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Measuring the Human and Economic Impact of Disasters

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Contents

Measuring the Human and Economic Impact of Disasters

Debarati Guha-Sapir[1] and Philippe Hoyois[2]

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[1] Professor, Institute for Health and Society
Centre for Research on the Epidemiology of Disasters (CRED), University of Louvain School of Medicine, Brussels, debby.sapir@uclouvain.be
[2]Invited fellow, CRED,

1 INTRODUCTION

During the past decade, incidents of natural disasters that meet EMDAT criteria have increased six fold compared to the 1960s and the increase is mainly due to small and medium scale disasters[3] (Guha-Sapir *et al*., 2004)[4]. Of the total, almost 90 % are hydrometeorological events such as droughts, storms and floods and scientific evidence suggests that global climate change will only increase the number of extreme events, creating more frequent and intensified environmental emergencies (Trenberth *et al*., 2011., Blunden *et al*., 2011, Field *et al*., 2012).

There is general consensus about the key role of risk reduction in mitigating the vulnerability of human settlements to natural hazards, although there is - a lively debate regarding the distinctions between risk and vulnerability. Sarewitz *et al* (2003) have summarised six central assertions that differentiate between drivers of public policies for risk reduction and those for vulnerability reduction. The authors argue that covering costs of risk do not depend on reducing vulnerability and that accurate prediction of incidence of events is unlikely to improve understanding of vulnerability and finally that while reduction of vulnerability is a human rights issue, risk reduction, which is essentially cost based, is not. At this time, these distinctions which are the basis of public policy still remain under discussion. Notwithstanding the debate around risk and vulnerability, the importance of reducing both risk and vulnerability is widely acknowledged. Yet funding patterns, an indisputable indicator of real priorities, show that it is disaster relief and not reduction that grabs the largest share of disaster funding. (Venton et La Trobe, 2007) And this is true for countries that provide aid as well as for the disaster-prone countries themselves.

There are several reasons for this.

First, disaster relief is media friendly, action oriented, quantifiable (tons of food distributed, number of family shelters shipped) and easily accountable to donor constituencies. They are concrete and tangible actions in response to a disaster. **Second**, compared to development aid, emergency relief is easier to obtain since it is morally difficult to refuse aid in the face of immediate misery and high death tolls. Emergency relief also bypasses standard legal and financial controls making access to funds simpler. **Finally,** lack of evidence on the effectiveness of preparedness in poor settings does not encourage public or private

[3]See Section 2 for EMDAT criteria and definition of disasters

investment. The impact of disasters, in terms of loss of livelihoods, premature death and disability, as well as costs to development, is badly understood (e.g. : Cavallo et Noy, 2010; Baez *et al*., 2010; Neumayer et Plümper, 2007; Rodriguez-Oreggia *et al*., 2008) and therefore funding of disaster prevention often becomes a matter of belief rather than rational decision making.

Recognizing the need for evidence and the increase in human impact, availability of systematic data on the consequences of disasters is rapidly becoming an increasing concern for national and international authorities. (ISDR Global Assessment Report, 2011) The role of disasters as setbacks to the development process was set out with devastating clarity after the Haiti earthquake (2010) or the Myanmar Cyclone Nargis (2008). Recovering only the infrastructure losses caused by these events can absorb significant national resources or international aid which could have been used for real progress instead of reconstruction. Moreover, large scale loss of lives such as the those in the Haiti earthquake or the cyclone weaken the social and economic fabric of affected villages in many ways. For example, loss of earning members of the family or livelihoods leads to destitution which in turn can spur mass rural urban migration. (Davis, 2011) The knock-on or indirect effects of disasters are only recently being discussed in global policy forum in addition to the more direct and immediate effects, but systematic data or studies monitoring these effects are still hard to come by.

Before discussion of disaster databases, a short overview of recent developments in disaster data collection methods is useful.

Until recently, assessing disaster impact was a mixed bag at many levels. Information was collected at the time of the emergency by service providers using whatever tools that were at hand. Methods or definitions varied across teams, as did concepts of needs and impact. Most importantly data from different sources could not be compared either across zones or over time. Absence of baselines meant that it became difficult to assess if the aid was in fact having an effect on the victims. Time pressures to respond quickly for fund raising or relief planning often becomes detrimental to the data quality. Finally, impact data also informs preparedness and prevention and therefore its quality is not only key for immediate response but also for the calculation of risks, historical trends, assessments of vulnerability.

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[4] See Section 3 for further methodological explanation for classifying disasters by size

Lately, serious efforts have been made to develop standardised methods. Among these, the **Damage and Loss Assessment (DaLA) Methodology** is increasingly used. Initially developed by the UN Economic Commission for Latin America and the Caribbean (UN-ECLAC) in 1972, it has since been improved through close cooperation of WHO, PAHO, World Bank, Inter American Development Bank, UNESCO, ILO to capture the closest approximation of damage and losses due to disaster events. The DaLA Methodology bases its assessments on the overall economy of the affected country. It uses the national accounts and statistics of the country government as baseline data to assess damage and loss. It also factors in the impact of disasters on individual livelihoods and incomes to fully define the needs for recovery and reconstruction. DaLA includes damage at the replacement value of totally or partially destroyed physical assets; losses in the flows of the economy that arise from the temporary absence of the damaged assets; resultant impact on post-disaster macroeconomic performance, with special reference to economic growth/GDP, the balance of payments and fiscal situation of the Government. (http://www.gfdrr.org/gfdrr/Track-III-TA-Tools)

Post-Disaster Needs Assessment (**PDNA**) is a synthesis of DaLA and human recovery needs assessment. It typically includes the recovery and reconstruction framework that guides the post-disaster recovery strategy. The PDNA covers damage, loss, and macro-economic impacts on the affected economy; impacts on livelihoods, incomes, and human development; short, medium, and long-term recovery and reconstruction needs; and, measures for mainstreaming Disaster Risk Reduction in post-disaster recovery and reconstruction plans. Eleven PDNA country disaster reports are currently available. (http://www.gfdrr.org/gfdrr/Track-III-TA-Tools).

Another initiative that has been recently launched to support disaster data collection is ACAPS, which provides guidance for direct observation and key informant interviews supported by a flexible data collection instrument such as checklists. It also indicates techniques for drawing purposive samples and will be providing questionnaires and data analyses. (http://www.acaps.org/en/pages/methodology).

The above are methods to collect post disaster data and as such they represent a global move towards standardized data collection.

2 EXISTING DATABASES ON DISASTER IMPACTS

The World's Disaster Databases Catalogue of the United Nations Development Program's Global Risk Information Platform (GRIP) website lists 48 disaster databases. (http://www.undp.org/content/undp/en/home/ourwork/crisispreventionandrecovery/projects_initiatives/global_risk_identificationprogramme/). Forty-six provide multi-risk data of which 5 are for the whole world, 40 at national and one at provincial level. Two databases are focused on storm and weather disasters at a country level.

The five worldwide databases listed in the catalogue are the GLIDEnumber database (Asian Disaster Reduction Centre), the Disaster Database Project (University of Richmond), NATHAN (MunichRe), Sigma (SwissRe) and EMDAT (CRED/University of Louvain). Three additional databases, the Lloyds Casualty Week, the Aon Benfield – Impact Forecasting 's Global Catastroph Recap and the CAT NAT database, are also described below although they are not included in the GRIP list.

i. The **GLIDEnumber database is a joint initiative of CRED, Relief/Web, ADRC and LaRed which** proposes a unique identifier number for a disaster, intended to facilitate linkages between records in diverse disaster databases. The Glide number site advises the users to "Keep in mind that disaster databases from different institutions have different inclusion criteria and coverage, and depend on different data sources. We ask you not to expect every disaster to be already included and GLIDEnumber coded in every database". It also signals, in a disclaimer, that "Glidenumber.net makes no claim as to the statistical accuracy of the GLIDE generation system, and discourages the use of the data on this site for secondary analysis". (http://www.glidenumber.net/glide/public/search/search.jsp?)

ii. The **Disaster Database Project**, which excludes "minor, routine emergencies typically handled in today's environment by a single public safety service", intended to cover many categories of events including natural and technical disasters but also events such as attacks (aerial bombardment, civilian massacres, nuclear attacks…), civil wars, disappearances, genocides, illegal immigrations, riots… and also "psychological events" like "vampire" and "witchcraft". The project lasted from 2002 to 2006, the only years for

which substantial data are available.
(http://learning.richmond.edu/disaster/index.cfm)

iii. **MunichRe**, one of the largest re-insurer in the world, established in 1974, a natural hazards department to analyse and evaluate the full spectrum of natural hazards to offer comprehensive information, tools and services in risk management and research to its branch offices and clients. This department developed the NatCatSERVICE loss database which collects information and assesses losses on natural disasters and covers a period from 79AD to the present although they consider the post 1980 data to be most reliable. There are over 30,000 entries in the database with approximately 800 new natural disasters entries per year. Events are entered on a country and event level and recorded information includes people killed/injured/affected, economic and insured losses, and scientific data such as wind speed, magnitude, and geocoding. Sources include national insurance agencies, reports from clients and loss adjusters, insurance related journals, press and media, UN agencies, NGOs, world weather services and scientific institutes. Priority is given to clients and branches, and insurance industry reports. NatCatSERVICE is able to provide detailed economic and insured loss data which is not always found in databases that rely on humanitarian agencies in the field.

Raw data is accessible to clients of MunichRe, but some summarized products are publicly accessible such as annual global statistics, summarized data on great natural catastrophes, top ten ranked events, time trend and percent distribution charts. The statistics/analyses provided remain the property of Munich Reinsurance Company but may be used without charge in printed and electronic media, provided Munich Reinsurance Company is named as the source and the supplying of a specimen copy of the publication.
(https://www.munichre.com/touch/naturalhazards/en/natcatservice/default.aspx)

Munich Re publishes also an annual data brief called Topics Geo, a review of the preceding year's top natural catastrophes, with “selected features, catastrophe portraits and background analyses describ(ing) the current risk situation, trends and market developments from the insurance industry's perspective”. Short lists, figures and histograms are also used here to summarize data. A more detailed list of the 50 major events of the year is provided. Although Topics Geo is published since 18 years but archives are available only to the last two years.

