East, South-East and central Asia are unrepresented. Fiji is considered in some of the analysis below, but again, only partially represents the nature of extensive risk impacts in the Pacific.

Secondly, the compilation of the disaster databases is far more recent than in Latin America. The Latin America databases were first compiled in 1995 and subsequently have been subject to numerous updates, revisions and analysis. The Asian databases in contrast were initiated between 2003 and 2006. Only Sri Lanka has published a summary of the disaster risk patterns and trends,<sup>13</sup> although a similar publication is underway in Tamil Nadu, India. Given that the databases themselves are so recent it is not surprising that an analysis of disaster data in Asian countries presently focuses on describing the main spatial patterns and temporal trends of the different risks and of hazards. To date, little research has been conducted on the role that underlying risk factors, such as urbanisation and rural livelihoods, play in explaining the risk trends and patterns manifest in the disaster databases. Given these limitations, our interpretation of the trends in extensive risk in Asia is less comprehensive and more incipient than in Latin America.

## **The rural-urban contrast**

Many cities in Asia are increasingly experiencing losses due to urban flooding. For example, there were 240 reports of flood loss in Colombo since 1974. Almost half these reports and about 80% of the associated housing damage has occurred since 2005. Chennai similarly experienced major flooding in 1990, 1994 and 1996 and Kathmandu in 2000 and 2002. Flooding in these, as in other cities across South Asia, would tend to suggest that in urban areas, rapid urban growth, the expansion of informal settlements, inadequate water management and an underinvestment in drainage are driving risk, in a way that is analogous to Latin America, although with very different characteristics.

In contrast to Latin America, however, all of the Asian countries, except for Iran, are still markedly rural. Iran had 66.9% urban population in 2005. In contrast, Nepal had 15.8%, Sri Lanka 15.1% and India 28.7% of their population classified as urban in 2005.

In Iran, flooding would appear to be mainly associated with torrential flash flooding as the snow melts in spring and due to seasonal heavy rains in a few river basins, particularly the Dugh River in Golestan Province in the north-east. In the other predominantly rural countries, however, flooding has a very different causality and manifestations. In Orissa, Tamil Nadu and Nepal, flood losses are associated with major concentrations of rural population living on the floodplains, near major river deltas and along coastal plains.

Environmental degradation, in particular declines in the regulatory services provided by forest ecosystems, may be contributing to increased flooding in some watersheds. In Nepal, increased flooding in the Terai region may be related to increased glacier melt in the Himalayas as well as to environmental changes in upland watersheds. In the two Indian states as well as in Sri Lanka and Nepal, housing damage in rural areas would seem to be closely associated with the high density of rural settlement in flood prone areas and the vulnerability of rural housing.

In contrast to Latin America, it is possible that disaster data has a rural bias, given likely deficiencies of loss reporting in urban informal settlements.

## **Sri Lanka**

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<sup>13</sup> United Nations Development Programme (UNDP) and Sri Lanka - Government, 2007, data sources: <http://www.recoverlanka.net/data/dataportal.html> and [www.desinventar.lk](http://www.desinventar.lk)

