Global Assessment Report
on Disaster Risk Reduction

GAR 2011

Preliminary Extensive Risk Analysis for the Global Assessment Report on Disaster Risk Reduction GAR 2011

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ISDR

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Background

Research has conventionally expressed disaster risk as a probability of future loss due to three factors, Hazard (the probability of occurrence of a potentially damaging physical event such as a cyclone, earthquake or drought); Exposure (the population or assets – including human settlements, infrastructure, crops and livestock – exposed to the hazard) and Vulnerability (the susceptibility to loss, related to a range of physical, social, economic and other attributes of the exposed elements).

Given the interplay between these three elements, disaster risk is highly dynamic in terms of its spatial patterns and its temporal trends. The dynamics of territorial occupation and land use, urbanization, environmental change, poverty distributions, governance and development in general are manifested as changing patterns and trends of disaster risk.

The 2009 UN Global Assessment Report on Disaster Risk Reduction – GAR09 (UNISDR, 2009) explored these patterns and trends at two different scales.

At the global scale: a statistical regression model, calibrated with loss data from EMDAT, was used to identify the risk factors that best explained historical loss patterns associated with a range of hazards (tropical cyclones, floods, earthquakes and landslides) and with both mortality and economic loss. Vulnerability was represented by a number of social, economic and other proxies available in global databases.

At the national scale: In a set of 12 countries , an analysis of over 126,000 local level loss reports from national disaster databases allowed an initial exploration of how patterns and trends of disaster loss are evolving, within the countries concerned. With a far higher resolution than was possible in the global analysis, and to the extent that disaster loss represented manifest risk, this allowed the identification of risk dynamics operating inside the global risk patterns and trends.

The national scale analysis showed statistically significant increases over the last 30 years in:

- the number of disaster loss reports, particularly those associated with wet hazards (storms, floods, flash floods etc.)

- the number of local administrative areas (typically municipalities or equivalent) reporting disaster losses and
- the average physical damage reported by loss event.

Case study evidence inferred strong connections between these trends, underlying risk drivers such as urbanization, territorial occupation and environmental degradation and potentially climate change. However, it was not possible to provide conclusive evidence for these connections for a number of reasons:

Improved disaster reporting, particularly since the introduction of the internet, almost certainly contributes to the reported increase in the number of loss events, but it is difficult to quantify by how much.

- It was not possible in GAR09 to identify metrics that could reveal the contribution of urbanization and environmental degradation to the increases described, using quantitative methods
- Similarly, it was not possible to assess any possible influence of climate change
- In the context of the 2011 UN Global Assessment Report on Disaster Risk Reduction (GAR11), it is proposed to revisit and enhance this national scale analysis.

The first activity conducted in order to fill these gaps was to update and collected data from a wider geographical sample of countries. The data from the 12 countries documented in GAR09 was updated to December 2009. In addition new data became also from Chile, Panama, El Salvador, Guatemala, Indonesia, Mozambique, Jordan, Syria and Yemen. Data updating and collection was undertaken on behalf of UNISDR by partners that include the United Nations Development Programme (UNDP) in Asia, the Arab Academy of Science, Technology and Maritime Transport in North Africa and the Middle East and the Seismological Observatory of the South-west (Corporacion OSSO) in Latin America.

Secondly, a set of rigorous quantitative analysis was carried out to further explore the trends identified in GAR09. These set of analysis included:

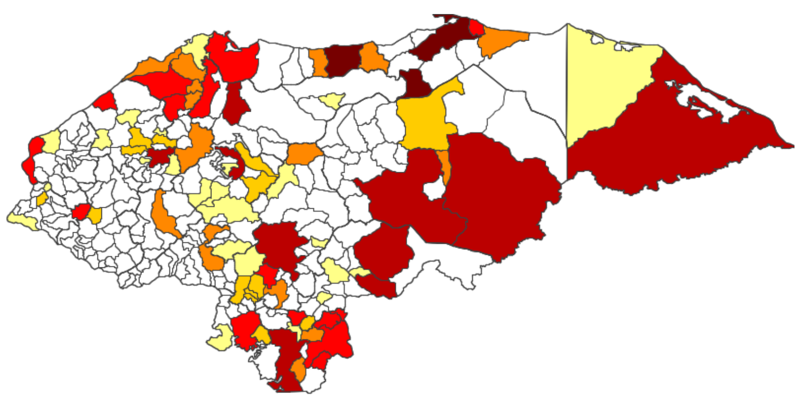
a) Revisiting and refining the statistical methods used in GAR09 to identify outlier events; the results of these exercises is documented separately (OSSO 2010, Freire 2010)
b) Conducting the same set of analysis that made the foundation of the Extensive Risk analysis in GAR 09, in order to determine their validity with a sample twice as large.
c) Normalizing the loss data to take into account increases in population and economic activity and applying the same analytical tools to verify if conclusions obtained by GAR 2009, and the traditional extensive risk analysis conducted in point b) still stand.
d) Conducting statistical tests to identify the influence of factors such as improved disaster reporting in the patterns and trends
e) Exploring correlations with other spatially referenced datasets to investigate the relationships with urbanization and ecosystems degradation.

This paper documents the internal GAR team efforts in points a) to e), which in conjunction with CorpoOSSO and Freire's Threshold analysis and several other related documents support the findings exposed in Chapter 2 of GAR 11.

General description of Data and method

The national disaster databases used in this analysis are compiled using the *DesInventar* methodology, which has been applied by governments, research institutes, universities and NGOs in approximately 30 countries worldwide. *DesInventar* differs significantly from other disaster databases, such as EM DAT both in its conception and methodology:

In EM DAT loss reports are organized by hazard events (a hurricane or earthquake, for example) and all the loss data collected (mortality, injuries etc.) is attributed to the event. In *DesInventar* loss data are considered as attributes of the risk patterns in a given local administrative area, typically a municipality or similar. The database structures of EM DAT and *DesInventar*, therefore, reflect different conceptions of disaster and risk. The structure of *DesInventar* is based on the concept that local areas manifest completely different risk patterns and processes. Disaster losses are a manifestation of those processes. For example, Hurricane Mitch, in Honduras, would appear as one loss report in EM DAT. In contrast, in *DesInventar* it appears as multiple local loss reports, associated with the hurricane but reflecting completely different local level risk manifestations. The map below shows deaths associated with Hurricane Mitch in Honduras. While the hurricane as a physical event affected most of the country, deaths were highly concentrated in only a few municipalities. Contrary to the conventional wisdom that Hurricane Mitch had devastated the entire country, most municipalities actually reported no mortality.



Deaths by municipality, Hurricane Mitch, Honduras, 1998

EM DAT uses a threshold to include hazard events and their loss attributes in the database (10 killed, 100 affected, call for international assistance). *DesInventar*, has no threshold and considers that all losses attributable to geological or hydro-meteorological hazards, are manifestations of risk and thus should be documented. As such, *DesInventar* documents tens of thousands of loss reports from highly localized hazard events, not included in international disaster databases.

In *DesInventar* data is collected by national institutions from national and local sources. However, the use of common definitions and methods (for hazards and loss attributes) means that the data is presented in a homogeneous and comparable format. Given, the heterogeneity of local data sources, no guarantee can be given of the accuracy of each individual loss report. Nevertheless, as far as possible data is checked by local experts to eliminate inconsistencies and at the global level, further quality control is carried out.

Most *DesInventar* databases have data collected over a 30 – 40 year period. However, data reports represent realized risk associated with hazard events of different return periods. While most local hazard events are frequently occurring, major concentrations of mortality and destruction are associated with extreme hazard events with long return periods (for example, the 2004 Indian Ocean tsunami or the 1985 Armero volcanic eruption in Colombia). The loss reports associated with extreme long-return period events appear as outliers in the distribution of losses in the data universe as a whole. In order to identify trends and patterns in the disaster risk manifested over a relatively short historical period (30 – 40 years) it is necessary to filter these outliers from the database.

In GAR09, after a consideration of different options, a simple statistical procedure was employed using fatality class intervals, calculating the smallest number of loss reports that concentrated the maximum number of deaths and destroyed houses (used as a proxy for direct economic loss). These loss reports were considered to be manifestations of intensive risk (outliers associated with extreme hazards with long return periods) and were filtered from the dataset. The remaining loss reports, were considered to be manifestations of extensive risk (associated mainly with frequently occurring hazard events).

GAR 11 Extensive/Intensive Thresholds

For GAR 11, two new statistically stronger approaches were taken by two independent groups of researchers, who defined the new thresholds that separate the universe of Extensive Risk reports and the Intensive Risk set. This threshold, as documented in the above referenced papers and in Appendix II of GAR 11 are as follows:

Mortality threshold:	**30 people killed**
Houses Destroyed threshold	**600 houses destroyed.**

Under this criteria, any record of damages in the DesInventar databases that includes 30 or more people killed **OR** 600 or more houses destroyed is considered Intensive Risk.

Analysis of trends and patterns of Extensive Risk in the GAR SAMPLE

The analysis of disaster loss datasets gathered for this report has confirmed that Extensive risk disasters continue to increment in frequency, mortality and economic assets destruction. Furthermore, data provide evidence that this trend applies to both developing and industrialized countries, and that the contribution of extensive risk to the overall economic losses may be larger than initially thought.

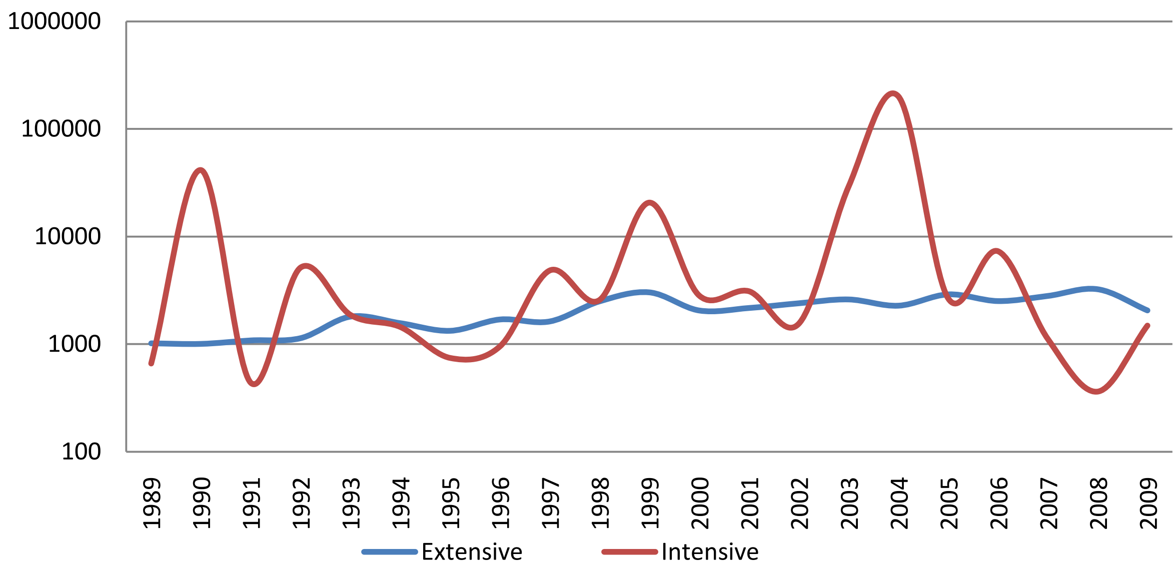


Figure 1. **Extensive and Intensive Risk mortality - 1989-2009, 21 datasets (logarithmic scale)**

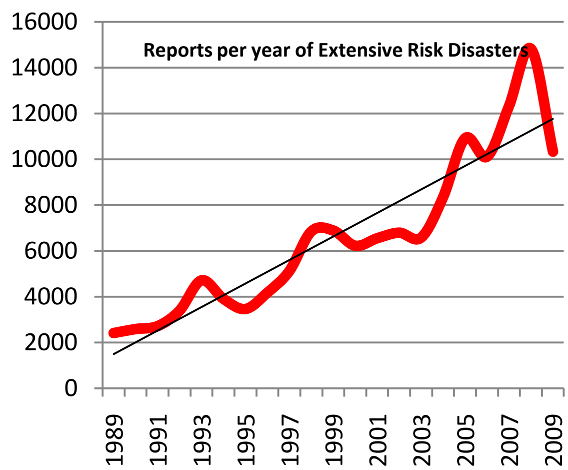


Figure 2. Number of Extensive Risk reports

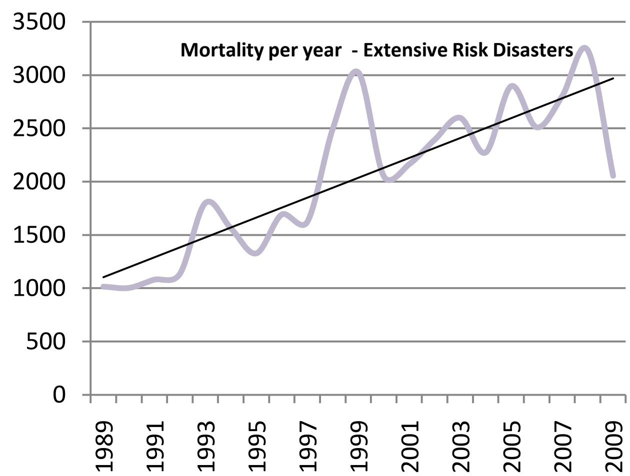


Figure 3. Extensive mortality - 1989-2009 (linear)

As mentioned in GAR09, most major mortality and economic loss is concentrated in a few *intensive* disasters, usually associated with low-frequency, high –severity risks. GAR09, however, also revealed an often invisible facet of disaster risk. Most damage to housing, infrastructure and livelihoods, particularly those affecting poorer households, is spread out amongst tens of thousands of high-frequency, low-severity disasters, *extensively* distributed in time and space. These damages are rarely taken into account in global disaster statistics or in the design of disaster risk management and reduction mechanisms.

Year 2009 was a 'mild' year in terms of disasters: for the first time in a decade no mega-catastrophes occurred in the world. Probably the largest of 2009's disasters was the Earthquake in Sumatra, Indonesia, with as death toll of 1,197 casualties as reported by the Government through the DIBI (Disaster Data Information System of Indonesia). Year 2009 total disaster impact, including extensive risk, was lower than in 2008 and previous years as reported by most of the 21 countries for which data was analyzed, including the United States. This fact was also globally confirmed by CRED using its disaster database EMDAT, where the number of events reported was lower than in 2008 and the mortality about 10% of the previous 9 years average.

However, this one year decline should be taken only as a manifestation of the randomness of the hazards, and not as a definite trend: year 2010 disasters in Haiti, Indonesia and other parts of the world have raised the numbers again to dramatic levels.

The trends from the sample of LAC/Asia/Africa countries show that **all** absolute, relative, extensive and overall mortality rates are going up in the aggregated 21 countries of the sample. However, absolute and relative mortality are decreasing in the USA.