Finally, an online NATHAN data service is reserved for the company's customers. Different online versions of NATHAN make natural hazard risk assessments easier. The Single Risk Online version of NATHAN, using high-resolution maps and satellite images, offers the option of exposure analyses down to address level. The Portfolio Risk Online gives underwriters the possibility to analyse natural hazard exposure of complete portfolios, facilitating premium calculation and accumulation control. The Portfolio Risk Pro is suitable for assessing large portfolios. (https://www.munichre.com/touch/naturalhazards/en/products_and_solutions/nathan_risk_suite/default.aspx)

Although being meticulously developed, the database has some weaknesses, like all large scale datasets. For example, the catastrophe category classification differentiates "events" (natural, small-scale loss and moderate loss events; categories 0,1 and 2) and "catastrophes" (severe, major, devastating and great natural; categories 2 to 6). But a semantic ambiguity remains in some "catastrophe" data provided, "events" and "catastrophes" being assimilated. Ambiguity regarding definitions of "great" or "significant", also pose difficulties for comparisons with other data sources.

iv. **SwissRe** is the second largest re-insurer in the world. (http://www.swissre.com/sigma/). It maintains the Sigma database, a limited-access global natural and man-made disaster database. Events are recorded from 1970 to the present. There are over 9,000 entries in the database with 300 new entries per year. Sigma requires at least one of the following for inclusion in the database; ≥20 deaths and/or missing, and/or ≥50 injured, and/or ≥2000 homeless, and/or insured losses (in 2011US$) >US$18 million (Marine), >US$35.9 million (Aviation), >US$44.6 million (all other losses), and/or total losses in excess of US$89.2 million. Its greatest strength is the detailed accounting of insured and uninsured damages. Sources of information include national disasters co-ordination bodies' publicly released information, press, industry reports, aid agencies reports, as well as internal primary research carried out by Swiss Re underwriting and claims assessors.

Sigma database is a proprietary disasters database, not publicly available. Swiss Re produces an annual list of previous year catastrophes in a PDF and hardcopy publication called SIGMA. It includes all disasters that meet their selection criteria

They report financial losses both insured and uninsured attributable to the event, including physical property damage, and business interruption as a result of property damage caused by the event. Insured losses are mainly drawn from property insurance claims payments. The definition does not include liability or life insurance claims payments even if losses are directly attributable to the event.

SIGMA is also a valuable source for estimates of indirect losses. These estimates cover losses suffered outside of the area affected by the event. For instance, it would include losses suffered by businesses unable to obtain goods from producers that suffered commercial interruption as a result of property damage caused by the event. Indirect losses are not included in estimates of total economic losses and therefore depending on the type of analyses, total losses could be an under-estimate of the real losses to the economy.

v. **Since 1988, CRED has maintained EM-DAT**, a worldwide database on disasters. The database's main objectives are to assist humanitarian action at both national and international levels; to rationalize decision-making for disaster preparedness; and to provide an objective basis for vulnerability assessment and priority setting. It is widely cited in policy documents and research analyses (IPCC, 2012; World Bank, 2012; IMF, 2012; Global Assessment Report, UN ISDR, 2011).
It contains essential core data on the occurrence and impacts of more than 19,000 disasters in the world dating from 1900 to the present. The data are compiled from various sources, including UN agencies, non-governmental organizations, insurance companies, research institutes and press agencies. Priority is given to data from UN agencies, followed by OFDA, governments and the International Federation of Red Cross and Red Crescent Societies. This prioritization is not only a reflection of the quality or value of the data, but it also allows triangulation of data as most reporting sources do not cover all disasters or have political limitations that can affect the figures. The entries are reviewed and corrected for redundancy, inconsistencies and incompleteness. The database is updated on a daily basis and made available to the public every 3 months after validation of the figures. Events are entered on a country-level basis and

information collected includes, amongst other, location, date, number of people killed/injured/affected, number homeless, and estimated damage costs. Sources include governments, UN agencies (UNEP, UNOCHA, WFP, FAO), NGOs (IFRC), research institutions, insurance companies (Lloyds) and press agencies. The database is searchable by country, disaster type, or time period. Due to the nature of the inclusion criteria, EM-DAT data is maintained at national resolutions. This creates difficulties for agencies attempting to disaggregate the impact of disasters on a more local level.

Finally, lack of sound definitions or or harministaion between sources or different levels of reporting (sun-national, nationam, global) is the major barrier today in impact assessment and monitoring. In this context, inter-operability between subnational units to global units would strengthen significantly national risk analysis.

CRED defines a disaster as “a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering”. For a disaster to be entered into the database, at least one of the following criteria must be fulfilled: 10 or more people reported killed; 100 or more people reported affected; declaration of a state of emergency; call for international assistance.

The EMDAT team finalises and closes a disaster record file 4 months after the event. It maintains a continuous, systematic search for past events that would have met EMDAT criteria but were not captured by the data supply sources.

Since 1960, events that have been overlooked by EMDAT system became progressively fewer until the 1980s when they became vanishingly small. Today, events that have occurred in this period, meet the EMDAT criteria and are not picked up by the system, are rare.

vi. Lloyd’s of England is the world’s leading specialist insurance market. It started with marine insurance, today covering risks in over 200 countries, and is often the first to insure new, unusual or complex risks.

A department of Lloyds, Lloyd’s List Intelligence, publishes the **Lloyd’s Casualty Week** which “contains information from worldwide sources of Marine, Non-Marine and Aviation casualties together with other reports relevant to the shipping, transport and insurance communities". Natural disasters, as a threat to traffic disruption as well as infrastructures destruction or immobilization, may lead to regional or international supply chain ruptures and are therefore covered by this company. The Casualties Service also offers real-time and personalized casualty alerts, a search engine in a 20 years casualty database and on request detailed information on major and minor incidents

However, all these services and the Lloyd's Casualty Week are only available through paid subscription. (http://info.lloydslistintelligence.com/our-services/casualities/).

vii Since 2010, Impact Forecasting® LLC, which is a catastrophe model development center within Aon Benfield, a world reinsurance intermediary and full-service capital advisor, publishes a monthly review of natural disasters named "Monthly Cat Recap" and, since January 2010, "Global catastrophe Recap". It also edits an "Annual Global Climate and Catastrophe Report" and some "Event Recap Reports".

Events registered are "defined as natural meteorological or climatological occurrences that caused noteworthy insurance losses, economic losses, human casualties or a large humanitarian impact", but criteria for selection are not provided.

Events are listed with event date, name or type and location; number of deaths, number of structures damaged or destroyed or number of claims and damages estimates in US$. Numbers of deaths are those "reported by public news media sources". Structures are defined as any building – including barns, family dwellings, and commercial facilities – that is damaged or destroyed by any natural-occurring phenomenon. The number of claims, which could be a combination of homeowners, commercial, auto and others, are those "reported by various insurance companies, through press releases or various public media outlets". Damage estimates are "obtained from various public media sources, including news websites, publications from insurance companies and financial institution press releases. These estimates can include insured or economic losses". (http://www.aon.com/impactforecasting/impact-forecasting.jsp)

viii Finally, a **private database** on natural disasters, CATNAT (http://www.catnat.net/) was developed in France, but its data are accessible uniquely against payment.

In addition to these global databases, there are a few that collect data at a provincial, national or multi-countries regional level or for specific hazard types.

An useful initiative amongst these is the **Desinventar** method and related database**.** This is a free open source data collection tool originally set upin 1994 by the Network of Social Studies in the Prevention of Disasters in Latin America (Red de EstudiosSociales en Prevención de Desastres en América Latina - LA RED). The concept and data contents are copyrighted by **Corporación OSSO,** Cali - Valle – Colombia. This effort was then picked up by UNDP and UNISDR who sponsored the implementation of similar systems in the Caribbean, Asia and Africa. The DesInventar open source Disaster Information Management System initiated approximately 23 national level natural and technological disaster databases. The databases are accessible on an individual national-level through downloadable software. The websites for each of these country datasets are available from Desinventar websites (http://www.desinventar.org/en/database, http://www.desinventar.net/). Though DesInventar utilizes government agencies, NGOs, and research institutes for source data, it relies heavily on news media as a priority source. Currently, no validation methodology is applied for data in the databases.

The conceptual basis is similar to NatCat, Sigma and EMDAT, all of which define a disaster as an incident that has implications for human society in contrast to, for example, meteorological or seismological data bases which are focused on the occurrence of the physical event, whether or not it has any direct human impact.

In contrast to EMDAT or Sigma, Desinventar includes all event that may have had any effect on life, properties or infrastructures, however small (eg; a single housefire affecting three persons or the drowning of an individual). Having no minimum threshold gives Desinventar the advantage of capturing very small incidents which when accumulated, can add up to significant impact, much like a number of road accidents can add up to a major train crash. Focusing on small incidents is sensible for local civil protection or national policies on accidents, may lead to losing sight of the devastating impacts of major disasters which, in instants may cause losses proportionally very much greater than those generated by small disasters in decades (Marulanda *et al*., 2010).

Another strength of Desinvetar is the small geographic units by which the data is reported allowing for local risk assessment. The sytem would be much enhanced if a standard global system of geocodes such as Global Administrative Unit Layers (GAUL) was used making regional or inter-country comparisons possible. All other human impact data variables such as dead, affected, missing have similar defintions to ones used by NatCat, Sigma and Emdat.