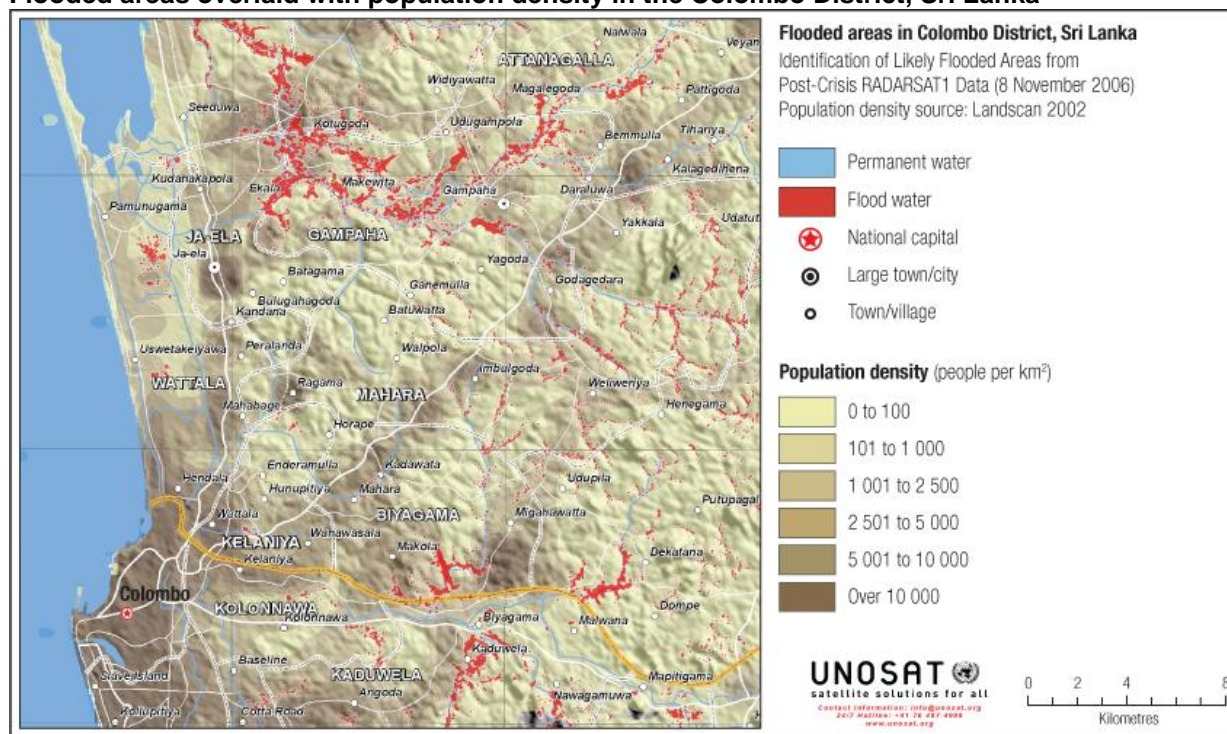
In Sri Lanka the number of houses damaged documented in extensive flood loss reports has approximately doubled since the early 1990s while the number of reports themselves has also increased.

Loss reports indicate two major concentrations of extensive flood risk in Sri Lanka. There is a major concentration of housing damage due to flooding in south-western Sri Lanka, which is relatively highly urbanised, with associated issues of inadequate drainage.

In Eastern Sri Lanka, there is another concentration of extensive flood risk primarily associated with monsoon rains in the low-lying flood plains in north-central and eastern Sri Lanka, for example around Polonnaruwa.

Flooding reported in early November 2006 in Colombo destroyed 221 houses, damaged 1,674 houses and affected 80,128 people. **Error! Reference source not found.** shows the distribution of flooded areas overlaid with population density. Floods were concentrated in urban areas indicating typical problems of settlements in low-lying areas and inadequate drainage.

#### Flooded areas overlaid with population density in the Colombo District, Sri Lanka<sup>14</sup>



<sup>14</sup> Contribution from the UN Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT)