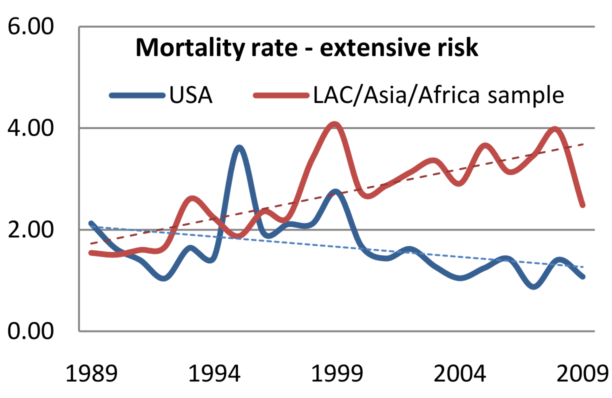


Figure 4 Comparison Extensive Mortality USA-GAR11
(Source: Serje 2010, Sheldus)

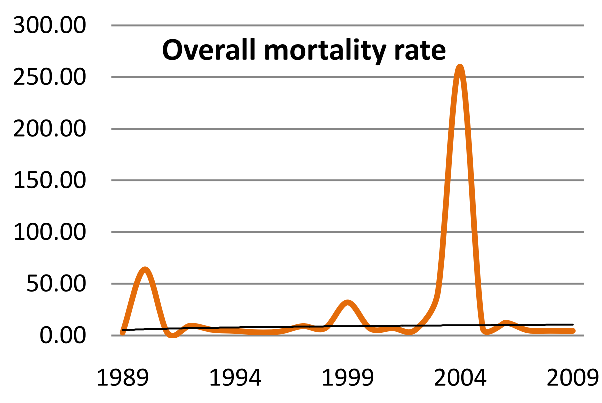


Figure 5 Absolute total mortality trend in 21 datasets

Extensive Risk analysis: Data and Method

The evidence presented in this Report has been culled from national disaster databases and case studies from 20 Asian, African and Latin American countries, 9 more than the past version of the GAR, with all datasets updated to end 2009, and data from new countries in other regions, Indonesia, Jordan, Syria and Yemen in Asia, Mozambique in Africa, and El Salvador, Guatemala, Chile and Panama in Latin America, providing 195,558 disaster reports for the analysis spanning a period of 40 years, covering more than 842 million people.

These 21 disaster datasets were all collected following the same methodology and indicators, allowing for comparison between countries and continents. Indicators of impact collected on these databases range from human losses, such as fatalities and injured, to a larger set of indicators about specific asset destruction and damage on houses, crops, livestock, schools or hospitals.

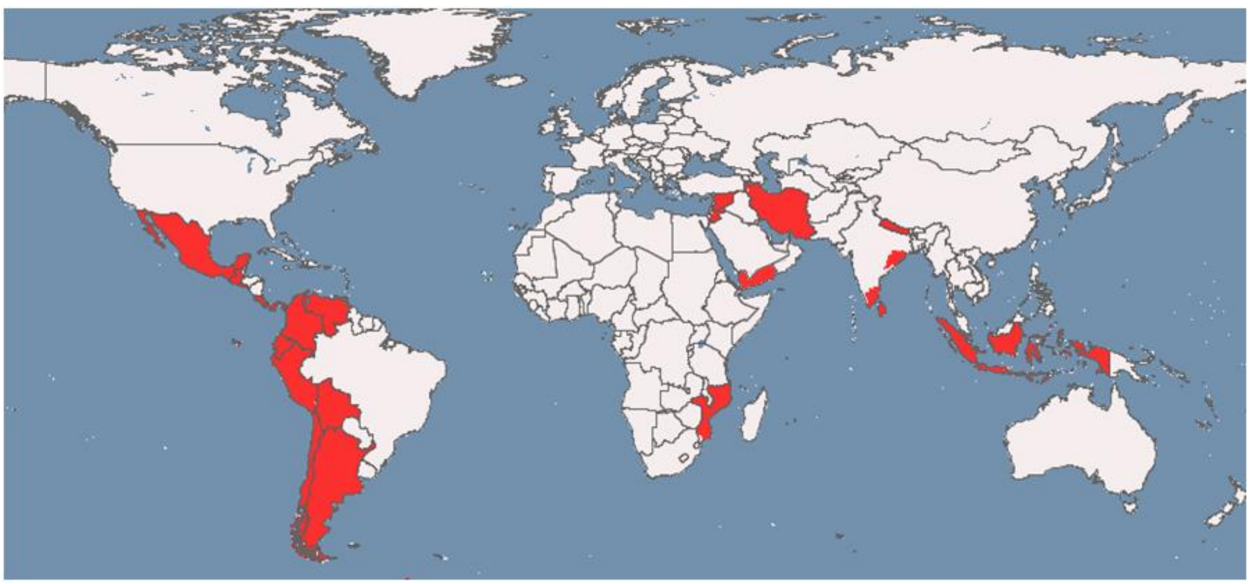


Fig.2. Coverage of GAR 2011 sample (in red)

The spatial units of analysis to which these data are attached are local government areas or second or third tier administrative units that can be assimilated to Municipalities, according to the political-administrative division of each country. These areas are highly heterogeneous both within and between countries, ranging from densely populated urban municipalities, where populations of several hundred thousand may be concentrated in a small area, to sparsely populated rural districts, where a much smaller population is spread over several thousand square kilometers. However, these spatial units are not arbitrarily defined. They reflect the way territory is organized and managed politically and administratively in each country.

In addition to these datasets and for the United Sates case study and analysis feeding this report, another very large set of disaster data was obtained from the SHELDUS database which contains more than 640,000 reports of disasters for the period 1960 -2009.

Given the indicators present on SHELDUS database are not the same as in the rest of the countries, except for fatalities and injuries, separate analysis were conducted on both datasets. A complete contributing paper is devoted to the analysis on the SHELDUS database.

One of the most important conclusions of the two stream of analysis is that mortality trends and patterns are very different in an industrialized economy like the US and poorer, developing countries undoubtedly as a reflection of a much lower vulnerability. However, the analysis on the impact of disasters reveals that economic damage and frequency of disasters seem to behave in similar fashion on all countries studied, independently of their economic and development status.

Country	Reports	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Affected	Population 2009	From year
Argentina	16,211	3,377	22,470	810	53,973	141,381	23,271,305	40,164,561	1970
Bolivia	2,655	1,190	1,133	254	6,249	8,200	832,980	10,187,067	1970
Chile	10,892	3,184	6,811	640	101,877	278,087	8,052,236	16,983,720	1970
Colombia	24,554	35,898	26,447	2812	183,106	681,404	22,688,062	45,103,268	1970
Costa Rica	11,076	516	51	62	8,796	50,800	32,405	4,509,290	1970
Ecuador	4,783	3,019	2,535	1228	12,074	58,785	1,293,799	14,032,233	1970
Guatemala	4,285	1,953	2,789	1113	20,941	105,985	3,339,301	14,009,133	1989
Indonesia	7,098	191,101	317,569	17059	1,078,498	1,113,316	17,808,509	231,298,009	1972
Iran	2,460	137,381	71,145	2501	138,072	325,186	2,684,134	73,736,600	1970
Jordan	444	140	2,181	34	83	582	331,022	6,318,200	1982
Mexico	22,054	31,442	2,882,359	9273	432,812	2,781,635	59,882,327	106,116,969	1970
Mozambique	3,907	106,741	1677	1037	899,442	194,810	42,044,552	21,891,905	1979
Nepal	13,512	11,541	12,446	2689	216,627	159,269	4,666,973	28,294,580	1971
Orissa	9,618	34,787	13,370	1205	1,729,236	3217,877	103,053,490	39,906,920	1970
Panama	3,002	339	1292	39	13,534	70,678	345,782	3,304,461	1989
Peru	15,268	40,994	65,675	9136	438,376	398,237	2,218,035	29,330,481	1988
Salvador	3,366	4,541	15,087	535	180,277	202,701	343,817	7,124,374	1970
Sri Lanka	13,326	33,553	21,645	1983	133,416	345,935	26,632,693	20,476,600	1974
Syria	7,326	679	1,312	0	468	1,311	809,681	20,463,800	1980
Tamil Nadu	13,800	5,610	4,819	3105	272,657	991,548	5,753,375	65,597,936	1976
Venezuela	4,449	3,015	379	1059	56,285	158,288	2,932,101	28,143,584	1970
Yemen	1,472	2,797	1,785,659	287	21,697	36,542	27,044	23,580,000	1989
TOTAL	**195,558**	**653,798**	**5,258,851**	**56,861**	**5,998,496**	**11,322,557**	**329,043,623**	**850,573,691**	**1989**

Table A-1 GAR 2011 disaster loss data universe: 20 datasets from 21 countries/states, all updated and reviewed up to 2009.

Global trends and numbers

The global patterns already identified in GAR 2009 still stand the new and wider sample.

As per its definition, the contribution of extensive to overall mortality is pale compared with the effects of catastrophic events that continue to impact high risk countries.

Risk Type	Hazard type	Reports	%	Deaths	%	Houses Destroyed	%	Houses Damaged	%
Extensive	Weather-related	137914	96.4%	42335	11.3%	729718	15.7%	4816806	53.0%
Extensive	Geological	3896	2.7%	1597	0.4%	82504	1.8%	324013	3.6%
Intensive	Weather-related	912	0.6%	43038	11.4%	2552562	54.7%	2709715	29.8%
Intensive	Geological	325	0.2%	289071	76.9%	1297570	27.8%	1242767	13.7%
TOTAL		143047	100.0%	376041	100.0%	4662354	100.0%	9093301	100.0%

The proportions stated for both types of risk and types of events remain roughly the same: a very small number of reports (0.8%) concentrate the vast majority of fatalities (88.3%).

The addition to the sample of two most high risk countries of the world, Indonesia and Mozambique introduced important changes to the figures and made more dramatic the gap between intensive and extensive risk. Just two disasters in these countries (2004 tsunami in Indonesia and 1982-85 droughts in Mozambique) almost duplicate the intensive risk figures obtained in the original 12 countries sample. Another important difference is that the drought fatalities in Mozambique increase the contribution of weather related intensive risk associated disasters in almost 10%. This distribution probably reflects better the actual global numbers, with geological origin disasters such as Haiti earthquake and weather related mega catastrophes such as Myanmar cyclone or the droughts in Africa.

As it be shown later, this distribution obtained in 20 developing countries in three continents, is dramatically different from the one in the United States, where proportions are the opposite: only 11.77% of fatalities can be associated with intensive risk events and 88.19% of fatalities can be associated with extensive risk events.

USA From Sheldus database					
Risk Type	**Hazard type**	**Reports**	**%**	**Deaths**	**%**
Extensive	Weather-related	598424	99.60	23710	**88.02**
Extensive	Geological	201	0.03	45	0.17
Intensive	Weather-related	2189	0.36	2820	**10.47**
Intensive	Geological	36	0.01	361	**1.34**
TOTAL		**600850**	**100.00**	**26936**	**100.00**

However there are a few numbers that remained fixed with the addition of these new countries to the sample: the number of houses destroyed and damaged, with the proportions of damages to housing almost identical in the two samples, 51% extensive and 49% intensive risk.

Another number that remained stable over different samples was the proportion of units on which manifestations of extensive/intensive risk were observed: 88% of the 7813 administrative units one or more reports. Is interesting to note the in the US this number is 99%.

Patterns of occurrence over space and trends over time remain also valid for this larger sample. As shown in Figure 2.3.1 and 2.3.2, trends for frequency of reports and mortality for extensive risk show the same increasing trend as observed in GAR09 sample.

The trends identified suggested that these increases in the manifestations of *extensive* risk identified in the *here and now* prefigure new concentrations of *intensive risk, especially for weather related hazards*.

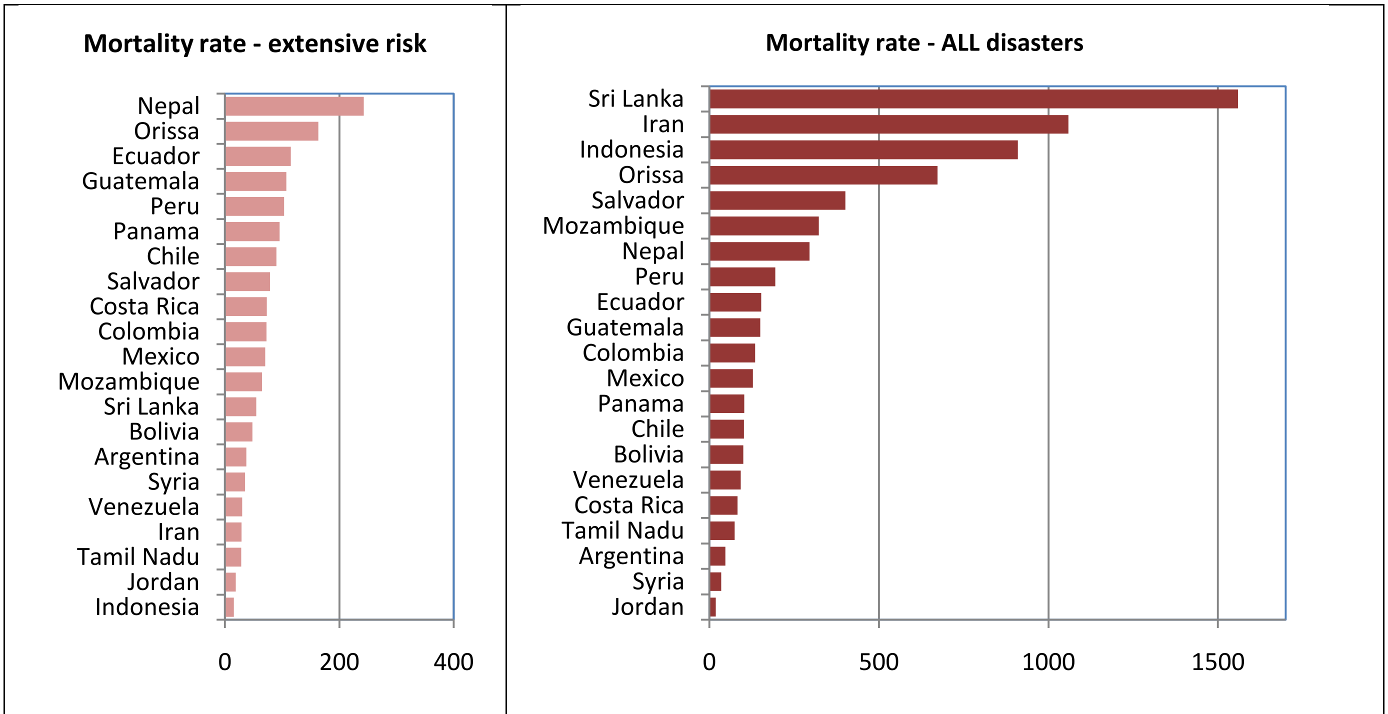
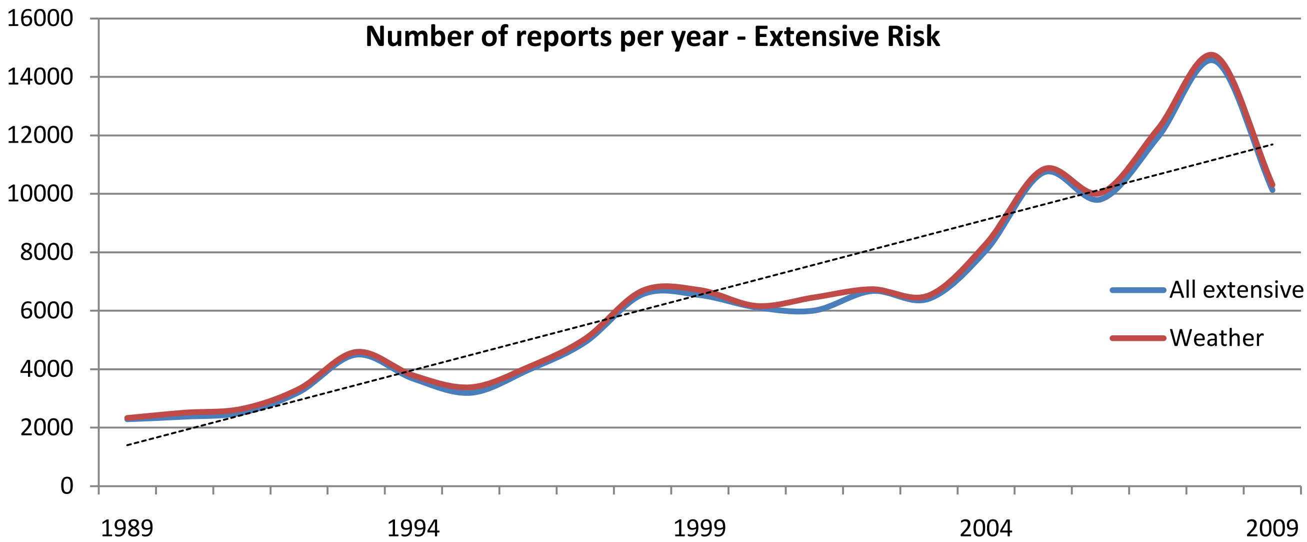