There are other specialized databases which monitor a specific hazards such as floods or earthquakes. Examples of these are the **Dartmouth Flood Inventory** (http://www.dartmouth.edu/~floods/), the **National Earthquake Information Center** of the Center for Seismology at Denver (http://earthquake.usgs.gov/regional/neic/) or the CATDAT Damaging Earthquakes Database (http://earthquake-report.com/). These list all past and present events, in their domain of specialization, which occurred worldwide. These datasets are focused on the physical events and not only those having human impact. As such, these lists are invaluable for risk computation or for disaster updating.

The main obstacle facing disaster databases today is the **absence of common set of definitions and method to collect human impact data**. Basic concepts of each disaster type and their subtypes need to be harmonized as well as methods that would measure impact. Notable efforts such as the DaLa (ECLAC) methods to standardize measures of economic impact has improved the quality of assessment but these methods remain complex and require significant time and agreed on a common disaster staff resources. Progress has also been made between CRED and Munich Re, whose scientific teams collaborated to agree on standard terms and definitions. They produced “Disaster Category Classification and Peril Terminology for Operational Databases” (Below *et al*. 2009) which is now used by both the institutions.

3 DISASTER IMPACT DATA - INTRODUCTION

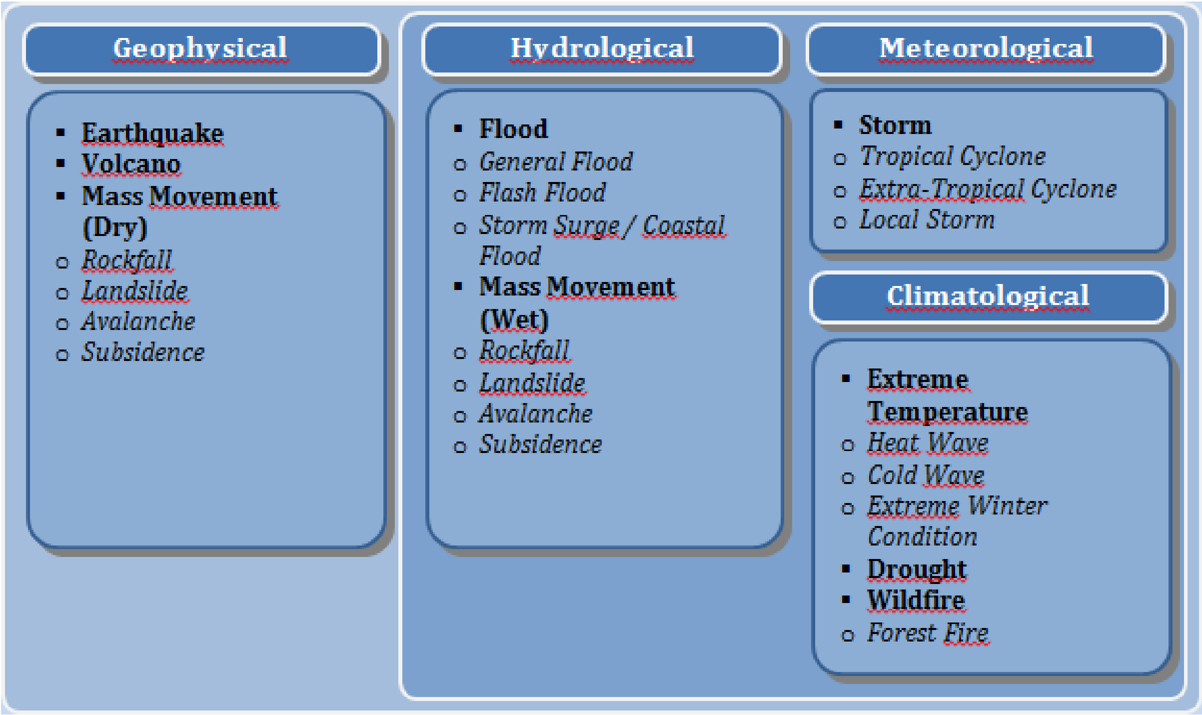
Our analyses uses 50 years of disaster data from the EMDAT database and covers 1961 – 2010, the period in which the coverage of large events is sufficiently reliable for global analysis. Issues related to coverage and limitations of the database are discussed later.
Our analyses categorises countries into high (US$ 12,276 or more), medium (US$ 1,006 - US$ 12,275) and low (US$ 1,005 or less) income categories as defined by the World Bank[5]; continents and regions refer to the UN geographic classification (see Annex 1). Geo-physical and hydro-meteorological disasters make reference to the CRED-Munich Re Disaster Category Classification and Peril Terminology (Wirtz et Guha-Sapir, 2009). For the purposes of this paper, hydro-meteorological disasters aggregate hydrological, meteorological and climatological disasters of this classification (see Table1).

Finally, the classification of disasters by size has been much studied by the EMDAT team. In 2003, CRED classified disasters into categories of large medium and small. A disaster was considered as “small” when the number of deaths was lower or equal to five, the number of people affected was lower or equal to 1,500 or the amount of economic damages was lower or equal to US$ 8 million, adjusted to 2003 dollars (or 9.79 US$ in 2011 values). The impact of a natural disaster was considered as “large” when the number of deaths was greater than or equal to 50, the number of people affected was greater than or equal to 150,000 or the amount of economic damages greater than or equal to US$ 200 million (in 2003 values or 244.69 in 2011 values). (Guha-Sapir *et al*., 2004).

In a more recent analysis of data, we considered the global distributions of direct impacts (numbers of people killed, numbers of people affected, amounts of damages) and used a classification according to distribution’s quintiles (Guha-Sapir et Hoyois, forthcoming). In this classification, “Large” disasters are those with a number of reported deaths equal to or greater than 75; a number of people reported affected equal to or greater than 150,000 and an amount of economic losses equal to or greater than US$ 589 million (in 2011 values).

These two “large disaster” categories successively used by CRED correspond well to the sum of Munich Re categories for Major, Devastating and Great Catastrophes.

Table 1 – Disaster subgroup definitions and classification



Between 1961 and 2010, a global annual average of 129.6 million (129,563,481) people were affected by natural disasters. These disasters claimed an average of almost 99,000 (98,816) lives per year. Between1961-1970, 1 in 138 persons worldwide were affected by natural hazards, compared to 1 in 28 in the decade 2001-2010 and the economic costs[6] associated with natural disasters increased more than eightfold. These numbers do not account for increases in post-disaster diseases, permanent disabilities or economic marginalization. Disaster driven processes such as rural urban migration due to recurrent drought or floods or chronic malnutrition and growth stunting are rarely studied and much of the socio-economic effects of these catastrophes remain hidden.

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[5] July 2011 version, classification based on 2010 GNI per capita (http://wdronline.worldbank.org/worldbank/a/incomelevel)
[6]at constant prices in 2011 dollar (source : US consumer price index annual average; ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt). An adjustment using national currencies and inflation rates with a final conversion in US$ was not performed : original data are often expressed in US$ but for some currencies old exchange rates and time series for deflators or price indexes are not always available.

4 TRENDS BY DISASTER EVENTS

The number of natural disasters worldwide that meets the EMDAT criteria has increased substantially since 1961 (Fig 1). Although there are potential biases in this increase and some of it maybe statistical and reporting artefacts, part of the trend is likely to reflect a real increase. Hydro-meteorological events such as storms including cyclones, typhoons and hurricanes, droughts, floods and wet landslides, account for anywhere between 70 – 90 percent in the last decade (Fig 2). In 2010, 92 % of the worldwide total were due to hydro-meteorological events and more than 96 % of the total affected. These events also accounted for almost 63 % of the total economic losses that year. Floods and storms tend to affect large populations as they occur in highly populous countries in South and South East Asia. Earthquakes have high mortality and costs but tend to affect fewer as the scope of their damage is generally more contained than the cyclone paths that can crash through large swathes of land mass.