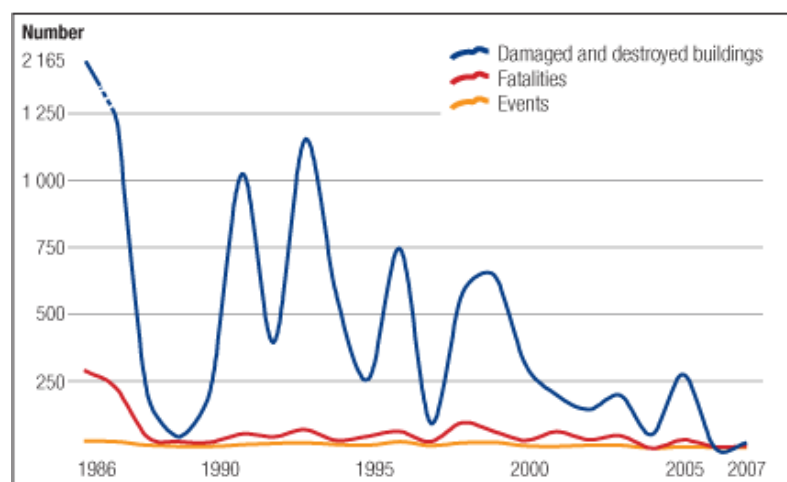
## Iran

The number of people killed and houses destroyed and damaged in manifestations of extensive flood risk in Iran is minimum compared to the losses in major earthquakes. Extensive risk flood mortality accounts for less than 2% of the total deaths over the reporting period. Nevertheless, there were a total of 2,481 extensive flood loss reports over the reporting period. Most of these reports were concentrated in a few peak years, for example 1982, 1987, 1993, 1995 and 1998, 2001 and 2007. Most flood events in Iran occur from March to May and are torrential floods related to winter snow melt.

Unlike other countries, the number of damaged houses is trending down which may indicate either decreasing exposure due to migration to cities or else improvements in housing, implementation of flood control measures and regulating land-use in flood plains. As in other countries, the number of areas affected by extensive flood disasters has increased over the reporting period. In general the geographic distribution of flooding is controlled by the countries topography and associated with the mountain ranges and fertile valleys in the East, North and South-West of the country.

### Annual Change in No Deaths and Building Damaged and Destroyed from extensive weather-related events in I.R. Iran, 1986-2007

Source: Forest, Rangeland and Water Shed Organization



## Orissa, India

Orissa is one of the least developed states of India with a per capita Net State Domestic Product about two thirds of the national average, and a low HDI placing it 11<sup>th</sup> out of the 15 major states of India<sup>15</sup> and a rural poverty head count ratio is still as high as 47%. The economy is primarily rural with 64% of the population working in the primary sector.

A large part of the mortality and housing damage reported in Orissa occurred in the 1999 super-cyclone and a large percentage of the housing destruction is associated with rural fires. Fire hazard has significantly reduced in recent years as the materials used in housing have changed.

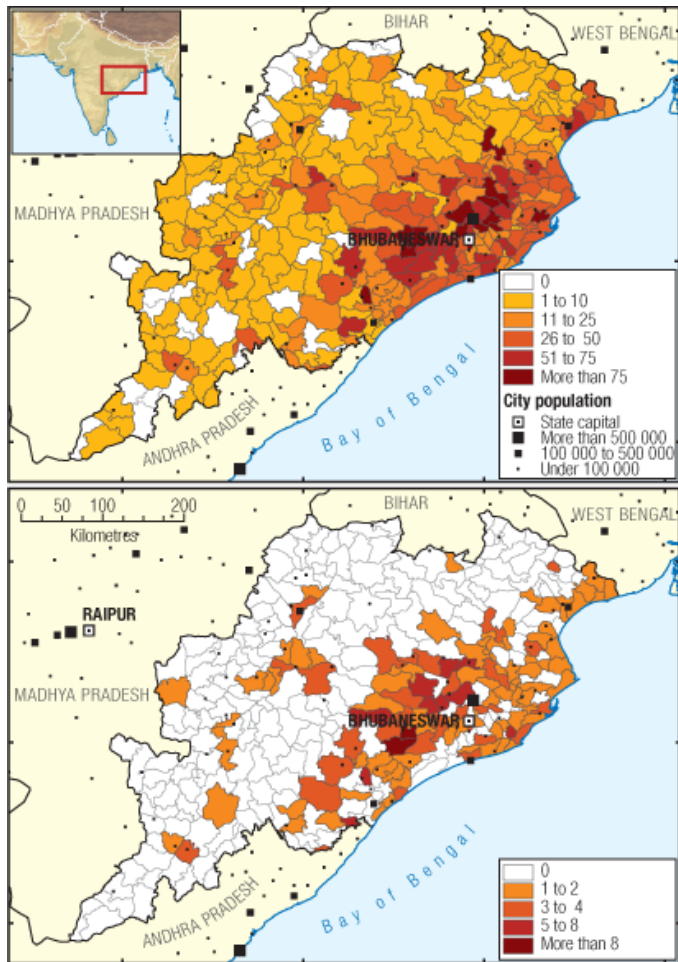
<sup>15</sup> The Orissa Human Development Report, UNDP 2004