Fig. XX. Mortality rate for all disasters compared to mortality rate due to extensive risk. Note that some of the countries with highest risk have a lower relative extensive mortality rate, such as Iran, Indonesia and Sri Lanka. In these countries mortality is extremely concentrated in intensive risk disasters.

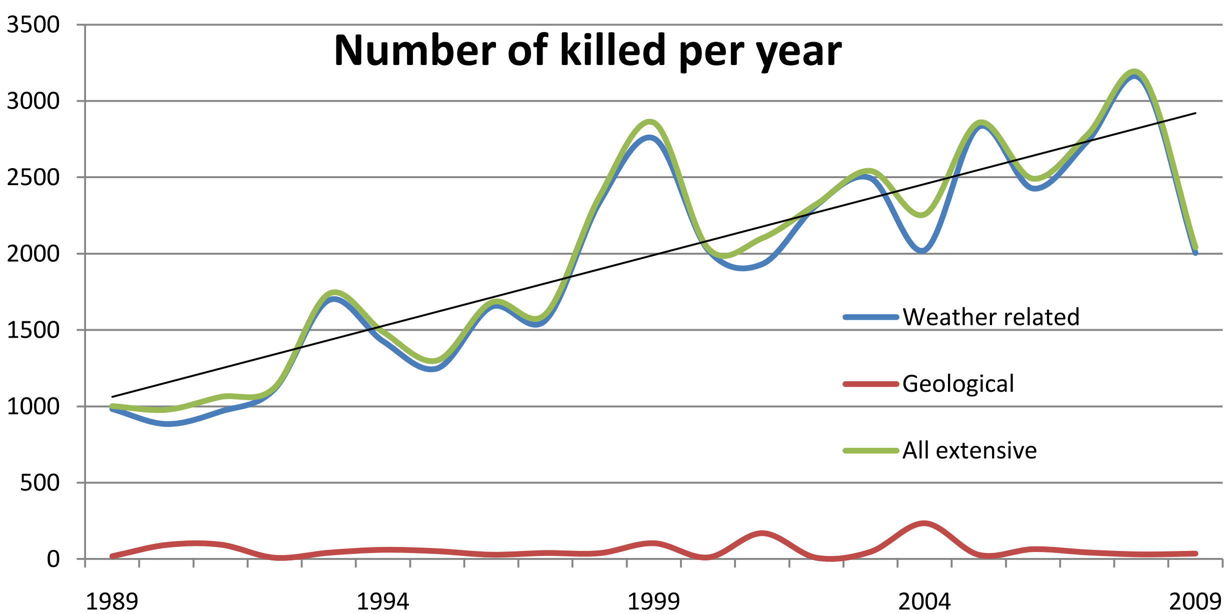
Trends of Extensive Risk: Frequency

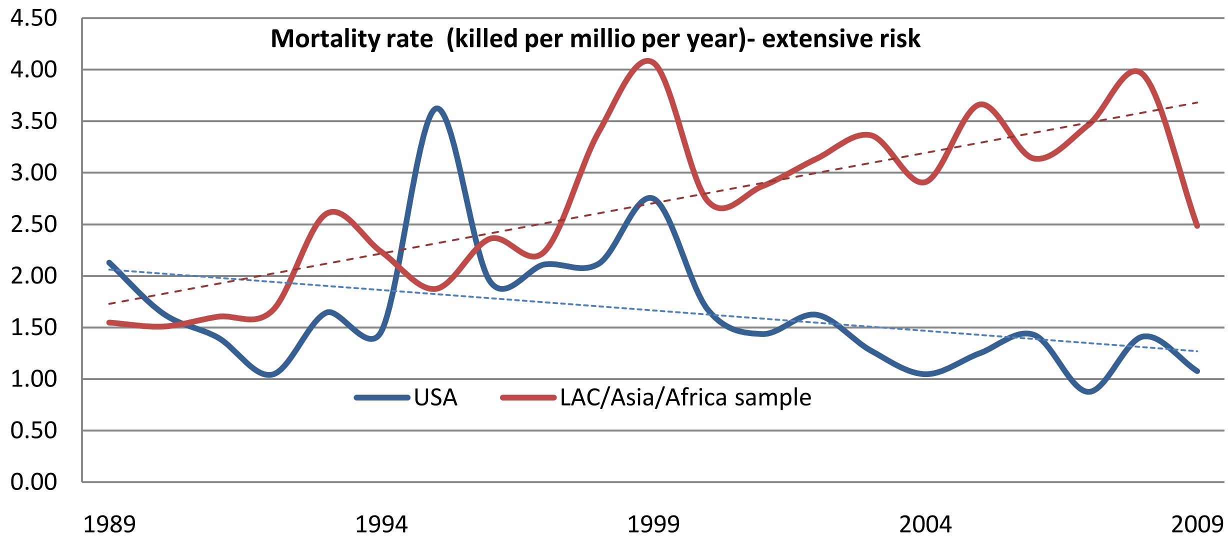
The number of reports per year is an excellent proxy for frequency of disasters and events. It could be argued that disaggregation distorts this numbers but as a fact in the sample around 50% of reports affect only one geographic unit, and while some hazardous events affect more units the average in the sample is 2.05 records per physical event.



Trends of Extensive Risk: Mortality

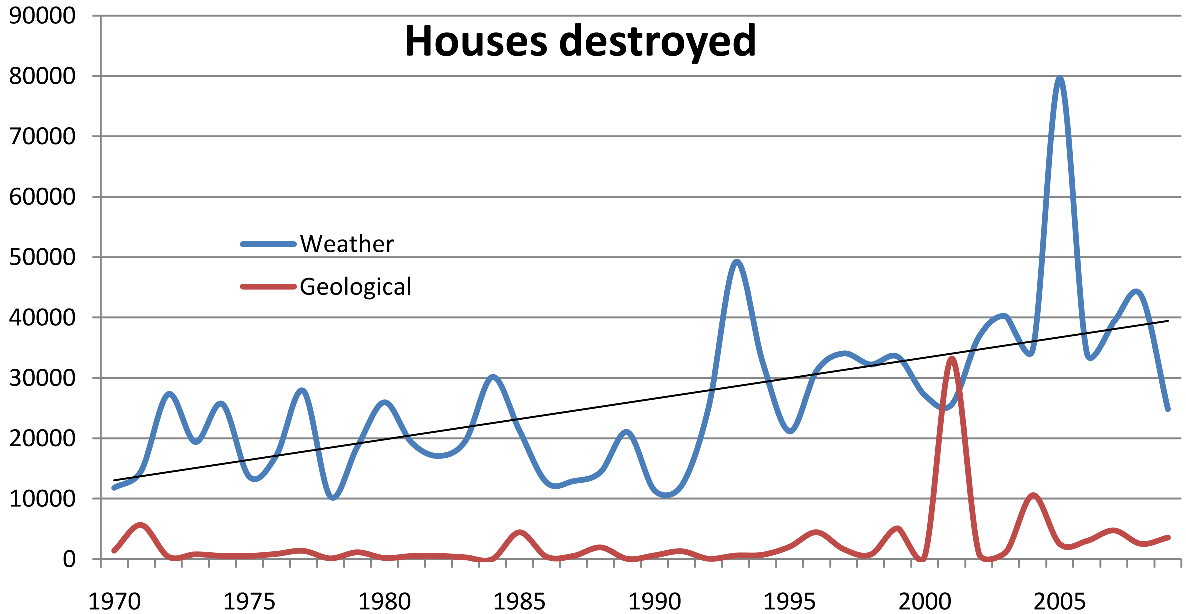
Mortality is the most robust indicator in all national databases of the sample. The absolute mortality due to extensive risk trend presented below shows a tendency to increase. However, as opposed to what was initially in GAR 2009, mortality rates due to extensive risk (and in most cases the overall mortality too) are increasing in most individual countries and in the consolidated of the entire sample.

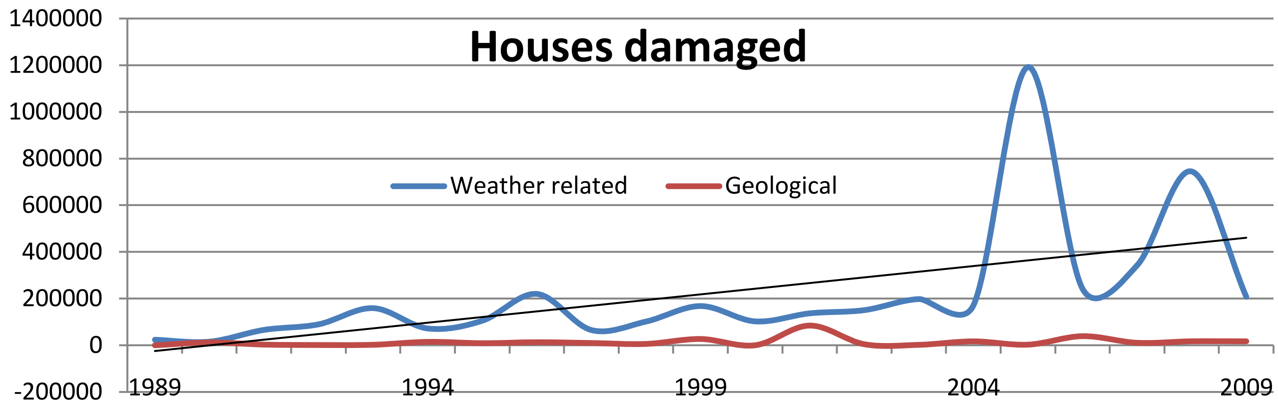




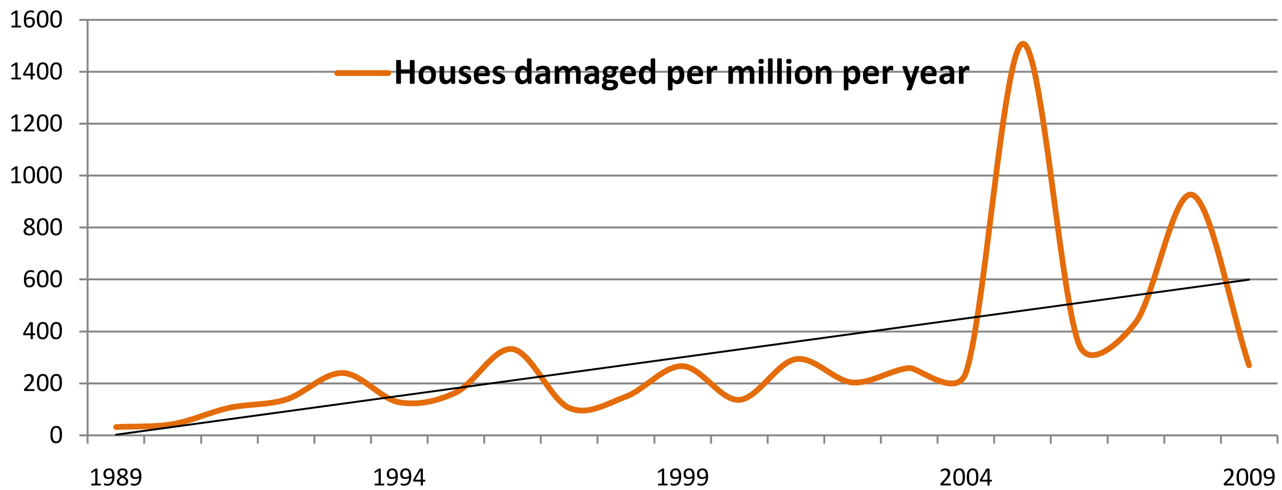
Trends in Housing Damage and Destruction

Asset destruction and damage, as found in other chapter of the GAR are increasing over time. This pattern is seen in every country of the sample and as it will be shown, also in developed economies such as the USA.





It is important also to highlight that these trends apply for both the ABSOLUTE and the RELATIVE (normalized per population) series. The next figure shows the number of houses damaged per million showing that the increase of the number of houses is far superior than the population growth.



Trends and patterns at individual country or regional level

Extensive risk patterns can be better seen using a sub-regional approach, which also allows for identifying differences due to geographic context, economic development, and recognizing the existence of specific hazards and vulnerabilities.