Figure 1 - Occurrence of natural disasters as reported in EMDAT: 1900 – 2010

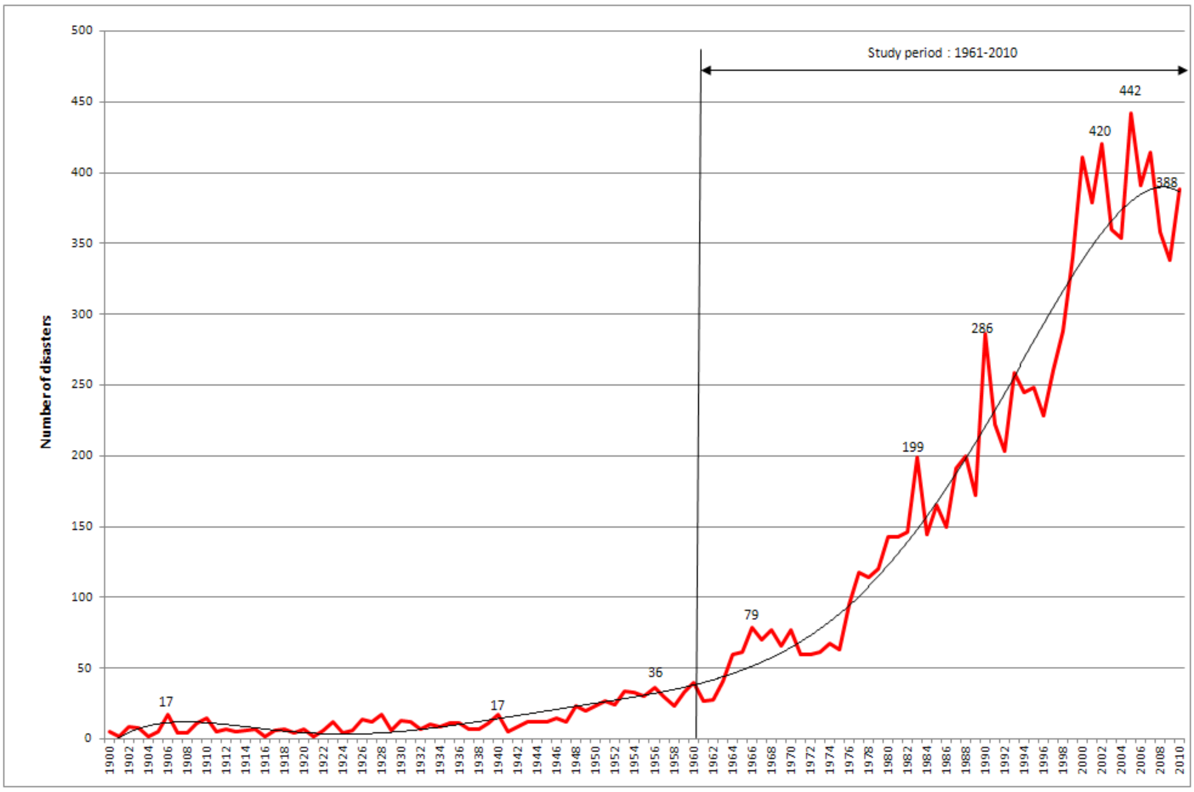
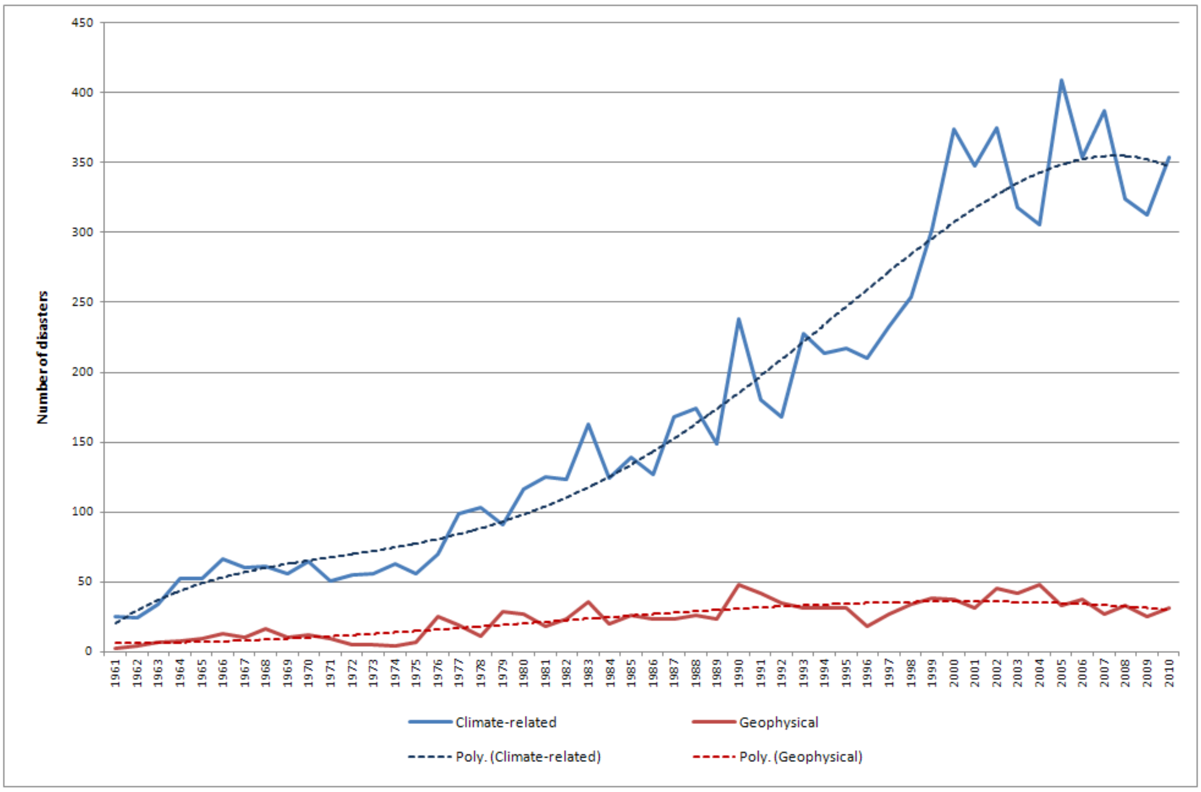
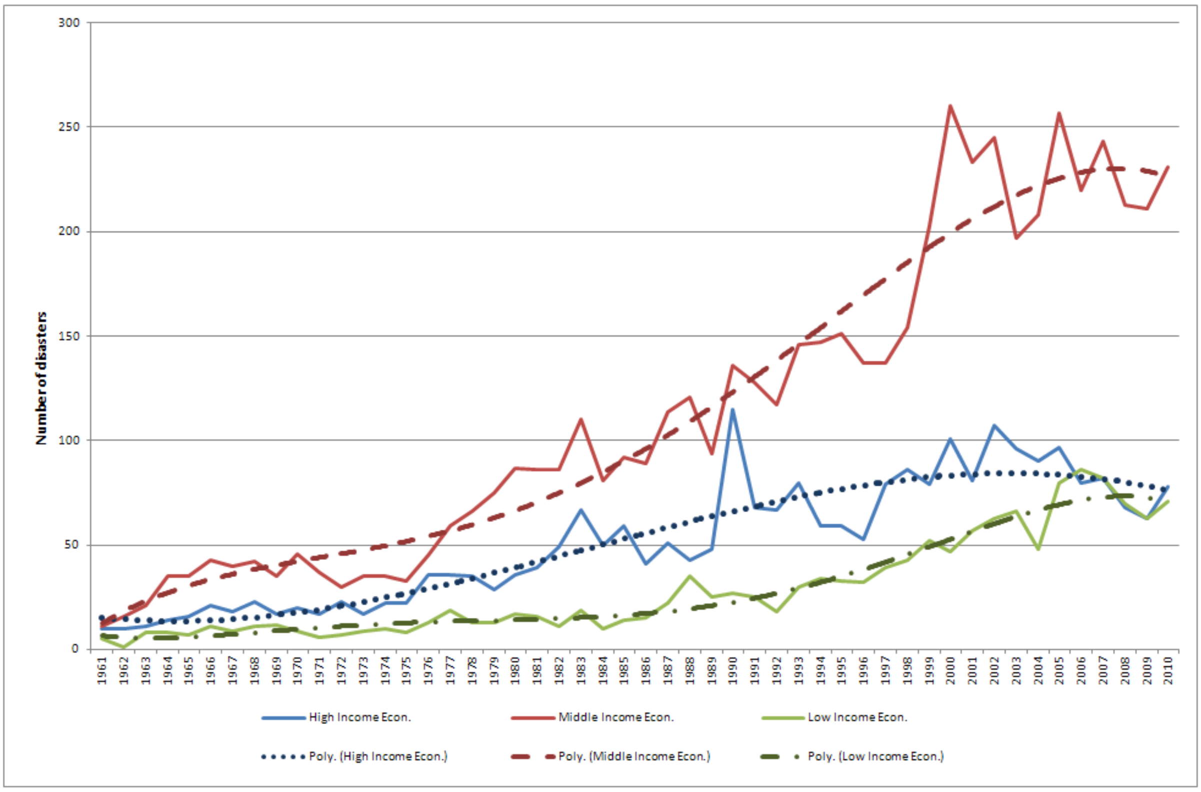


Figure 2 - Number of geophysical and hydro-meteorological disasters, 1961-2010



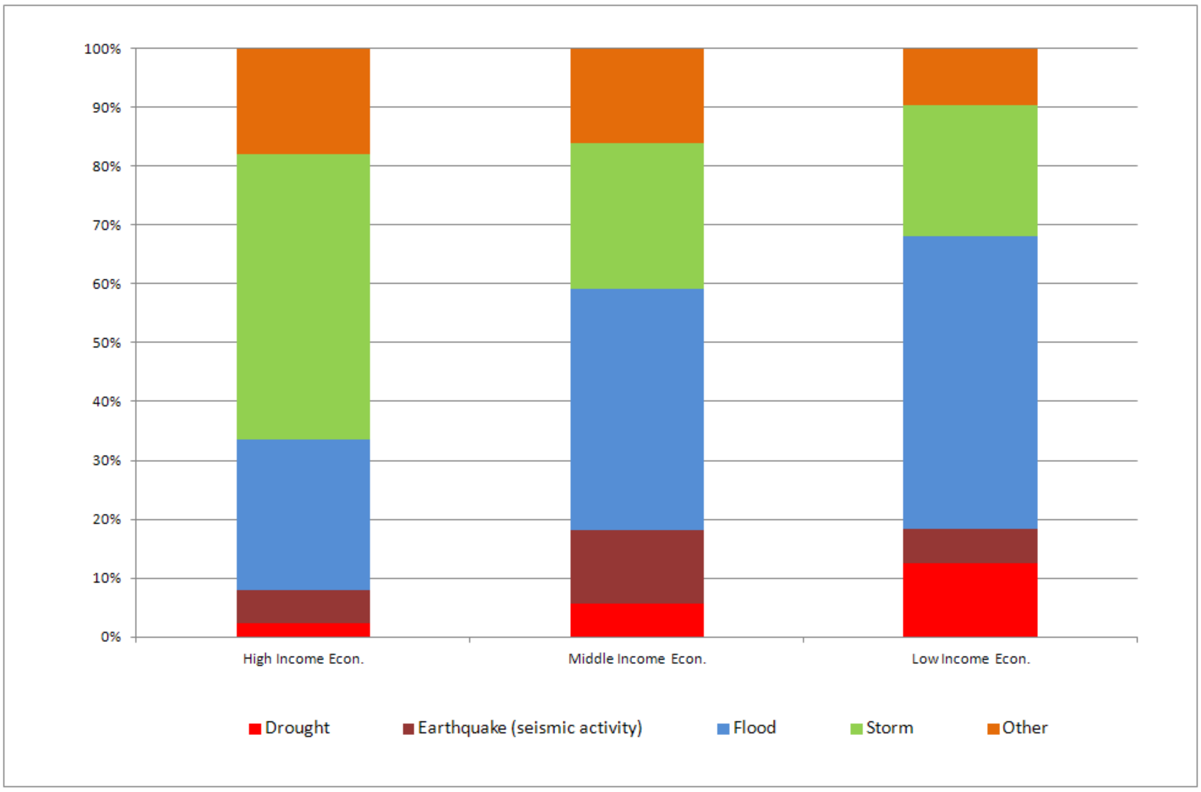
While all regions show an increase in the number of disasters, middle income countries know the greatest increase (Figure 3). Part of this is due to large countries, such as China and India, which by their sheer size, are exposed to more hazards and their population density renders them more vulnerable. The middle income category also includes countries at high seismic and volcanic risk such as most in South America and some in Asia such as Turkey, Armenia, Azerbaijan and Iran. Although the size of countries reflects exposure to natural hazards, it is the capacity of the national government and its infrastructure that remains the main determinant for effective response, preparedness and prevention.