Extensive riverine and coastal flooding are concentrated along the Eastern flood-plain, both in the Northern districts of Bhadrak, Kendrapara and Jajapur, which have low-incomes, low urbanisation and a high proportion of scheduled tribes as well as in more urbanised Districts to the south, in the floodplain and delta of the Mahanadi river. Factors which could be contributing to increased extensive flood and drought risk in Orissa include the lack of access to and control over land and common property resources like water, forest and common land, land degradation, the decline in regulatory ecosystem services provided by forests, and ineffective water management.

The geography of extensive flood losses has also changed over the years with increasing concentration in the coastal districts in the north, in many ways previewing the intensive losses associated by the 1999 in those areas. The distribution of mortality and affected people, however, highlights the extreme vulnerability of Southern Orissa. The Districts of Kalahandi, Bolangir and Koraput are characterised by repeated droughts, floods, extreme poverty, food insecurity and chronic income poverty and localised near famine conditions. While the distribution of extensive risk loss reports is skewed towards the central Eastern coastal region, the distribution of mortality is skewed towards the extremely poor rural Districts mentioned above. In other words, while flood incidence would seem to be associated with higher levels of urbanisation and with relatively affluent agricultural areas on floodplains and deltas, mortality is far higher in the poorest most food insecure inland areas. See the figures below.

**Extensive risk loss reports in Orissa, India (1970-2007)**

**Mortality in extensive risk loss reports in Orissa, India (1970-2007)**



### Tamil Nadu, India

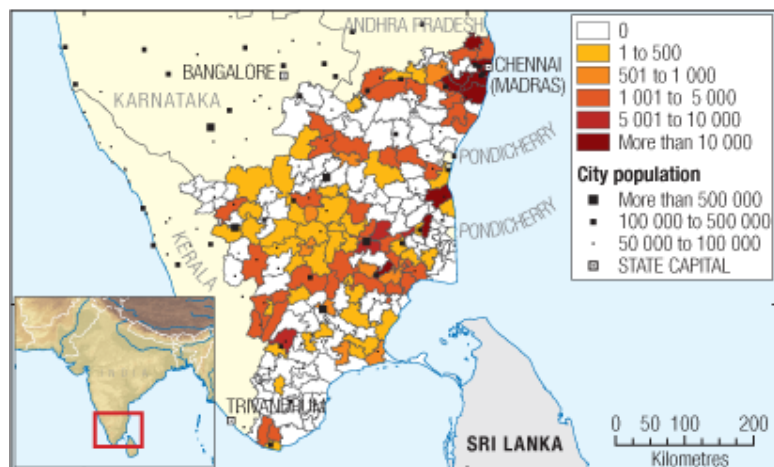
Tamil Nadu is India's most urbanised large state, with 44% of its population living in urban areas with a diversified economy. On the Human Development Index it is third among India's 15 largest states and has been successful in reducing poverty. The rural poverty head count ratio declined from 32-23 % between 1993 and 2004, while the urban head count ratio fell even faster, from 40-22%. However, the state has high differential vulnerability, with Scheduled Castes having twice the mean poverty head count in urban and 50% higher in rural areas.