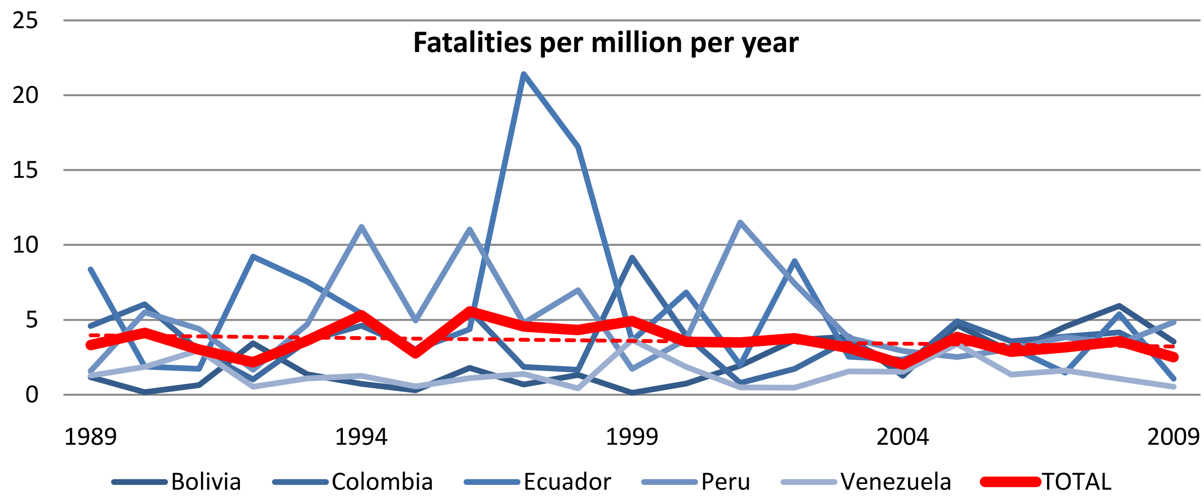
Andean Region

Datasets from the Andean countries are some of the most mature databases of the sample, making these trends extremely reliable.

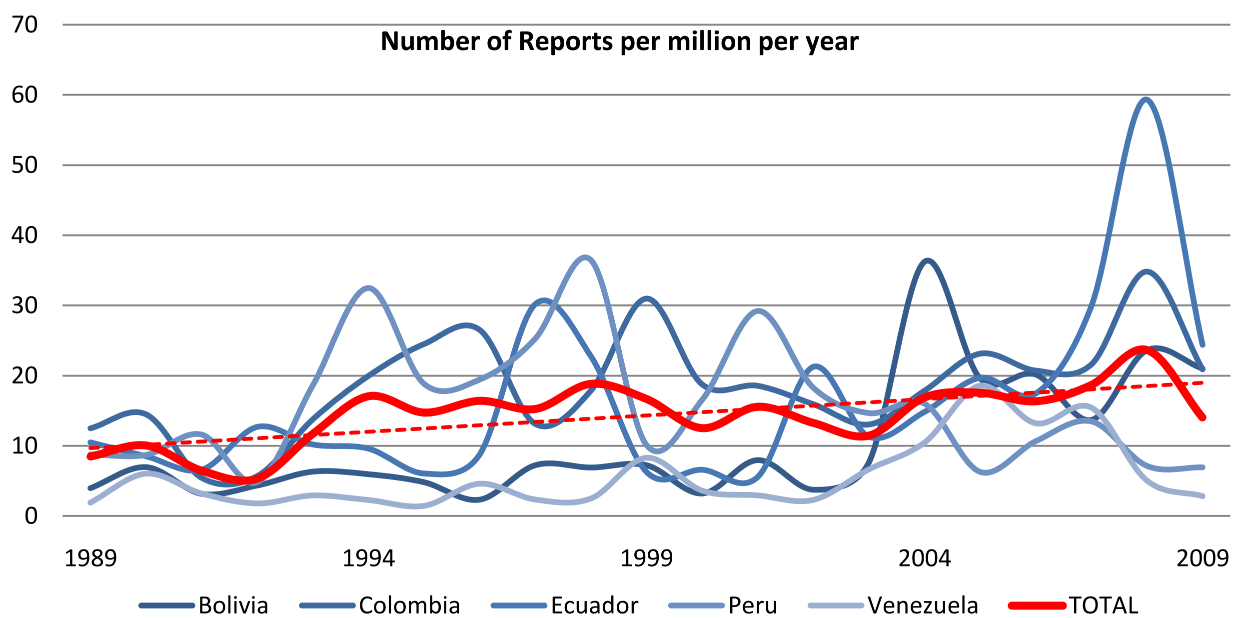
- Absolute mortality, frequency, other indicators still going up. However, mortality trend slope for the region is lower than the 20 country sample
- Normalized losses: a fact to highlight, there is a trend to slightly decrease mortality per capita (mortality rate).

- Other indicators per capita (housing damage, etc) are on the rise, both in absolute and in relative terms.
- Number of reports per capita are increasing, but with a much slower pace than the absolute number.

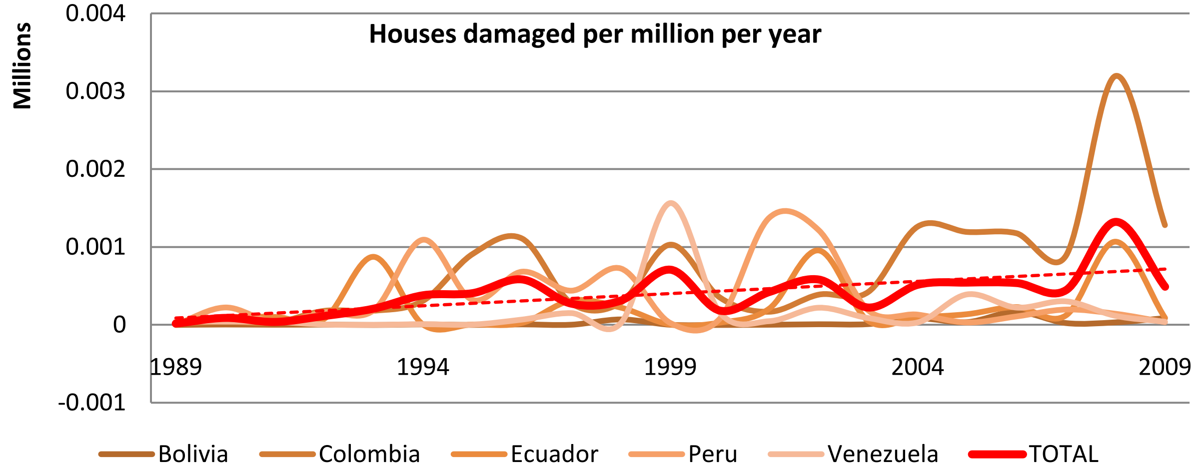
This last fact is important in terms it may confirm the consistency and reliability of trends in *extensive* risk, discarding to a large extent potential data bias such as improved reporting. There is a strong believe that the



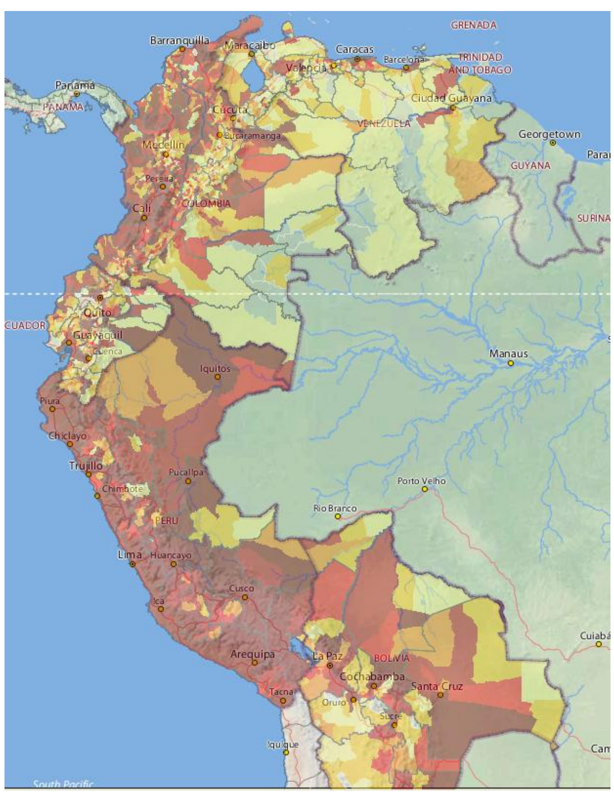
Extensive Mortality rate is slightly decreasing in the Andean region consolidate



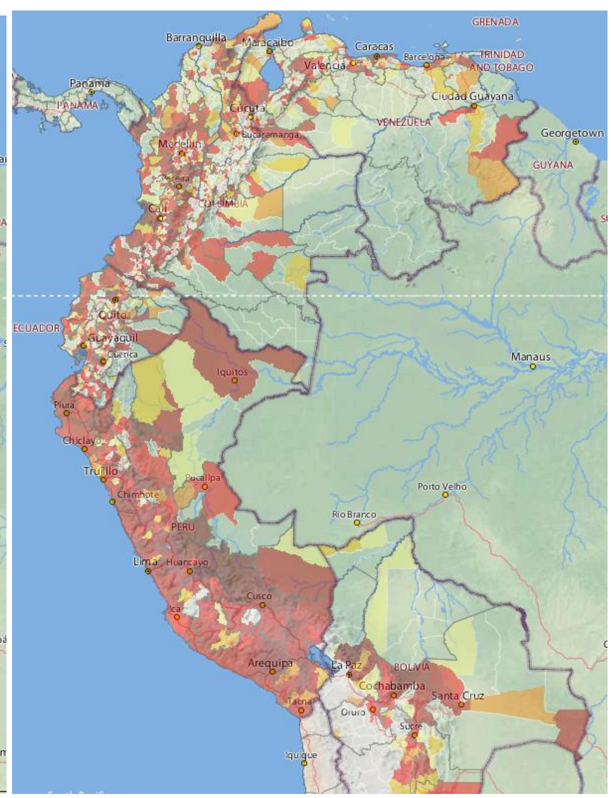
It is apparent that the moderate increase in the number of records per capita, especially in these very solid, robust and mature datasets, is simply a consequence more exposed population and of increased vulnerability.



Consolidated maps of extensive risk occurrence and impact show that practically every municipality of the region has been affected by disasters during the period of the study.



Frequency

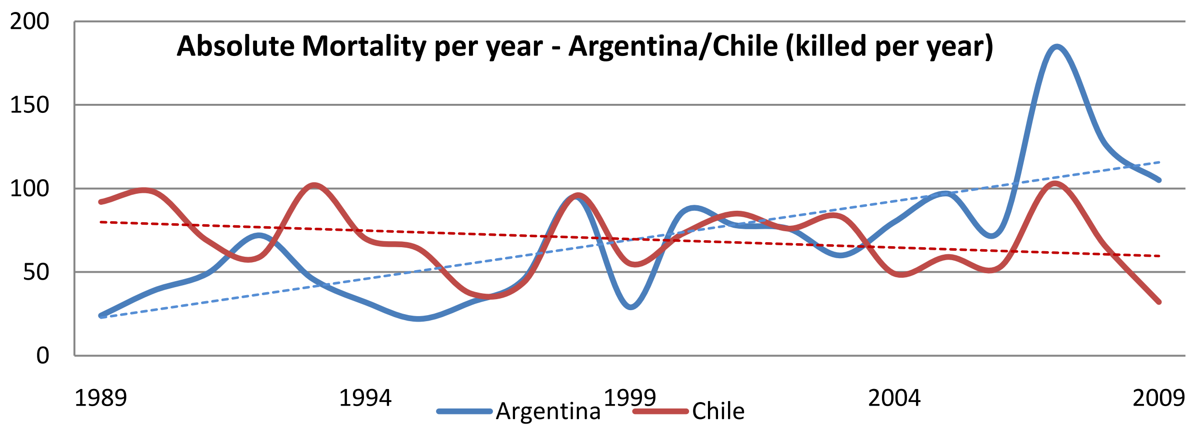


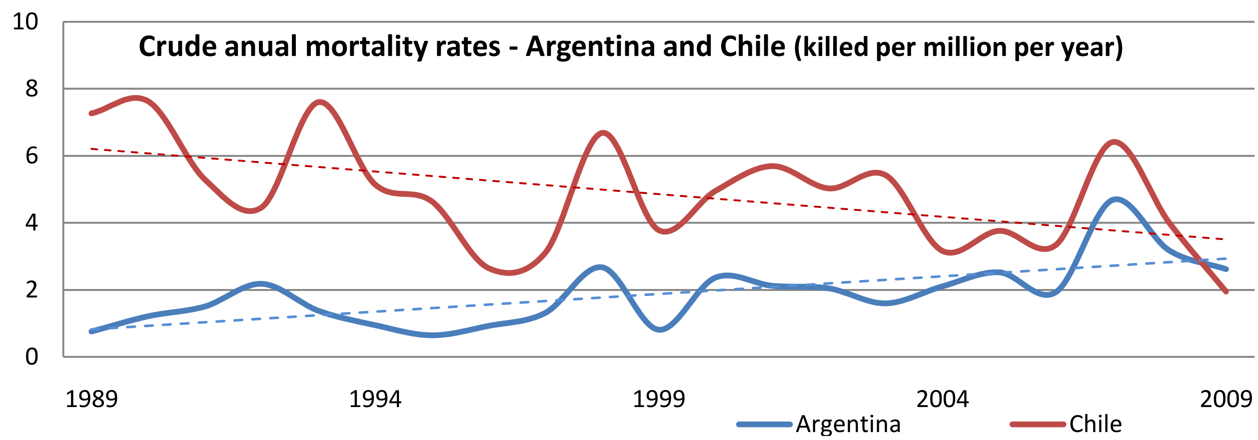
Mortality

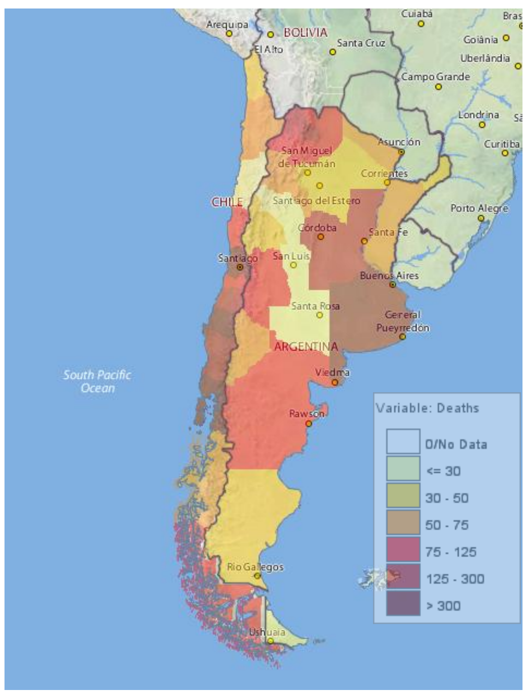
Southern Cone (Argentina and Chile)

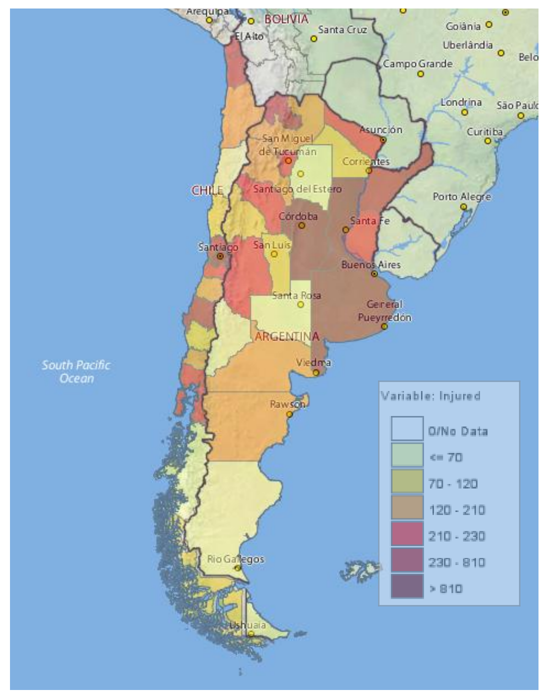
Facts to highlight:

- Argentina and Chile are, with Brazil, the most developed nations of South America.
- None of the countries have been impacted by large scale disasters, as opposed to most other countries in South America in the period of study, which doesn't include Chile's earthquake of 2010.
- As found in countries with low hazards and/or vulnerabilities, the overall contribution of extensive risk to mortality is higher than intensive risk. This phenomenon can be seen in countries where risk levels are low, either because hazards are low (see Middle-east countries later in this section) or vulnerability is low, as the case of developed economies such as the USA.
- Argentina and Chile show almost identical accumulated figures for the past 20 years, for both intensive and extensive risk types of events: Totals of 1453 Argentina and 1464 killed in Chile by extensive risk events, and 372 – 191 killed respectively for intensive risk. Houses destroyed are 9127 and 10564 respectively, but in the case of intensive risk Argentina has less housed destroyed than Chile (10580 and 40464)
- However, trends are very different for both countries: while absolute mortality on Argentina is on the rise, mortality is decreasing in Chile. Mortality rates (killed per million) follow the same patterns. Note, however, that population is much lower in Chile, thus making its mortality rates higher in general than Argentina until year 2009 when the two lines intercepted bringing the mortality rate per year to the same levels in both countries.
- As expected, extensive risk is well spread over the country. It is possible to notice that concentrations of mortality and other impacts are associated to geographic areas with higher exposure such as larger cities.