Figure 3 - Number of natural disasters according to levels of economies, 1961-2010



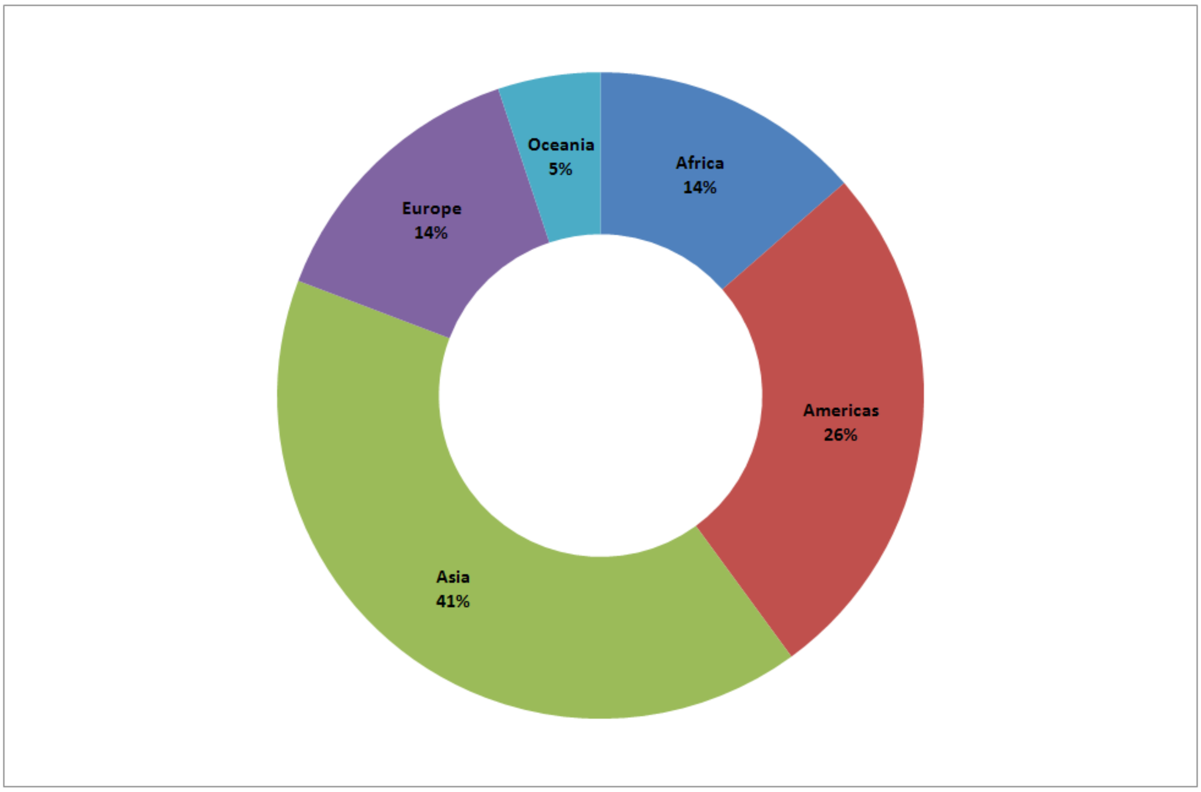
In terms of shares by disaster types, floods are by far the most common, accounting for nearly half of all catastrophic events in developing countries (Figure 4). Together with storms, these two events account for nearly 70 % of all natural disasters worldwide. Over the last 5 years a detailed examination of EMDAT data indicates that the number of floods may have decreased, but they still account for about 145 out of an average of 370 events per year.

Figure 4 - Distribution of disaster types by levels of economies, 1961-2010



On a continental level, Asia accounts for 2 out 5 disasters during the last 5 decades. Of these, South and South East Asia are the main contributors of the Asian share (Fig 5). Many of the countries in this continent are in cyclone and typhoon paths and several are in highly volcanic and seismic areas. Large river basin also increase the propensity for major floods. However, socio-economic contexts can sometimes be a stronger determinant of mortality than the physical characteristics of the event. Most recently, Cyclone Nargis in Myanmar (2008) was an eye opener with regard to the complexities of its impact. Although this cyclone swept through Eastern India and Bangladesh, it caused few or no deaths there, but killed more than 80 000 in Myanmar. The advance warning sent by the Indian Meteorological Organization to Rangoon was not adequately passed on to the communities (Webster, 2008), leaving them trapped in the Ayerwaddy Delta. The number of deaths may have risen further as humanitarian agencies faced difficulties to access the devastated region to provide aid to victims for 3 or 4 weeks after the event (Guha-Sapir et Vogt, 2009). Long and densely-populated coastlines in Asia also increase vulnerabilities to tsunamis and coastal flooding, but so do cultural practices. For example, age-sex patterns of mortality in Tamil Nadu after the 2004 tsunami were indicative of differentiated risk by demographic groups where mortality risk was elevated for girls who were typically unable to swim (Guha-Sapir *et al*., 2006)

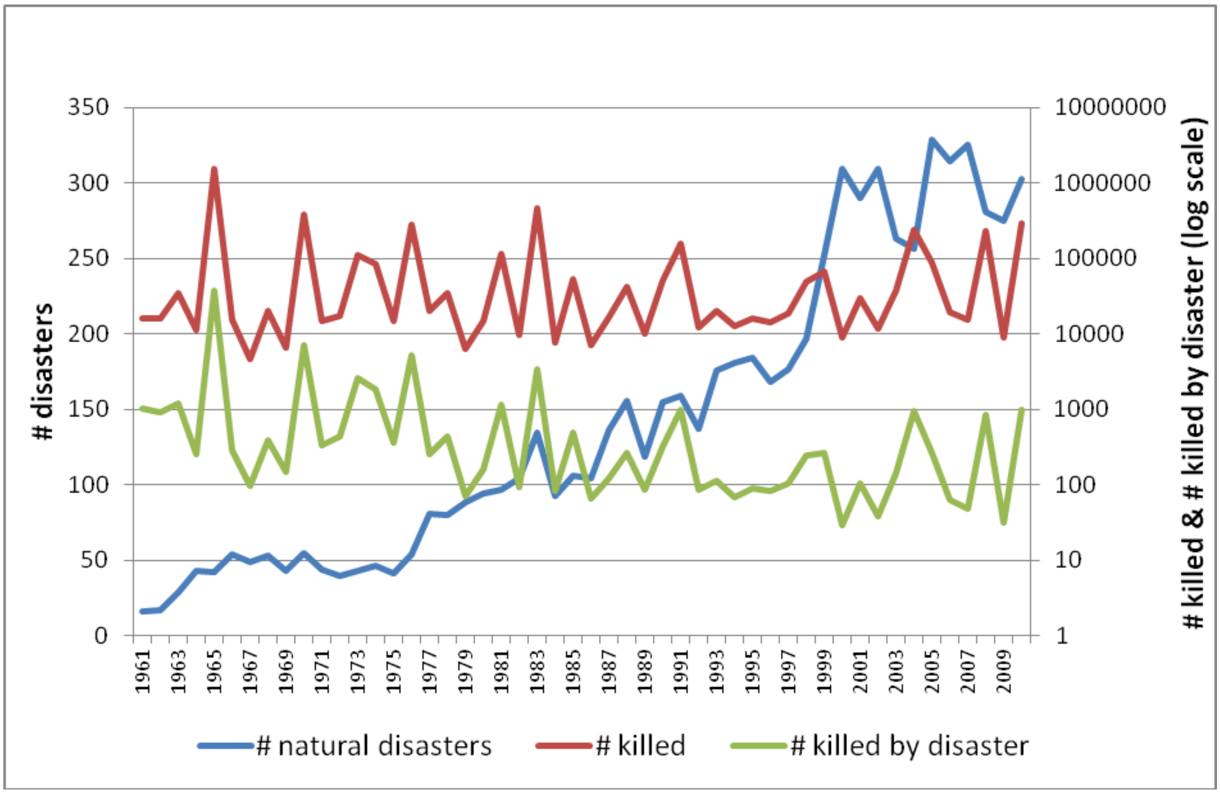
Figure 5 - Disaster occurrence by continent, 1961-2010



The American continent ranks second in the number of disaster events. High population densities in Asia and massive metropolises in Latin America influence the numbers of victims and lead to mega-disasters. In contrast, the African continent has fewer massive acute disasters. Lower population densities mean that large-scale disasters, when measured by human impact, are fewer in this region. Moreover, data reporting is also weak in many African countries, so the statistical bias may still be an issue here. The region is mostly affected by droughts, a disaster whose human impact is badly assessed. The 2011 Horn of Africa famine was a disaster that led to more than 10 million persons being displaced. The mortality and morbidity brought on by this catastrophe is underestimated, reducing its importance in setting policy and priorities in the region (Jeeyon et Guha-Sapir, 2012). Droughts (see Box1) are complex phenomena, often occurring concurrently with conflict and leading to famines, and the intricacies of merely defining a drought and famine are daunting. The human impact of droughts and famines are difficult to measure and are usually done through nutritional surveys. By the time these surveys show serious malnutrition, the window for effective action can be past. The lack of methods to estimate deaths from droughts and famines is a major weakness in this regard.