Extensive risk is spread throughout the state, associated with droughts, floods, fires and epidemics. While most of the mortality was concentrated in the 2004 tsunami, a significant proportion of housing damage and destruction is a manifestation of extensive risk.



Extensive flood risk, as elsewhere in South Asia would seem to present two different patterns. As **Error! Reference source not found.** shows there is a concentration of extensive risk housing damage around urban centres in the North-East of the state. While poorly studied, flooding would seem to be associated with the high level of urbanisation, and associated problems of settlement of low-lying areas, increased run-off and inadequate drainage. In Chennai, for example, 18.9 % of the urban population was living in slums in 2001.<sup>16</sup> The other concentration of housing damage is along the floodplain of the Kaveri River, in the watershed of the Ponnaiyar River and in the Kambam Valley. Tamil Nadu has a long history of chain tank irrigation, which has fallen into disuse. Much flood damage in rural areas is associated with chain-tank failure and the silting of irrigation channels. In upland areas, increasing extensive flood risk may be associated with issues of environmental degradation.

#### Distribution of housing damage in extensive flood and heavy rain loss reports in Tamil Nadu, India (1970-2007)



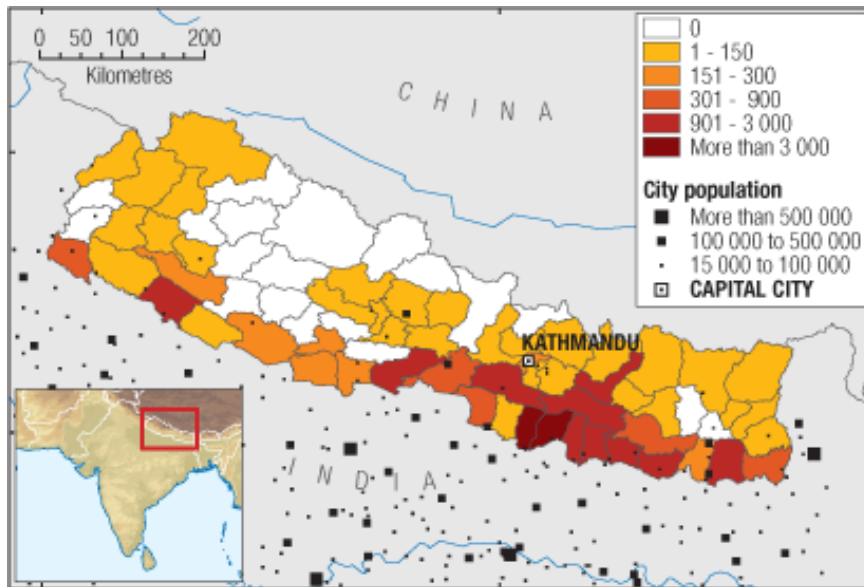
#### Nepal

In Nepal, extensive flood risk and associated housing damage is concentrated in the densely populated alluvial plains of south-eastern Nepal in the Terai region (**Error! Reference source not found.**). Floods in this case are not a consequence of urbanisation or population density, but a cause. The richness of the soils is due to the frequent replenishment of nutrients through flooding and the reason why the region can support such a large dense population. Other extensive risk manifestations, associated with landslides, are spread across the mountainous centre, North and West of the country and are responsible for more mortality than floods.

#### Housing damage by extensive flood events, Nepal

<sup>16</sup> Office of the Registrar General & census Commissioner, 2005





## Fiji

Fiji is regularly exposed to natural hazards. Between 1970 and 2007, 90% of reported disasters were weather-related, with a particular sharp increase in the number of floods, the remaining 10% were caused by earthquakes and tsunamis. The disasters caused an estimated damage of US\$ 532 million, a total of about 2 million people were directly affected and 419 lives were lost.

The Fiji Islands Bureau of Statistics stated in 2007, that 35% of the population were living below the poverty line. However, the analysis of data suggests a two way relationship between poverty and disaster: hazard impacts are actually worsening Fiji's current development levels leading to increasing poverty, which in turn is increasing vulnerability to hazards.