Mortality **Injuries**

Spatial distribution of Extensive risk impacts, Argentina and Chile, showing again total spatial coverage.

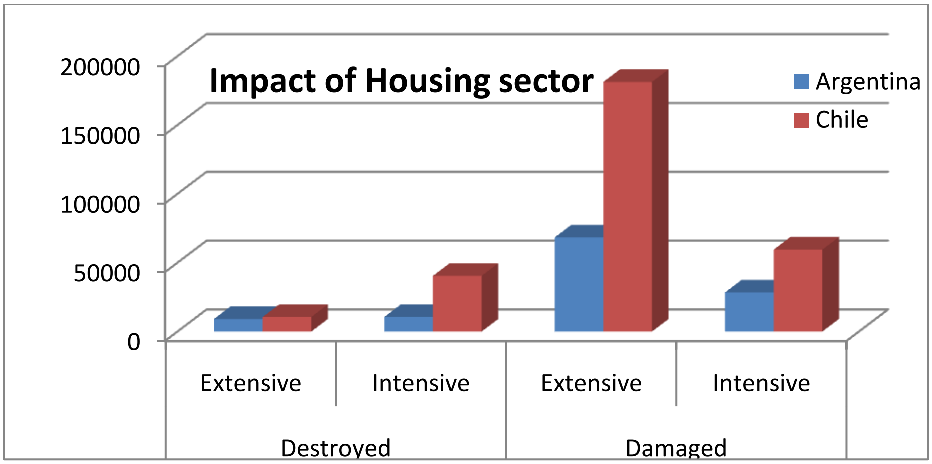


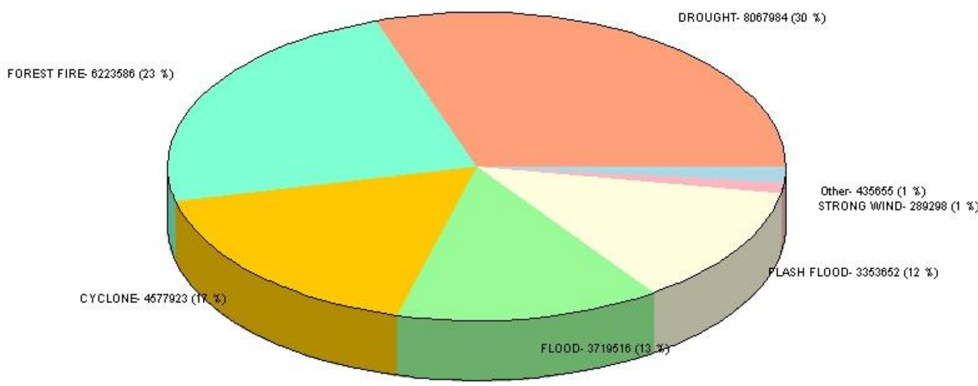
Figure xx. Comparison of Intensive and extensive risk impact on Housing sector, Argentina and Chile, 1989-2009

The chart shows the fact that intensive risk contribution tends to be higher in destruction of houses but lower in contribution to house damages when compared to extensive risk.

This same pattern is observed in the overall sample and in the majority of individual datasets.

Africa: Mozambique

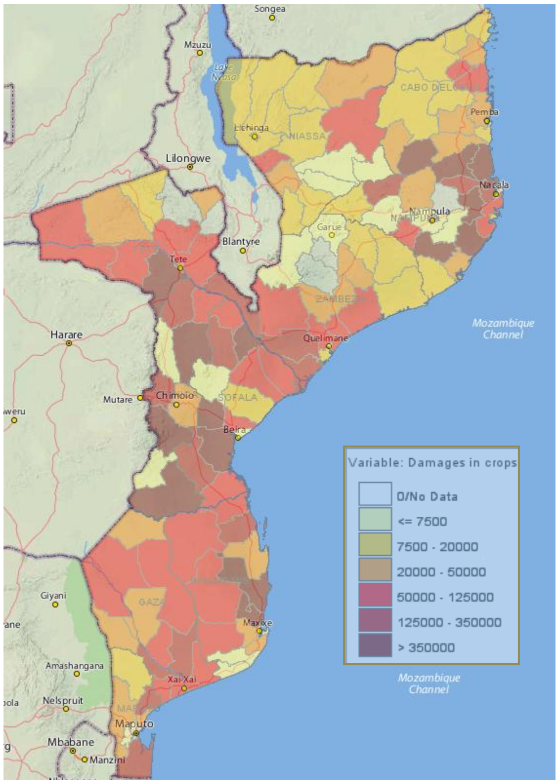
Fact: Mozambique database has the best documented set of reports with damages to agriculture of the whole sample. About 30% of its records (1394) contain detailed information on area and type of crops destroyed and affected. This allows for the first time to look into extensive risk and its effects in rural livelihoods, and may open a greater window of understanding of the impact of floods and droughts in the country and in the south east coast of Africa.

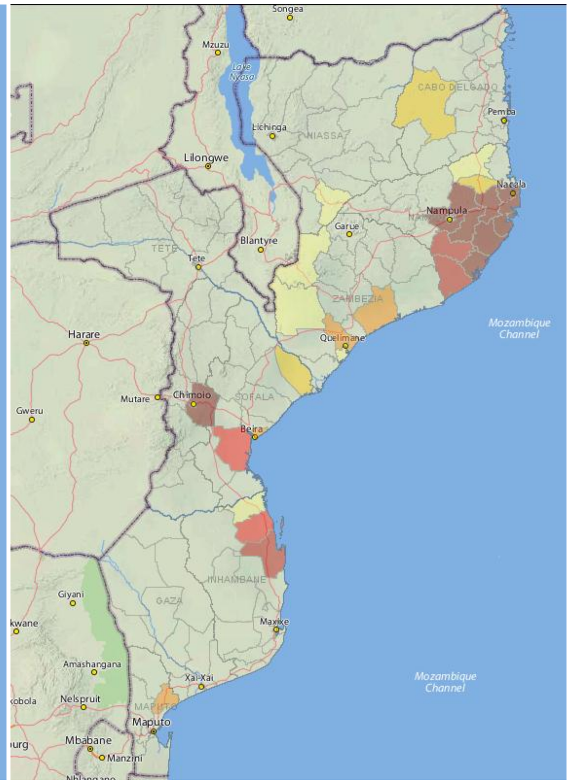


Impact of natural hazards on Agriculture, extensive risk events, 1989-2009, Mozambique

In addition to numbers in Agriculture, Mozambique database contains a wealth of information on Education (schools and classrooms destroyed and damaged, as well as students affected), and for the first time, a set of gender-enabled indicators. These indicators of effects on women, children and elder are present only in a small subset of the database (in about 200 reports) which does not allow for statistical processing; however, it is extremely important information that could be used in case studies, which is a milestone in the development of disaster databases.

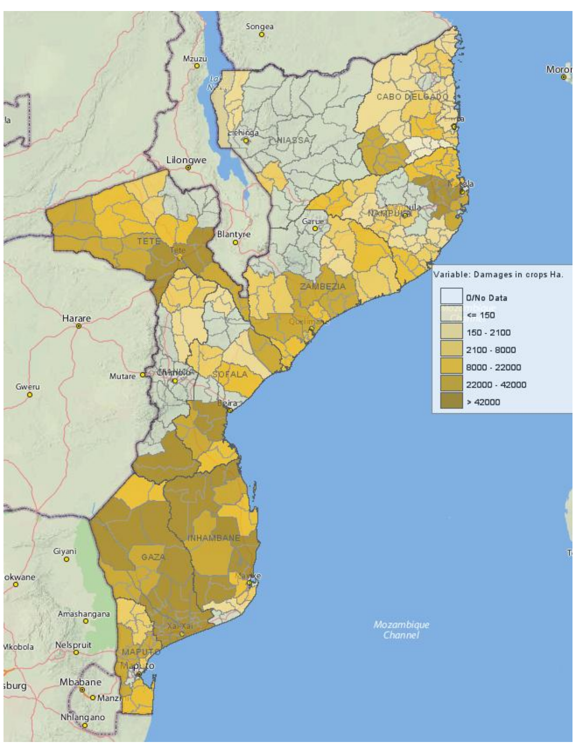
The following pages show the distribution of the impact of extensive and intensive events in Mozambique. They show in general the high level of impact of extensive risk, especially in terms of livelihood and housing assets.

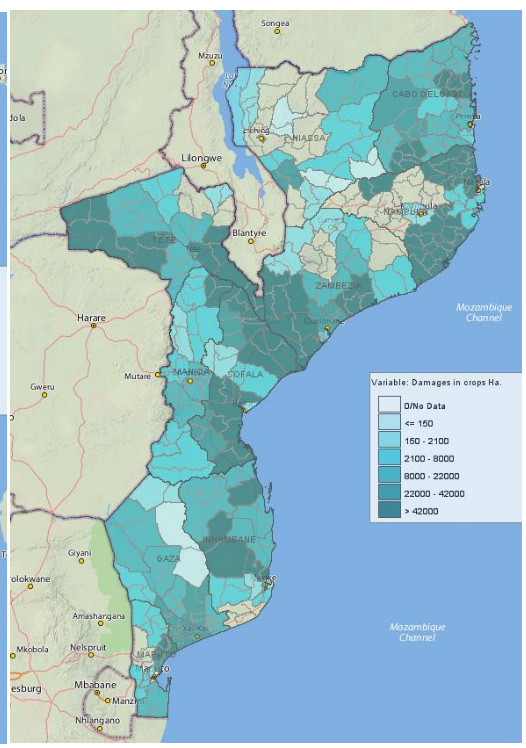




Extensive risk damage to Agriculture Mozambique, 1989 - 2009

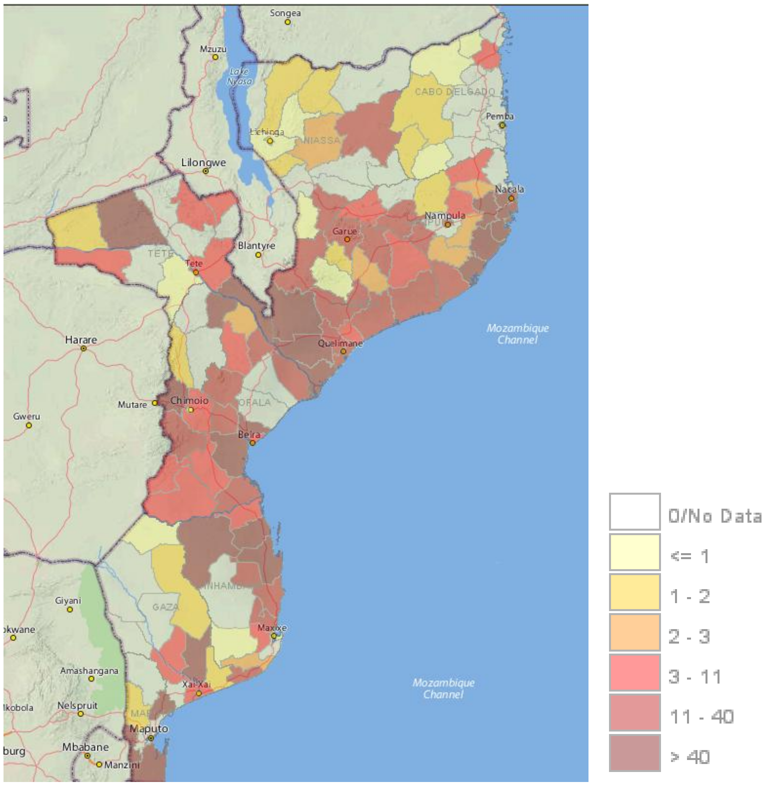
Intensive Risk events damage to Agriculture





Drought related damage to Agriculture

Flood related damage to agriculture



Schools affected (damaged or destroyed) in Mozambique, 1980-2009, extensive risk.