Overall, the number of disasters peaked in the later part of the decade of 2000 and has been decreasing since. The causes behind this decline are complex and maybe quite different for different disaster types or, indeed, in different regions. While global analyses from the EMDAT database can provide some insights, micro level studies are required to identify the factors that determine impact and therefore lead to effective policy. Small scale indicative studies show that the effects on health (Ahern *et al*, 2005; Mondal *et al*., 2001; Moreira Cedeño, 1986) and may be more significant in the medium and long term than estimated. A recent study of floods in Orissa demonstrated that educating mothers on the risks of malnutrition during flood periods can effectively protect the children at very low cost. The study also confirmed that children living in villages exposed to recurrent flooding display significantly more chronic malnutrition compared to equally poor children in non-flooded villages (Rajna-Dash *et al*., 2011).
In general, the importance of disease transmission following water-related disasters, for instance, is badly understood and relief interventions or even preparedness actions are planned on assumptions and stereotypes (Gayer *et al*., 2007).

Figure 6 - Trends in disasters and mortality in middle and low income countries, 1961-2010



There has been a steady increase in disaster events in low and medium income countries over the last 50 years but deaths per disaster event have decreased. The change in ratio is mainly due to an increase in the denominator i.e. an increase in the number of disasters with low or no mortality (Fig 6). Finer analyses to establish whether there is a real statistically significant change in victims of disasters and the determinants of this change is needed to guide preparedness programmes.

The decrease in deaths per disaster could also be linked to investments in prevention and preparedness programmes. But tempting as it is to arrive at this conclusion, the current state of scientific research on the differential impact of disasters on prepared and un-prepared communities does not allow for such causal associations. Drawing such a conclusion would require studies with quasi–experimental design where villages with and without interventions are compared. For instance, the widely cited success of cyclone shelters in Bangladesh in reducing cyclone related mortality requires sounder analysis of causal association. Randomly controlled trial designs are now much in vogue for these types of studies and may be useful to explore in order to clarify the impact of preparedness and prevention.

5 PATTERNS IN ECONOMIC LOSSES

Economic losses are widely used to indicate the severity of a disaster and to justify the need for preparedness. The distribution of natural disasters and their impact vary widely according to economies. Causes of flooding are complex involving among others, population distributions, economic resilience, earth sciences, hydrology, climatology and civil engineering. For example, their impacts can be very different in countries such as the UK compared to say, West Bengal in India. At the most proximate level, zoning regulations and flood-basin management practices play a significant role in preventing flood disasters. All of these institutional mechanisms are present and reinforced in wealthier countries which therefore are generally protected from devastating consequences of flooding.

Droughts are also reported more frequently (nearly two fold) in poor countries and are equally environmentally complex in nature. The lack of insurance, infrastructure such as irrigation systems, governmental programmes for market access may quickly turn a small rainfall anomaly to a disastrous drought. Unfortunately, droughts are also frequently made more complex, in regions such as Sub-Saharan Africa, by conflicts and insecurity that, together, lead this process towards spectacular famines that threaten Sahel Africa regularly.

Economic losses from disasters differ widely between countries, even when accounting for intensity. The greatest losses in absolute terms are from the wealthier countries while poor countries typically report low economic losses for disasters. Indeed, wealthier countries lose around 16, for every dollar lost due to natural disasters in poorest countries.

In contrast, for every person in wealthy countries who died in a disaster in the last 50 years, almost 30 individuals died in poor countries. In other words, the global ranking of disasters depends on the indicator used. Richer countries rank higher if economic loss data is used as an indicator of impact, while poor countries rank higher if death tolls are used as the impact indicator.

The use of economic loss data on a global level is troublesome for a variety of important reasons and should be handled with care.

First, economic loss data is **available for a minority of disaster** events. Some 36% of all disasters in Emdat since 1961 have economic losses reported and most of these are from upper or upper-middle income countries. Increasingly, loss figures are also generally reported by insurance companies, governments of affected and inter-governemental agencies. As a consequence, in countries or communities where ownership and value of economic assets are low, reported economic damages and insurance penetration are also likely to be commensurately low. About a fifth of poorest countries report economic losses at all and, as in these countries insured assets are a minor part of the losses incurred by disasters, the loss data from insurance sector can be misleading for global analyses.

Second, **methodology to assess economic loss is not standardized** and therefore precludes even broad comparability between estimates. The ECLAC Damage and Loss Assessment (DALA) and its derivative PDNA are used by the World Bank and others. Its applicability for most events remains limited due the wide scope of the assessment. Both methods require a large team of economists trained in its use and a long field presence, sometimes over a month, to complete the exercise.

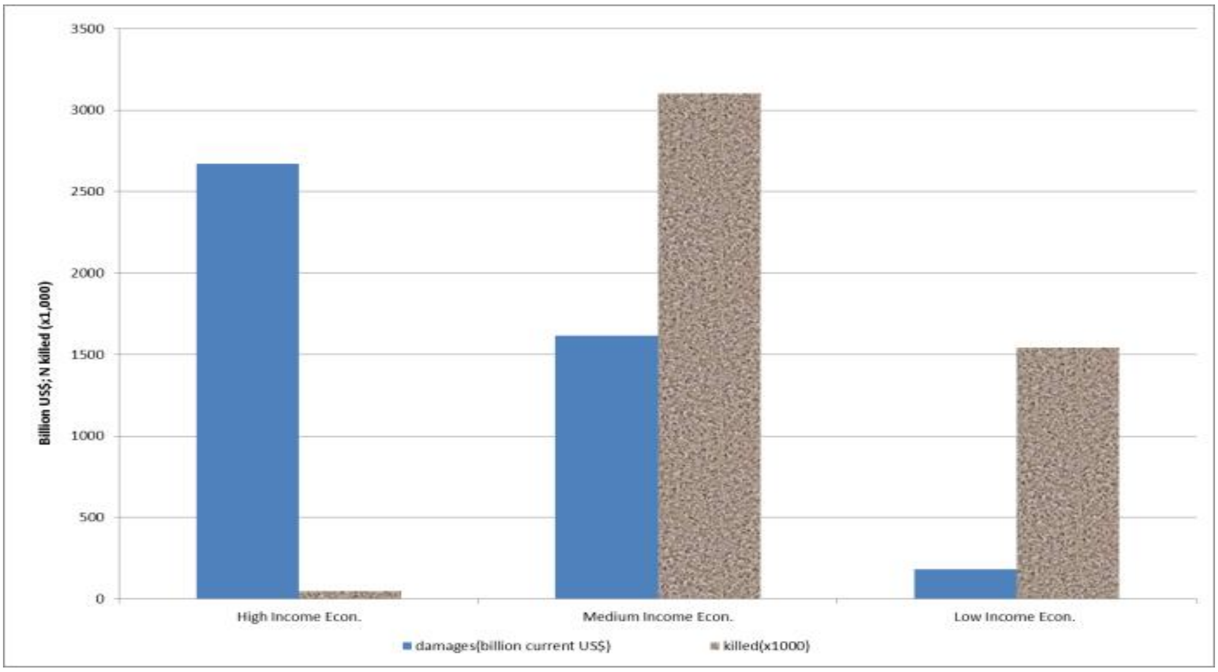
Third, **loss of life is not included in the economic loss calculations,** seriously underestimating the loss in poor countries, where values of physical assets are low and lives lost are high. Poor countries have difficulties qualifying for loans and grants as loss estimates are based on physical infrastructure damage. Methods such as the DALA or PDNA do not account for the value of lives lost. In consequence, losses from disasters such as Cyclone Nargis (80 000 dead) or Haiti (225 000 dead) remain relatively insignificant as the economic value of human lives lost is not factored in. The wider debate around the economic valuation of life and its ethical implications complicates the calculation of a global estimate. But meanwhile, the death tolls are not factored in at all in recovery planning.

Notwithstanding all these limitations, the loss data from the EMDAT database does provide some insight and this are presented below.

6 COMPARATIVE ANALYSES OF LOSSES BY SIZE OF ECONOMIES

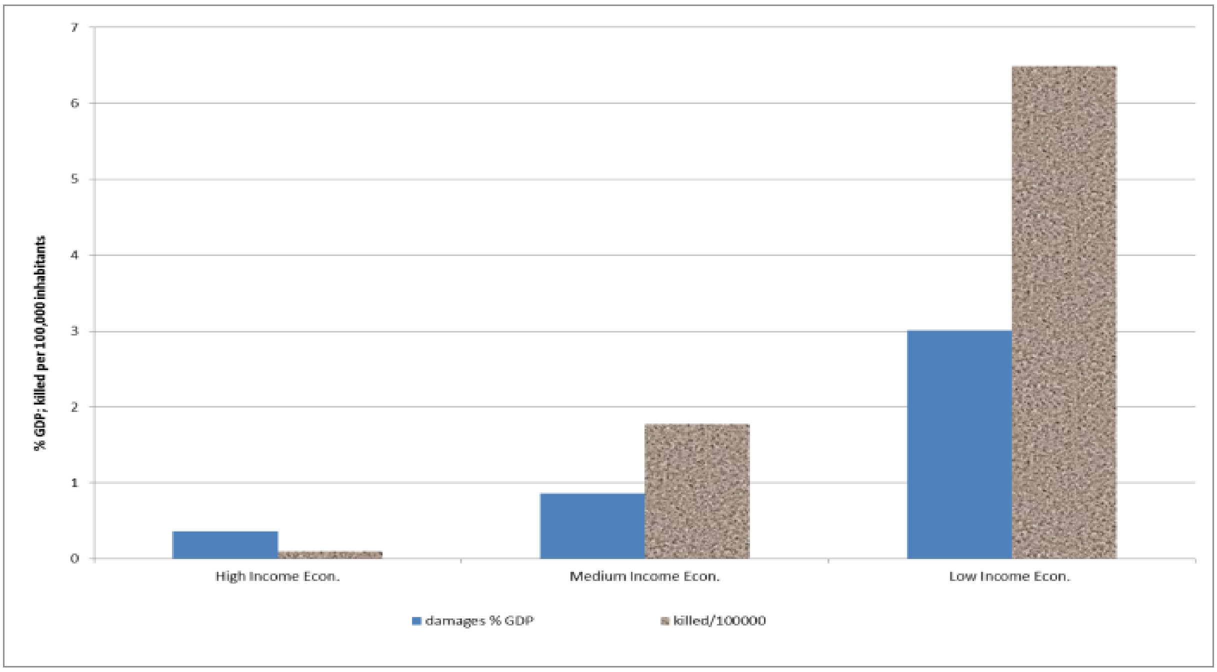
The pattern of economic losses when classified by wealth is significantly higher in richer countries than in poorer ones. In contrast, death tolls from disasters are higher in poorer countries (Figure 7). The massive Tohoku tsunami in March 2011 killed 20,319 people and generated US$ 216 billion in damages. The Kobe earthquake in 1995 made 5.297 deaths and cost 147.3 billion (in 2011 US$) and Hurricane Katarina in 2005 registered 1.833 people killed and 143.6 billion (in 2011 US$) in losses. Inversely, the earthquake in Haiti in 2010 made 222,570 deaths and an amount of damages of 8.3 billion (in 2011 US$) and the cyclone Nargis, in Myanmar in 2008, killed 138,366 persons and 4.3 billion (in 2011 US$) in losses.