## Africa

Systematic historical disaster data is not readily available in countries across African countries. In South Africa, a detailed database has been developed and maintained in Cape Town<sup>17</sup> and a national database is currently being compiled in Mozambique. However, these are still exceptions in the region.

As such, it is not possible to explore extensive risk patterns and trends as in Latin America and Asia. Nevertheless, a series of case studies from sub Saharan African cities highlight most of the underlying drivers of extensive flood risk in Latin American and Asian cities, with manifestations that if anything are even more extreme.

<sup>17</sup> Disaster Mitigation for Sustainable Livelihoods Programme (DiMP), University of Cape Town, South Africa developed a disaster incident tracking system for Southern Africa (MANDISA)

Four types of flood have been identified in African cities: (1) localised flooding due to inadequate drainage (2) flooding from streams whose catchment is entirely within the urban areas (3) flooding from major rivers on whose banks the cities and towns are located and 4) coastal flooding from the sea or by a combination of high tides and river flows. According to Action Aid, the first two kinds of flood are most prevalent.

The underlying cause has been the gap between the very rapid growth in the population of many urban centres and the capacity of urban governments to cope. Although growth rates in many urban centres have declined, far too little attention has been given to needed measures to improve urban governance. Very poor conditions in many rural areas including the combined impacts of conflict, floods and drought have underpinned much rural to urban migration. Due to poor urban governance, most cities absorb growth through the expansion of informal settlements, which often occupy low-lying flood prone areas. 72% of Africa's urban population lives in informal settlements. Investment in drainage infrastructure is often non-existent while there is little or no maintenance of existing infrastructure.

#### **Flooding in African cities<sup>18</sup>**

##### **Kampala, Uganda**

Construction of unregulated settlements has reduced infiltration of rainfall and land cover change increasing runoff to six times that which would occur in natural terrain. It has been reported that after the 1960 floods a channel from Nsooba to Lubigi was dug and workers were employed to clean it regularly. There were no further flood problems until the 1980s but since then residents of that area had to re-build their houses after flooding up to six times. Some of this is because the main drainage channel, originally two metres deep, is now only 30 cm deep because of an accumulation of sediment and rubbish.

##### **Nairobi, Kenya**

Flooding is a major problem in all informal settlements in Nairobi. Houses are built of weak, inadequate building materials. Migration has led to more houses being built close to streams, with consequent greater disruption when floods occur. Many local residents link increased flooding to both local activities and climate change. Slum inhabitants agree that floods now occur in places where they did not two decades ago.

##### **Accra, Ghana**

Women in Alajo, Accra, observed that patterns of rain and flooding have become unpredictable since the 1980s. They noted that it used to rain heavily in June and July but since 2000, the heavy rains sometimes start earlier and in other years start only after July. Consequently, it is difficult for them to prepare for flooding in Alajo. Since, slum dwellers' livelihoods depend on activities such as small-scale commerce, petty trading and artisanal trades, which get disrupted by floods and merchandising in wooden kiosks do not withstand the force of the floods, people lose working time, economic opportunities and income. The immediate impact is the loss of livelihood support for food and bills, including children's education and health bills.

##### **Saint Louis, Senegal<sup>19</sup>**

The population of Saint Louis almost doubled from 115,000 to 200,000 between 1998 and 2002. Floods affect low-lying areas, without drainage, that have been settled by very poor rural migrants, fleeing the effects of rural drought. In order to protect against the flood waters, residents make barriers using household waste, but this increases the incidence of health hazards. Flood risk in Saint Louis is basically a problem of poor urban governance. Basic information on flood risk is not available and urban development and risk reduction policies or projects are both uncoordinated and not inclusive.

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<sup>18</sup> Action Aid International, 2006

<sup>19</sup> Diagne, 2007