Indonesia

Facts:

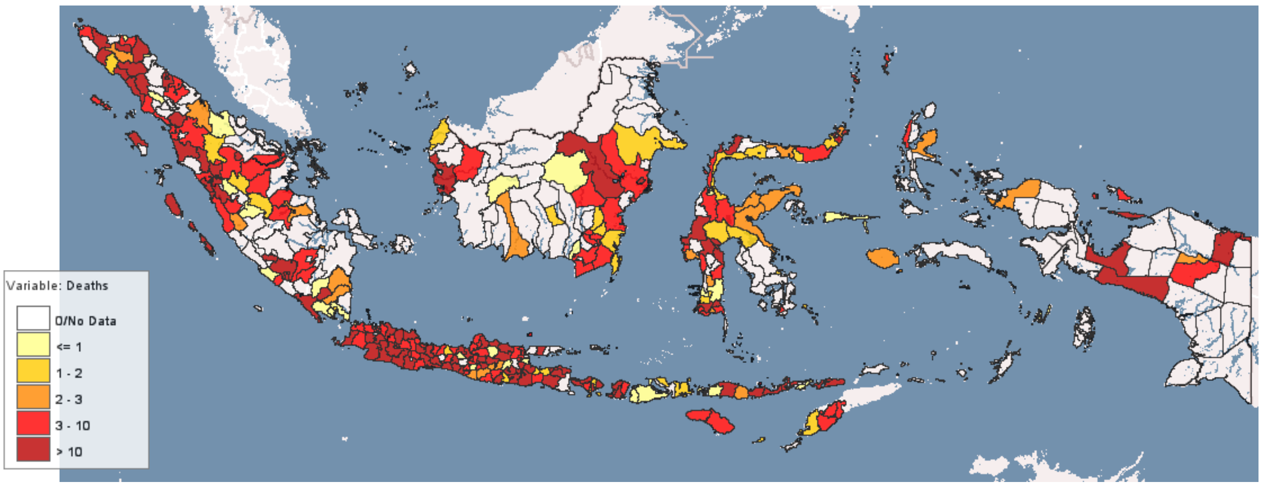
- Indonesia is the country most affected by intensive risk disasters of the sample, and probably in the world during the past 20 years. All indicators of loss in terms of mortality, injuries, asset destruction in general and frequency are either the highest or close to the highest.
- Reporting level changed 10 years ago (to Kecamatan=block) – so it'very difficult to obtain accurate trends when looking at more than 10 years. However, during this consistent period official reporting has occurred showing a definite trend to increase the number of reports, consistent with the rest of the sample or more.
- Mortality has also a dramatic rising slope, probably the highest of the sample.
- While it has some of the highest figures in absolute mortality (3156), missing (1670), housed destroyed (94360) and houses damaged(272792), the impact of extensive risk relative to the size of the population is one of the lowest of the sample – a counter-intuitive fact.

Intensive risk:

- Highest mortality of all datasets of the sample.
- Is the second most frequent of all datasets of the sample (216), after Orissa, India
- Highest number of houses affected (damaged/destroyed)
- Affects more districts (133), with a higher percentage (27%) than in any other country.

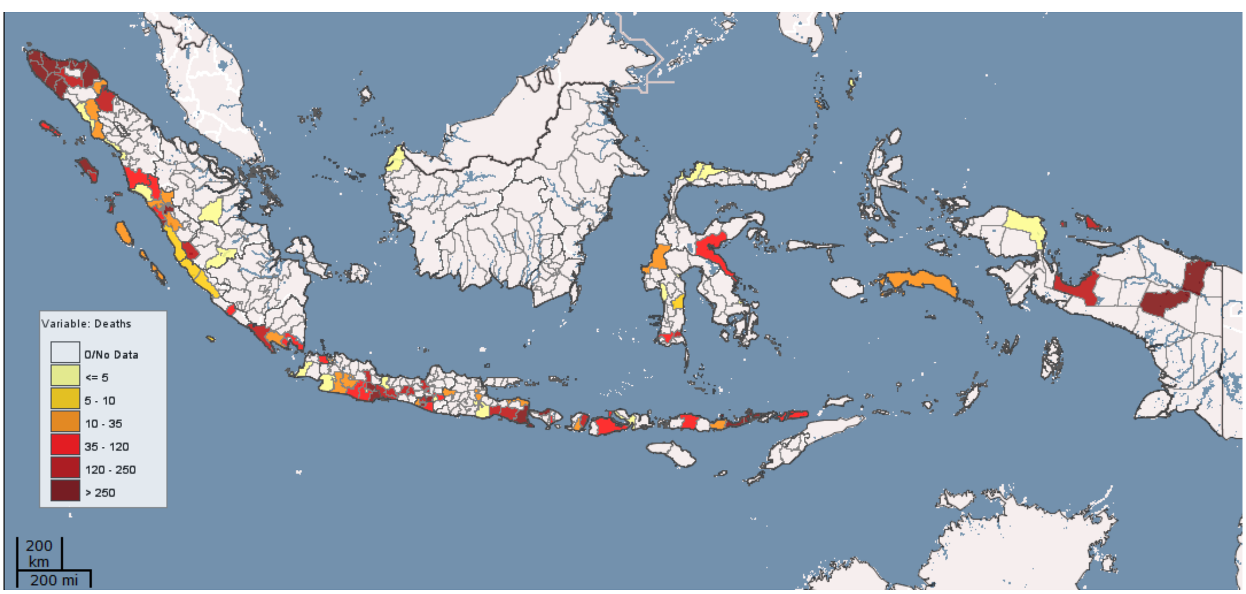
Extensive risk:

- 422 districts of 484 (87%) are affected



Extensive risk mortality in Indonesia (1989 – 2009)

High levels of risk in Indonesia seem to have as a consequence that a higher percentage of the overall impact is due to intensive risk. The same situation can be found in other high risk countries as



Intensive risk mortality in Indonesia (1989 – 2009)

BOX: Applications of Disaster Data in Indonesia

'DIBI' is the Indonesian acronym for the Indonesian Disaster Data and Information Management Database. Currently, the data available online in DIBI is based on official government data for the years 1815-2009. Sources of data for the DIBI have been drawn from the former sub-national units for disaster response coordination - Satkorlak PB (Provincial Units for Disaster Response Coordination) and Satlak PB (District Units for Disaster Response Coordination). Satkorlak PB transformed into BPBD by the end of 2009 and Satlak PB transformed into BPBD at the district level where risk of disaster is deemed to be high in that particular district.

The national DIBI include the results of Indonesia's first national disaster risk assessment and Historical Disaster Risk Index (HDRI), and is already being used as the basis for national DRR policy, national disaster management plan, budgeting and development planning decisions. DIBI provide information for reporting on the implementation of the HFA. DIBI already provides details of losses for some of the provincial and district level, which when coupled with the national disaster risk assessment will enable a more in depth analysis of the progress made in reducing losses through the implementation of preparedness/mitigation programs and capacity development initiatives.

The BNPB has already used DIBI to identify Hazard Prone areas across Indonesia. The Hazards Prone Index considers nine disaster types across all provinces and districts based on historical data. The Hazard Prone Index which was the basis for decisions on which districts would have its own BPBD.

Within BAPPENAS, the Directorate for Poverty Eradication is using DIBI to apply prioritization based on disaster prone areas. This prioritisation of disaster-prone areas should be carried-out for all SCDRR activities, as well as other donor funded programmes. Other donor-funded programmes include: PNPM Mandiri: Rural Development Programme (PPK); Urban Poverty Handling Programme (P2KP); Underdeveloped and Special Regions Development Acceleration Programme (P2DTK); Rural Infrastructure Development Programme (PPIP); and, the Regional Socio-Economic Infrastructure Development Programme (PISEW). Essentially this is aimed at improving the data in DIBI to assess the level of vulnerability in regions, and the risk exposure.

The process has begun to incorporate the data sourced from the Forum Data and Information members to include school age children, health status, infrastructure, public facilities, income levels, types of livelihoods and some spatial planning data. This will enable better targeting of programmes to reduce disaster risk within the most vulnerable areas. In addition to these BAPPENAS examples of DIBI-usage, it is also planning to use the same methodology to monitor the impact of the global economic crisis.

Middle East: Iran, Jordan and Syria

Facts:

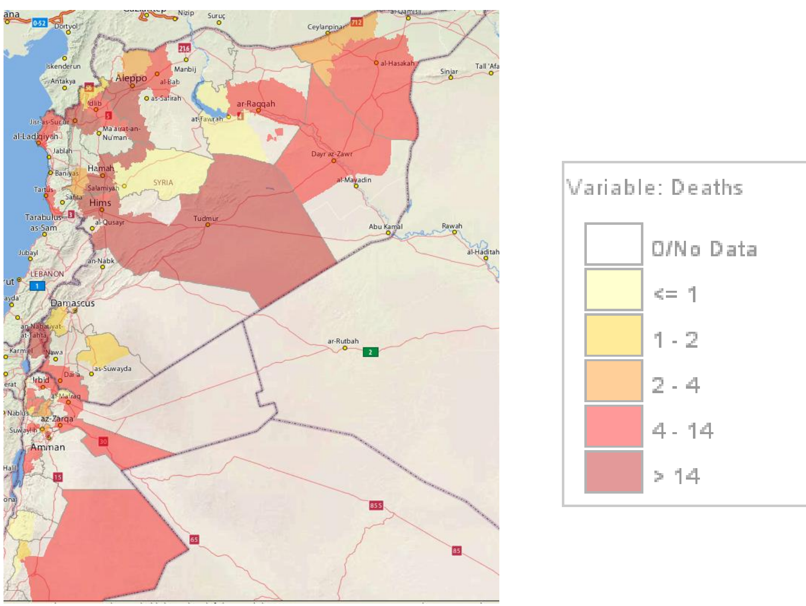
- Jordan and Syria are the only two countries of the sample with NO intensive risk events.
- Accumulated <u>**extensive** mortality rate</u> is about the same for the three countries. Jordan has the lower rate, and Syria and Iran has almost the same <u>**Extensive** risk mortality</u> rate.
- However, Iran has an extremely high number of intensive events. Both in relative and absolute terms are over 20 to 30 times this impact.

Extensive Risk in Iran, Syria and Jordan (1982 – 2009)

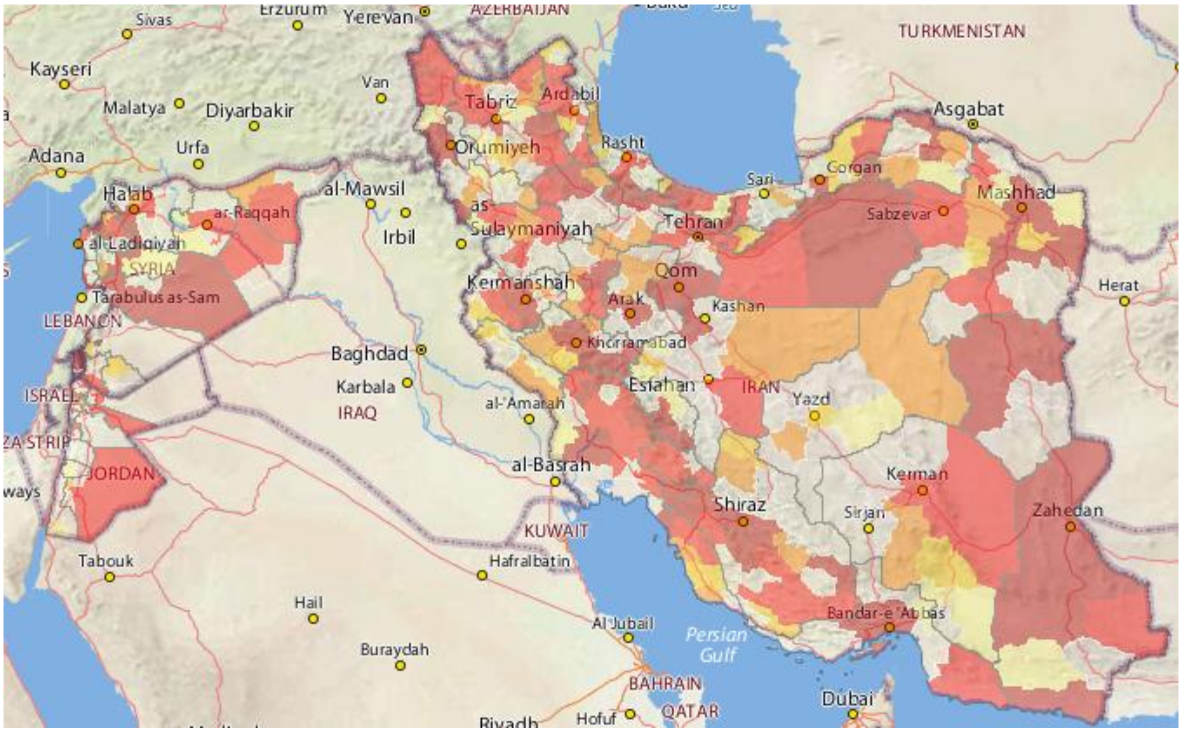
Country	Population 2009	Number of Reports	Deaths	Mortality rate
Iran	74,783,000	2323	2543	34.0
Jordan	6,472,000	444	140	21.6
Syria	20,814,000	7295	675	32.4
	102,069,000	10062	3358	32.9

Intensive Risk in Iran

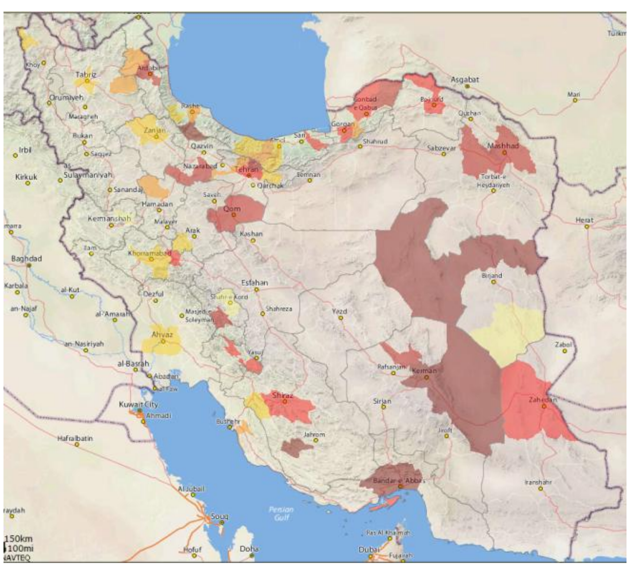
Country	Population	Number of Reports	Deaths	Mortality rate
Iran	74,783,000	71	72737	**972.6**



Absolute mortality – extensive risk in Jordan and Syria.



Extensive Risk Mortality patterns in Jordan, Syria and Iran. Large areas without any impact are associated to desert inhabited zones.



Intensive Risk Mortality patterns in Iran.

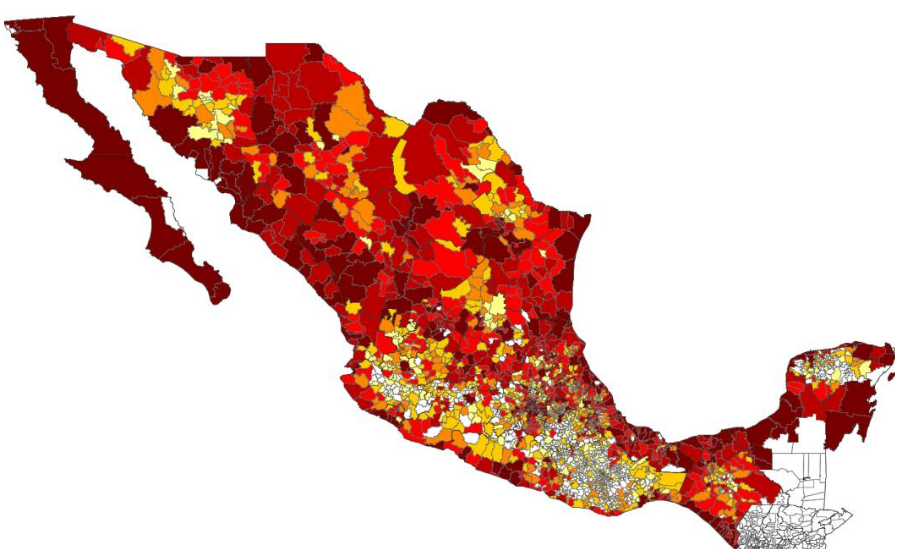
Jordan and Syria are found to have similar rates of hose destruction and damage. As opposed to the case of similar mortality rates due to extensive risk, Iran has 10 to 20 times higher rates of house destruction due to the tectonic origin of most of its disasters.