Figure 7 - Economic damages and mortality by level of economies (WB Classification), 1961-2010



As both wealth and population size influence the death toll and economic loss, we standardized deaths by calculating population-based mortality rates and expressed economic loss as a percentage of GDP. In that case, both mortality and economic losses increase as economies get poorer, reflecting more accurately the burden of disasters (Fig. 8).

Figure 8 - Economic damages relative to GDP and mortality per 100,000 inhabitants by level of economies, 1961-2010



Models or indices to reflect comparative vulnerability to death and economic losses are useful tools and need to be further researched for policy setting and resource allocation. Although some global attempts at ranking countries by vulnerability exist, they tend to simply reflect poverty rather than a more refined differentiated scaling of countries. Ranking countries according to their risk, vulnerability or protective factors to disasters is a potential policy tool of significance as it helps to guide resource allocation for large donors. Some of the best known ranking indices are:

- The Disaster Risk Index (UNDP, 2004) which assesses disaster risks from various types of hazards. The model has been refined, identifying key risk drivers and spatial distribution of hazards, exposure and risk. Results are made available on-line through PREVIEW Global Risk Data Platform (Peduzzi *et al*., 2010);
- The World Risk Index, developed by the UN University Institute for Environment and Human Security (2012) is a combination of four components : exposure, susceptibility, coping capacities and adaptive capacities (http://www.ehs.unu.edu/file/get/10487.pdf);
- The Climate Vulnerability Monitor was developed by DARA, an independent organisation committed to improving the quality and effectiveness of aid for vulnerable populations suffering from conflict, disasters and climate change . It evaluates the vulnerability of countries to climate change as well as its impact on health, weather disaster risk of

occurrence, losses in habitat and economic stress (http://download.daraint.org/CVM2-Low.pdf);

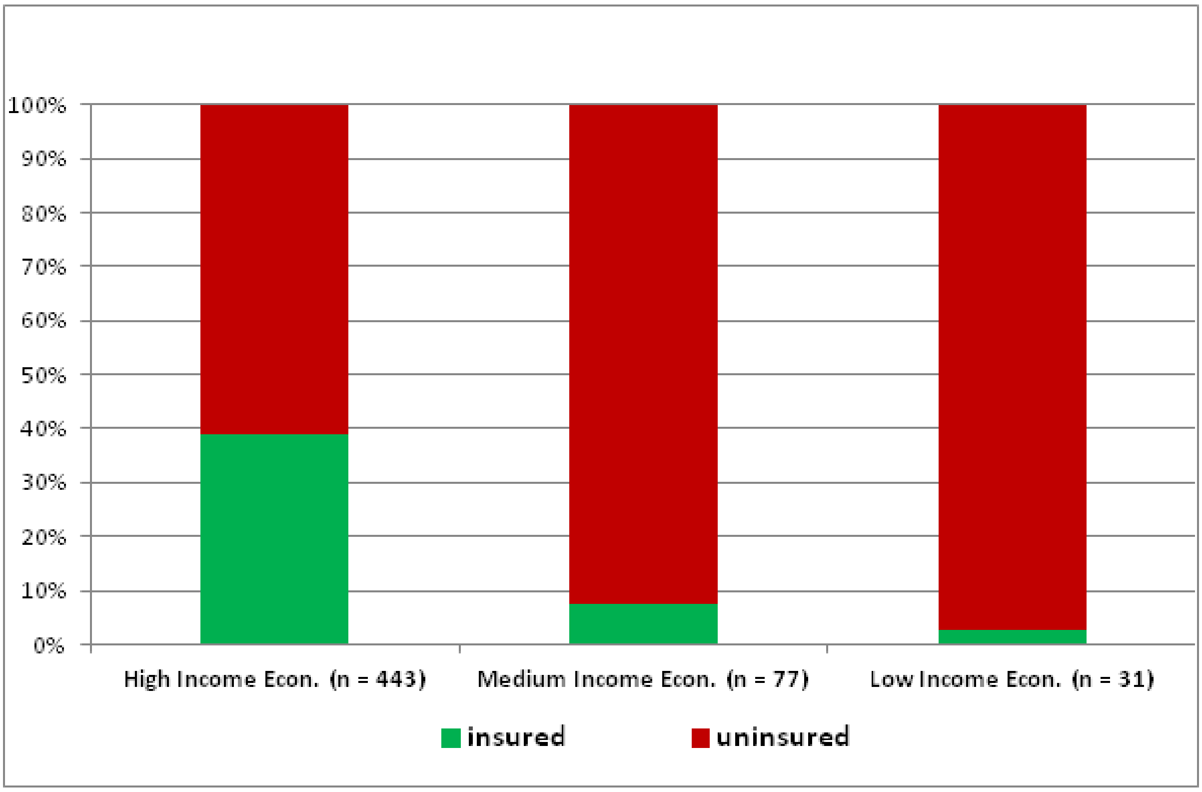
- Maplecroft, a private firm, offers to its clients, among others, a Natural Disasters Risk Index, a Natural Hazard Economic Exposure index and a Climate Change Vulnerability Index (http://maplecroft.com/)

Each of these indices has its advantages and documents different aspects of risk factors for each country. However, the focus on risk neglects the direct observed impacts of natural disasters on human populations and economies which remains of paramount importance for global assessments of impact. To fill this gap, we are currently exploring a model to generate a disaster sensitivity index (DSI) which summarizes the human and economic impacts of disasters. Using only the largest disasters, a first level DSI is computed for each country. Using this approach, Bangladesh, Haiti, Iran and Philippines rank the highest for the last five years. Further details are provided in Box 2.

7 REPORTING INSURED LOSSES

Most countries do not report economic damages from disasters and of these that do, richer countries report more often than poorer ones. Out of the total number of disasters in EMDAT for the period of this report, 572 (about 5%) provided data on total and the share of insured losses. Furthermore, insured losses represented nearly 40% of those reported from wealthier countries in contrast to less than 5% of total losses in the poorest ones. Insurance companies are the main source of insured data and are discussed below. Although reporting bias maybe a factor for the low insured losses in the poor countries, in reality, tit is more likely that widespread poverty preclude households to spend their income to insure their assets or livelihoods.

Figure 9 - Insured losses as proportion of total losses by income categories (n=572), 1961-2010



8 LIMITATIONS AND BIASES IN DISASTER DATASETS

Global and regional disaster database face challenges in quality and accuracy of data they routinely register. Occurrences of disasters as well as their human and economic impacts are susceptible to a variety of biases and have rather specific limitations.

Bias related to sources

Global database, like Swiss Re's Sigma, Munich Re's Nathan and CRED's EMDAT compile and compare different data report sources before entering disaster information in their databases. Chief sources for reinsurance companies are internal or client reports while CRED gives priority to data from governments, UN agencies and US Agency for International Development (US Office of Foreign Disaster Assistance), Red Cross. Both complement their records with data from NGOs, insurance and reinsurances periodicals, government offices, scientific sources and organisations. Information from press agencies and newspaper are also be used but are deemed low priority. While they admittedly report valuable narrative detail, they contain inaccuracies, especially when passing on unfounded reports and can be biased towards more newsworthy events. (Glave *et al*., 2008)

A key problem with all of the above mentioned sources is the differences in the methods used to collect and formalize data. The original information is often not specifically gathered for statistical purposes and, although the compilers such as NatCat (Munich Re or EMDAT apply strict definitions for disaster events and parameters, the original suppliers of information may not.

Whereas for developed countries, quality can suffer from a excessive production of data which can overload systems, the problem in developing countries is often the opposite: there are few sources of information with limited options for validation.

The quality of disaster data may also vary as reporting can be biased according to the specific political context of the disaster. Authorities may not be willing to admit failure to respond or allow foreign agencies to enter sensitive areas and therefore may under report. A recent analysis showed that countries with non-free press and countries with higher "bureaucratic quality", as a measure of effective governance, tend to report fewer disasters than more democratic countries or those with a freer press (Jennings, 2011). Political concerns may also lie behind governmental decisions to declare a state of emergency. (Garrett et Sobel, 2007). On the other hand, the potential of international aid may encourage overstating the case in generally needy communities.

Moreover, completion issues are typically a problem in most global datasets but they are especially relevant for certain type of disasters or for certain characteristic. For example, in the case of droughts, a number of people killed are approximations at best because of the difficulties to appraise deaths as a direct result of the disaster. Economic losses are often reported in developed countries, although inter-country variation,   but much less so in developing ones.