	Houses Destroyed	rate	Houses Damaged	Rate
Iran (Extensive)	7802	104.33	156532	**2093.15**
Jordan	83	12.82	582	89.93
Syria	468	22.48	1311	62.99
Iran (Intensive)	**126539**	**1692.08**	**164854**	**2204.43**

Mexico

Mexico is the most affected country by extensive risk of all the studied countries in the database very close to consolidated figures from the two states represented from India.

With 108.4 million inhabitants, very near to 107.1 million of Orissa and Tamil Nadu, Mexico's dataset has 21,887 reports in the period 1970-2009, while the O/TN dataset has 21,637. Mortality is 9,524 against 9384, giving roughly the same accumulated mortality rate. Differences in these figures are about 1%, a surprising fact between two countries so far apart, in a period of 40 years, suggesting that patterns of extensive risk can be more alike than initially thought. Other figures are also similar, although not as close as 1%.



Extensive Risk and the underlying Risk Drivers

As seen in the previous sections, there is enough evidence suggesting not only that *extensive* risk is increasing rapidly. GAR 09 analysis suggested that its expansion is strongly linked to processes of environmental degradation, poverty and inequality and badly planned and managed urbanization and territorial development.

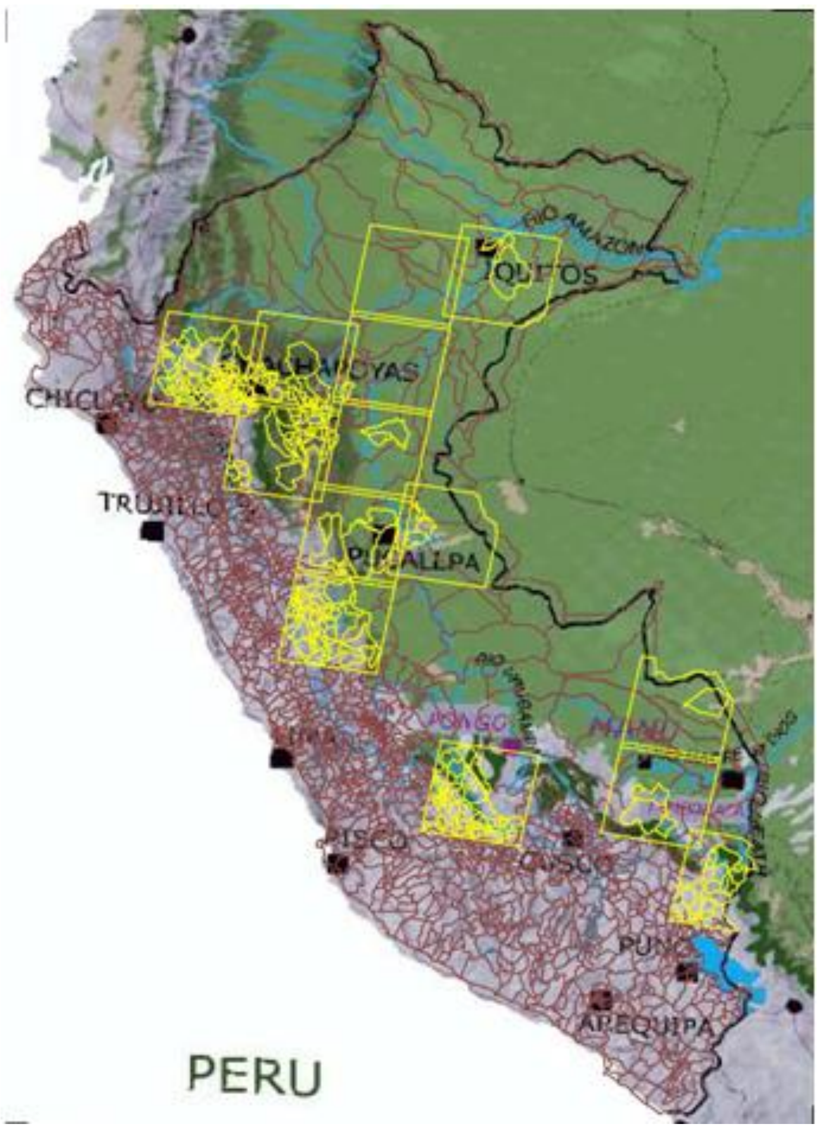
The underlying risk drivers identified in GAR09 suggested that new risks are being rapidly generated on the development *frontier* both in peri-urban areas as well as in regions with new and rapid economic development.

A series of punctual case studies have explored the relation environmental degradation disasters, showing for example the tight relation between deforestation and landslides. (Mansilla 2010, …)

While these studies explain the different factors that are driving quite extraordinary increases in disaster risk in peripheral regions they are still extremely localized and it is impractical to attempt to apply its methodologies to national levels.

Driver 1: Environmental degradation

In order to probe this hypothesis in a rigorous and statistical way a preliminary case study was conducted on Deforestation and Disasters in the Amazonian watersheds of Peru. The outcome of this study would be the development and initial testing of a methodology that could be applied in multiple geographic contexts using loss information from national disaster databases and remote sensing technology that could allow large areas to be analyzed in search of evidence that would support the claims of GAR 09.



The study initially selected a sample of areas in the Amazonian watersheds of Peru (the vast Atlantic watershed) for which satellite imagery of suitable resolution was available in two windows of time. Satellite imagery was obtained at a resolution that was enough for the analysis, clear from clouds, and at a level of detail that could permit later work at national level in a reasonable effort.

All satellite images underwent a supervised classification work from which changes in forest, agricultural areas, bare soil, ice and urban areas were measured. These changes were associated to the corresponding districts for which disaster data is available, and statistical regressions were conducted to look for a relation between these changes and loss data. Statistical processing, however, did not fully succeed in finding a definitive relation at this level, which can be explained for a number of reasons: the sample of districts was not exhaustive; many of these districts where deforestation occurred have very low population and small size; the span of time between images was relatively short, among others.

Given the small size of the majority of the districts it was apparent that the consequences of deforestation would spread beyond their borders. As suggested by many punctual and qualitative studies the problem potentially could be better comprehended using geographic units such as watersheds.

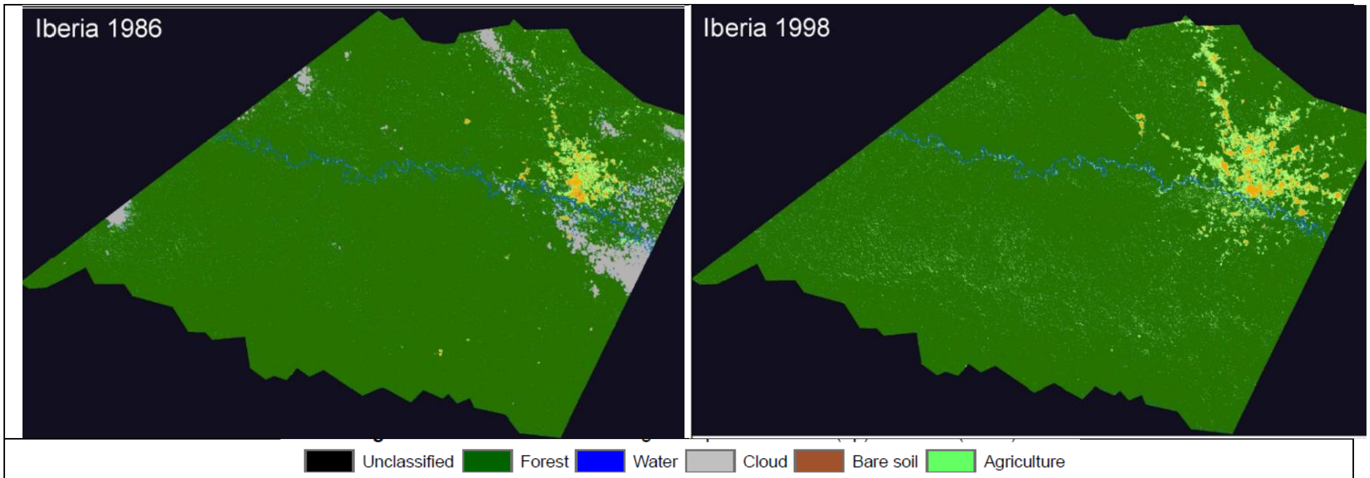
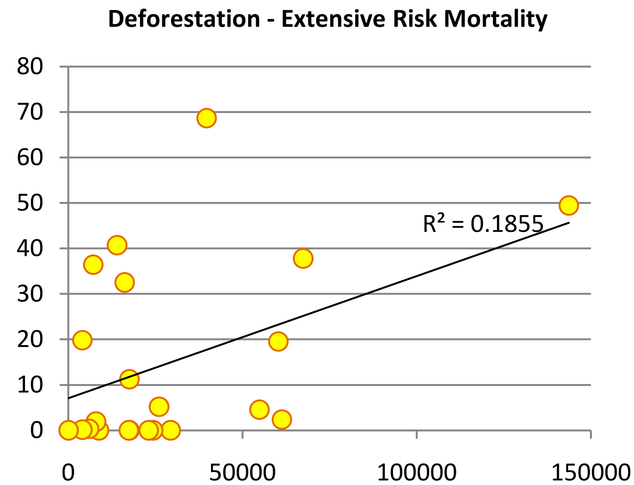


Fig. XX. Classified Landsat images acquired on 1986 (left) and 1998(right). The deforestation and environmental degradation can be seen easily as the lighter areas of the image, where forests have been turned into agricultural and bare soil.

After re-grouping these results by medium size watersheds the results are very promising and definitely tend to sustain the hypothesis that in those watersheds where deforestation is higher there seems to be also a higher weather-related disaster impact. Two preliminary analysis were conducted, one using only those districts for which data on deforestation and losses exists, and a second taking the entire set of losses “down the river” in watersheds for which districts with deforestation was measured.



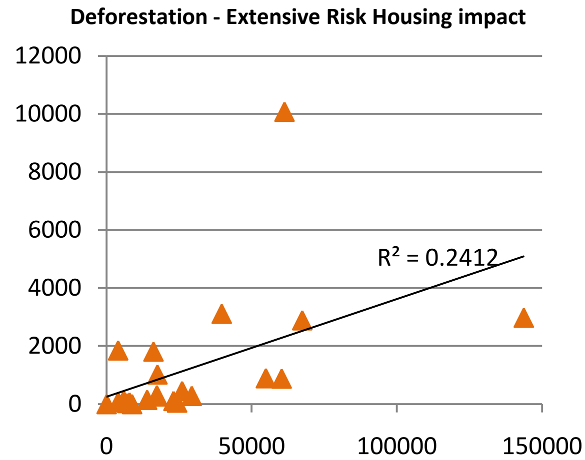


Fig. XX. Correlation between Deforestation in watersheds and disaster losses due to extensive risk

In both cases positive correlation was found between deforestation and losses, both in absolute terms and in terms of losses per capita. Levels of correlation were, however, relatively low (R^2 between 0.18 and 0.54, depending on the indicator and selection of risk type, intensive or extensive).

While there are a number of outliers to the regression line, it can be seen if Fig. XX that as deforestation increases (horizontal axis), the impact (mortality or destruction of houses, in the vertical axis) tends to be higher.

It is important to clarify that a very close linear correlation is not expected, because the analysis only attempts to explain the incidence of one of the multiple variables (environmental degradation measured by the proxy of deforestation) over realized risk, as a manifestation of the combination of Hazard, Exposure and Vulnerability. Distribution of hazard and exposure are likely very different in each of the watersheds analyzed which results in different levels of risk, which in turn explain why a high level of correlation will never be obtained unless accurate estimators for all involved variables are developed and included in a multiple variable regression analysis, and a comprehensive coverage of the entire area of study is achieved.

Driver 2: Urbanization

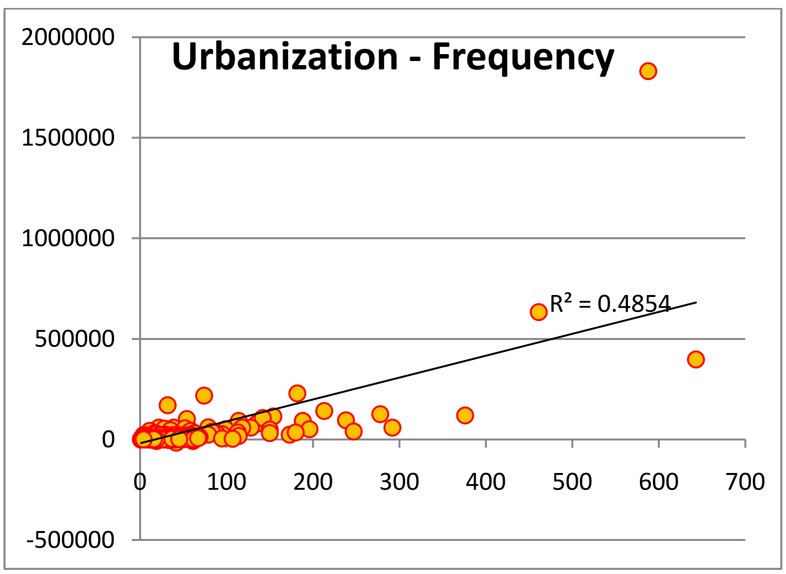
Cases: Colombia and Peru have population data for 2 censuses including urban/rural population on each district/municipality.

The GAR team carried out an exercise attempting to correlate urbanization process and disasters using statistical measures and taking advantage of detailed disaster loss data available. The increase in urban population directly measures of urbanization allowing a simple but effective analysis of trends.

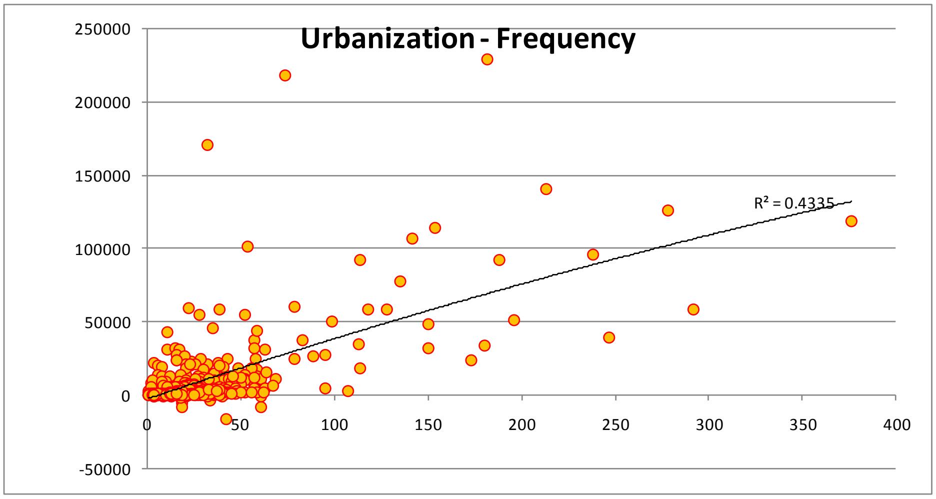
The exercise took into account the fact that, on each country a significant number of municipalities is created between two censuses which makes impossible or extremely hard to process the new municipalities and those which are split to segregate new ones. This phenomenon, along with others such as migration and displacement makes a significant number of municipalities to show a decrease in population.

For the exercise only those municipalities that showed a positive or null increase in population were taken into account. A statistical regression was conducted to test the relation between urbanization and loss indicators (mortality, frequency and house destruction) taking into consideration that risk, and thus disasters, depend on several variables, notably hazard, exposure and vulnerability. Urbanization processes reflect at the same time increases in exposure and in vulnerability.

However, for each area there is still the Hazard variable with is not taken into account – not even calculated due to its complexity. Thus, a regression between an urbanization indicator and losses will never have a perfect correlation factor – it's missing a big part of the equation, the hazard which usually varies a lot between districts. Nevertheless, the empirical data analyzed yields a relevant relation , with a R^2 factor between 25% and 60%.



Linear regression between disaster frequencies (average number of reports per year) with three mayor urban areas as outliers (Bogota, Medellin, Cali) shows good fit to the regression line. A quadratic regression yielded R^2=0.61, even higher.

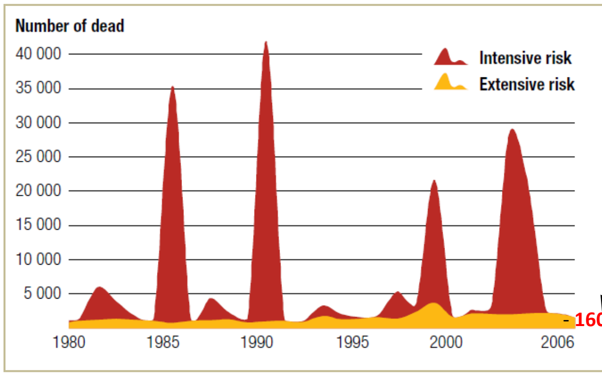


Linear and quadratic regressions also show good correlation without the outliers. The graphic of distribution without the outliers reveal visually the correlation. Other variables measured yielded also R^2 factors in the order of 0.3 – 0.4.

Comparing the LAC-Asia- Africa sample to the United States of the America: a summary

The study conducted in GAR 2009 did not address the distribution of extensive and intensive risk in developed, fully industrialized countries. While this could be seen by some as an oversight, it is due to the need for a greater understanding of the problematic of disasters in poor countries, where the impact of disasters on development is significant given the scale of the events affecting them and the much lower resilience and capacity to recover of their economies and communities.

Nevertheless, the availability of large amounts of quality data for the United States has facilitated the decision of taking a closer look at the impacts of natural hazards in a developed economy, in order to test several of the hypothesis that have proven to be true for the majority of the population of the world, and compare how disasters affect different economies.



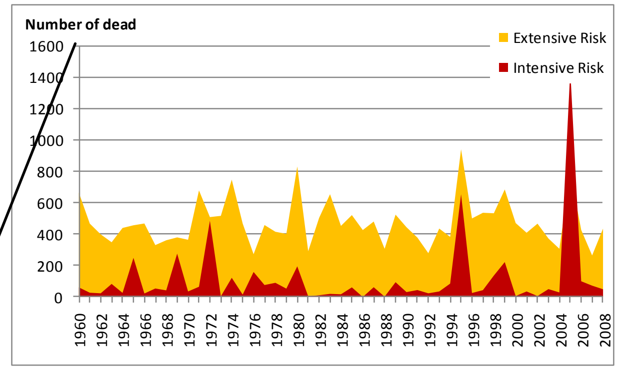


Figure XX. Extensive/Intensive Risk mortality pattern in LAC-Asia **Figure XX. Extensive/Intensive Risk mortality pattern in USA**

The first outcome of the study is the confirmation that high-intensity mortality is much lesser in the US than in the rest of the studied countries. The most destructive event found in the period of study (Katrina) is lower in orders of magnitude than mega-disasters occurring in Asia and Latin America.

Secondly, the study found that extensive risk driven, low-intensity **mortality** widely spread over the territory and frequently occurring accounts for the majority of casualties in the US, whereas in other countries of the GAR 2011 sample low intensity mortality is a very small part of the total mortality.

Figure XX shows the distribution of mortality across the sample between 1980 and 2006 in the GAR 2009 LAC-Asia region, while Figure 4 shows the same distribution for the US. The US chart included the very rough figures obtained from different data sources for Katrina hurricane in 2005.

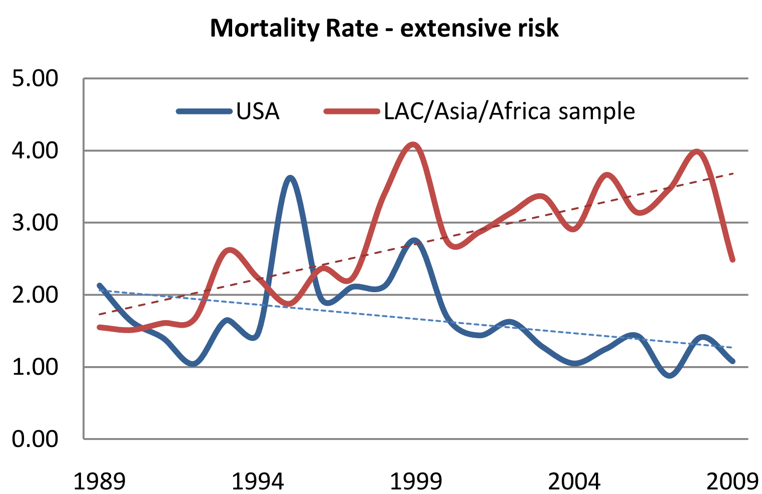


Fig. XXX. Comparison of number of casualties per million per year due to extensive risk events in the USA and in 20 developing countries.

Trends of the unequal distribution of mortality in an industrialized country like the US as compared to the LAC-Asia-Africa sample of developing countries are shown in Fig. xxx where evolution of mortality rate is shown. While in the developing countries this rate (and the absolute amount of casualties) is growing over time, in the USA it is decreasing.

However, the study confirmed that, in the same way it occurs in developing countries, low-intensity **damage and asset loss** is both extensively spread and frequently occurring. Temporal trends and patterns of asset damage associated to events at all scales and the relative contribution of intensive and extensive risk events to overall damage seems to follow approximately the same relative proportions and patterns in the US and the sample countries of LAC and Asia.

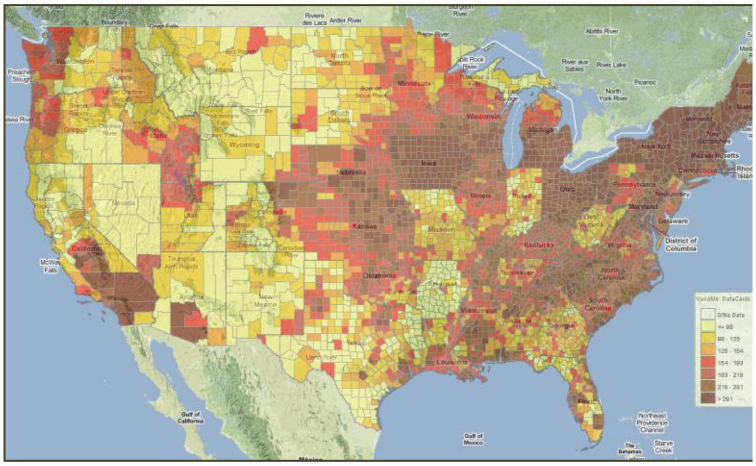


Figure 13. Multi-hazard iso-frequency map of extensive reports per county, USA, 1960-2009. From Sheldus. Background map: Google map (Terrain)

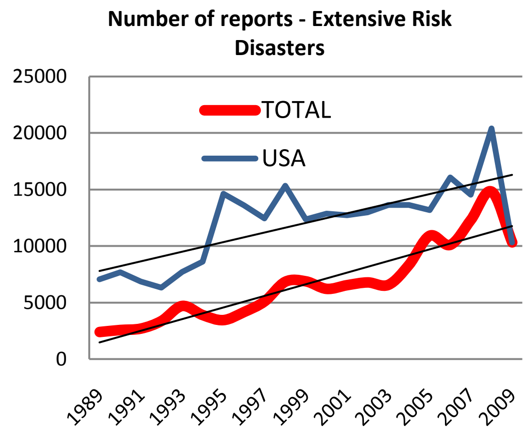


Fig. 13a Comparison of number of reports between the USA and LAC-Asia-Africa sample, 1989-2009

The following mortality rate map at county level provides a more detailed view of these patterns (without Katrina, though). which lead to the questions posed in the GAR in relation to the link disaster-poverty, strongly confirmed in LAC-Asia: why are these less populated areas apparently at higher risk? Is this a problem of measures of DRR more strongly enforced and implemented in populated, richer areas? Are these counties also the poorer counties of the country?

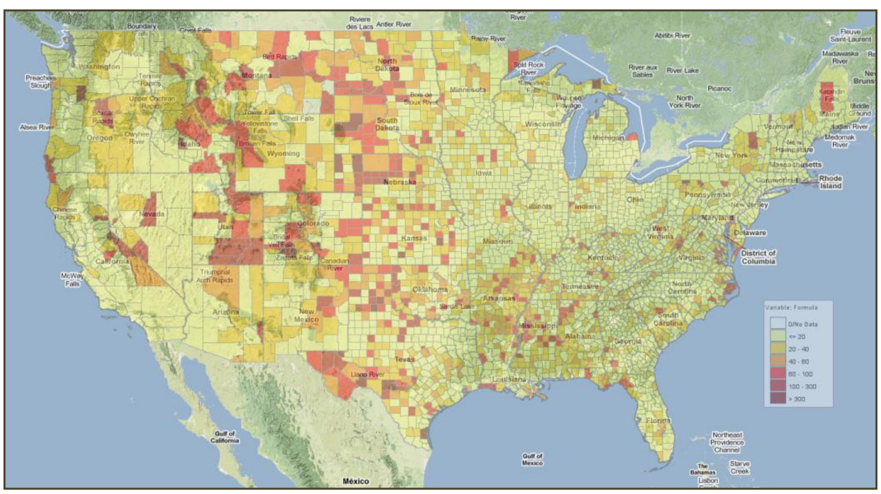


Figure 18. Multi-hazard iso-frequency map of Crude mortality rate (accumulated mortality per 100,000 habitants) per county, USA, 1960-2009. Sources: mortality from Sheldus; population year 2000 Census Bureau. Background map: Google maps.

Answers to these questions are outside of the scope of this document. Preliminary regression analysis were conducted trying to relate income or GSPC Gross State Product per capita with mortality rates or economic losses without finding any significant correlation at State or County levels. Perhaps this means the link poverty – disasters is not as strong in developed economies as it is in developing countries.

However, a visual representation of mean household income in 2006 shows there are important overlaps between the two maps, especially in the central plains (North and South Dakota, Nebraska, Kansas, Oklahoma and Arkansas) where a significant number of counties in the lower limit of household income (less than 35,000) show some of the high mortality rates; however, not all cases are similar, such as the case of Colorado and Wyoming along the Rockies, where counties with higher income have also high mortality rates. Of course, risk dependency on many factors such as the hazard itself, exposure and a number variables affecting vulnerability make hard to establish poverty as the only causal variable – causing the statistical regression not work.

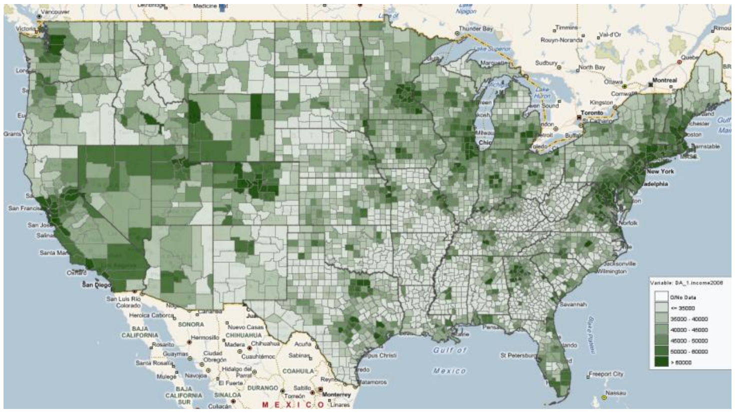
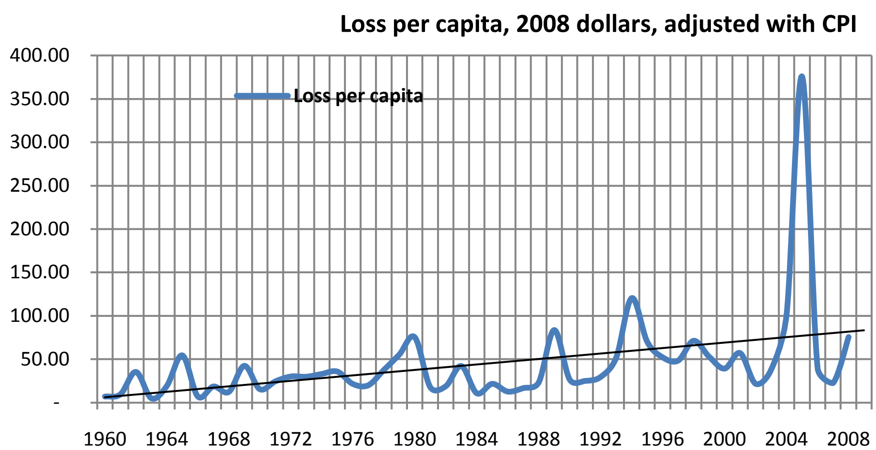


Figure 19. Average household income per county in 2006, US Census

While mortality shows no increase trends over time, or even a decrease when looked in relation to exposed population, economic losses seem to be increasing at a high rate. In this sense, extensive risk outcomes are the same in developing and developed economies.



A very interesting fact is that, with a few exceptions, major contributors to mortality (heat, tornado, cold weather events) in the US are different from major contributors to economic damage (hurricanes). The spatial distribution of economic losses could not be strongly correlated with the spatial distribution of mortality, despite there is some overlap especially on counties subject of intensive risk events.

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Cepeda, J., Smebye, H., Vangelsten, B., Nadim, F. and Muslim, D. 2010. *Landslide risk in Indonesia*. Background paper prepared for the 2011 Global Assessment Report on Disaster Risk Reduction. Prepared by the International Centre for Geohazards, Norwegian Geotechnical Institute. Geneva, Switzerland: UNISDR.

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