Standardisations and Definitions

One of the main barriers for reliable disaster data is the poor availability of standardized methodologies and definitions.

For example, data on deaths are usually available because they are an immediate proxy for the severity of the disaster. However,   reported deaths may aggregate “dead and missing people” and thereby leading to a significant reduction in the final death tolls once the missing are removed from the death list. In EMDAT, the category for “killed” is defined as “persons confirmed as dead and persons missing and presumed dead”. The numbers put forward immediately after a disaster may, therefore sometimes be revised, occasionally several months later.

Data on the numbers of people injured, homeless, displaced, evacuated or affected by a disaster can provide some of particularly useful figures for planning both disaster preparedness and response, but the details are insufficient. In addition, definitions may vary and increase uncertainties on the accuracy and comparability. For example, “displaced” would need to be defined for permanency (eg evacuees never returned to their original homes) or duration (eg homeless for 6 weeks or 2 years). Most of the time, only a global number of “people affected” is provided and they could be motivated by various political drivers at both local and international levels. Even in the absence of manipulation, data may be extrapolated from old census information on the population of the affected area with assumptions being made about percentages affected. Therefore, numbers of people affected in particular for all databases, should be cautiously regarded and considered as a proxy for disaster size rather than an accurate measure of disaster impact.

On a global scale, sometimes the real scope of the impacts may remain partially unknown. In some places, where population size is undocumented, fatalities and number of people affected cannot be calculated.

Damages and losses reported immediately, after an event, are generally unreliable and are sometimes overstated with the hope of mobilising more emergency aid (Wirtz *et al*., 2012). If insured losses are easy to compute for reinsurance companies, they are almost non-existent for countries of the developing world. In the absence of insured values of losses, sound assessments of economic losses would be a source of key impact data especially for poor countries. However loss assessments in communities where informal sector is large and assets are less documentated, this becomes a more complex exercise and in the few occasions where it is done, the results are available long after the event. Loss estimates, such as they are depend heavily on the methodologies used for calculating, but these are rarely documented. In these circumstances, losses provide a rough indication of the scope of the economic impact rather than an exact figure.

Conceptual ambiguities

Disaster data terms also suffer from conceptual ambiguities. Dates can be a source of confusion and can in some cases, seriously mislead analyses. For example, while a start data for drought is necessary in databases, it brings an overrated precision as a drought does not occur on a single day. EMDAT typically uses the date that the national authority or an UN body declares an official drought emergency.

Changes in national boundaries are another example of a source of ambiguities in the data and may make long-term trend analysis tricky. Minute adjustments have to be made to the data as ex Soviet Union countries get created and Sudan splits up.

In disasters that strike several countries, each country may use different methods for assessing deaths and losses making it complicated to evaluate the globalised loss of that one multi country event.

Another problem arises from losses and deaths that are reported for the event that either span a few years (such as droughts) or cross over two calendar years (floods). In these cases, attributing these losses to any one year is difficult and pose problems for trend analyses.

In some cases, independent disasters occurring in the same region in quick succession may get associated. For example, prolonged heavy rains may cause landslides in one valley and a flood in the downstream plain, but both disasters are reported as one event.

Historical and time series data

Historical data of importance for time-series analyses, may also be affected by other inconsistencies. The increase in the numbers of disasters, clear in all global databases, may be explained by enhanced disaster reporting from development of telecommunication technology, increased international co-operation and a greater attention of media. Growing coverage of disasters by insurance schemes in developed countries as well as the taking into account of the impact of disastrous events by specialized agencies such as the UN World Food program, the World Health Organization or the US National Oceanic and Atmospheric Administration explains also the better reporting of disasters in the last decades (Guha-Sapir *et al*., 2004)

Better focusing on disaster risks lead to better reporting, but it could also be a consequence of widespread establishment of disaster agencies, which may tend to present mere incidents into full-fledged disasters (Kirschenbaum, 2004) or because of semantic shifts from - small - “events” or “accidents” to disasters.

In addition, increases in humanitarian funding may also have encouraged the reporting of more disasters, especially smaller events that were previously managed locally.

From a technical point of view, changes in disasters definitions or in assessment methodologies over time will bias registered data. Furthermore, changes in country boundaries can complicate analyses especially if complex aggregation or disaggregation methods cannot be used for data processing.

However, historical biases are of greater concern for small disasters than larger ones which are better reported over time. In the EMDAT system, the number of the large geophysical disasters in the decade 2001-2010 increased by a factor of 1.6 and small events by a factor of

5.8, compared to 1960s. Similarly, in the 2000 decade, large climate-related disasters were 3.5 times greater but small climate disasters were 9.8 times greater than in the 1960's.

Database comparisons

Differences among global or country-level disaster databases for the same events can create confusion and misunderstanding. Databases focused on full risks analysis tend to register all events with no minimum impact value. Other databases, like CRED's EM-DAT or Swiss Re's Sigma, are focused on impacts whose societal or economic consequences can be seriously detrimental for regions hit and for which important external relief and/or financing could be needy. Therefore they use thresholds for data selection, defining de facto a first level of severity for events.

There is discussion around the importance of accumulated deaths or losses from many small events that can be equal to or greater than a large event. The weakness in this approach is that very small events (affecting 3 houses or killing one individual) should not qualify as an catastrophe or disaster as it does not overwhelm the capacity of the local community to respond. Further According to available data in EMDAT, for the period 1961-2010, "large" disasters accounted for 98.4 % in the total number of people killed by natural disasters; 98.8 % in the total number of people affected and 93.8 % of all reported damages. Similar observations were made in Australia (Bureau of Transport Economics, 2001) or can be deduced from available data (see Marulanda *et al*., 2010)

Lack of availability of detailed terminologies and methodologies limits the transparency of databases but also complicates comparisons because of ambiguity and/or differences in definitions used. In the absence of standardization in terminologies, classifications, geo-referencing, indicators used comparability becomes uneasy.

Sources used by different databases may also have an impact on data produced. The more or less wide availability of information, proximity with data sources, accessibility to assessments and reassessments of impact may lead to differences in data provided.

In conclusion, part of the solution to all these data problem lies in retrospective analysis. Data is most often publicly quoted and reported during a disaster event, but it is only long after the event, once the relief operation is over, that estimates of damage and death can be verified.

Some data gatherers, like CRED, revisit the data; this accounts for retrospective annual disaster figures changing one, two and sometimes even three years after the event.

However, the most important part of the solution lies in standardization of terminologies and classifications used to describe the events and of methodologies to assess their impacts. The “Disaster Category Classification and peril Terminology for Operational Databases” was a first step (Below *et al*., 2009). Determination of common rules for geo-coding and definition of impacts indicators are current ongoing tasks.

9 CONCLUSIONS

Risk reduction pre-supposes an understanding of impact and the burden of past disasters and, in that context, disaster data collection systems are receiving much attention.

Initiatives like EMDAT have made progress to standardize methodologies and definitions and bring a scientific approach to collecting disaster data at the global levels. Munich Re and CRED have worked on definitions and data collection methods. But some critical steps remain to be taken in order to establish global standards and norms. Lack of common definitions and interoperability between data collected at sub-national levels, regional levels and global levels also reduce the quality and usability of disaster data. Systems that are harmonized between different geographic levels (sub-national, national, regional, global) would significantly improve the quality and coverage of data. A plan to establish a regional consortium in Asia to address this is currently under discussion between GFDRR-World Bank, USAID, CRED and Asian Universities.

Natural disasters also need to be studied systematically in terms of their impact on human populations, and not only as geo-physical or meteorological events. Their direct impacts in terms of deaths, disabilities and disease need to be monitored and understood both at global and at community levels. Better understanding of the risk factors for death, disability and livelihood loss at community levels can substantially strengthen early warning and disaster preparedness programmes. An example is described in Box 3.

Finally, influential reports such as UNDP’s Human Development Reports and the World Bank’s World Development Report should include disaster statistics as standard table elements. This simple and low-effort action would effectively help mainstream disasters in development discussions.

REFERENCES

Ahern M., Kovats R., Wilkinson P., Few R., Matthies F. (2005) *Global Health Impacts of Floods: Epidemiologic Evidence*. Epidemiologic Reviews 27 (1), 36-46

Anbarci N., Escaleras M., Register Ch. (2005) *Earthquake Fatalities: The Interaction of Nature and Political Economy*. Journal of Public Economics 89 (9-10), 1907-1933.

Baez J., de la Fuente A., Santos I. (2010) *Do natural disasters affect human capital ? An assessment based on existing empirical evidence*. IZA Discussion paper n° 5164: Bonn, Germany.

Below R., Vos F., Guha-Sapir D. (2010) : *Moving towards Harmonization of Disaster Data : A Study of Six Asian Databases*. CRED Workig Paper n° 272

Below R., Wirtz A., Guha-Sapir D. (2009) *Disaster Category Classification and Peril Terminology for Operational Purposes. Common accord*. Centre for Research on the Epidemiology of Disasters and Munich Reinsurance Company. CRED Working Paper n° 264. CRED: Brussels, Belgium.

Blunden J., and Arndt D. S., Eds. (2012) State of the Climate in 2011. Bulletin of the American Meteorological Society 93 (7), S1–S264.

Bureau of Transport Economics (2001) *Economic costs of natural disasters in Australia*. Canberra, Australia.

Cavallo E., Noy I. (2010) *The economics of natural disasters*. IDB Working Paper Series n° IDB-WP-124. Inter-American Development Bank.

Chou Y., Huang N., Lee C., Tsai S., Chen L., Chang H. (2004) *Who Is at Risk of Death in an Earthquake?* American Journal of Epidemiology 160 (7), 688-695.

Davis I. (2011) *Reducing disaster risks 1980–2010: Some reflections and speculations.* Environmental Hazards, 10 (1), 80-92.

DARA (2012) *Climate Vulnerability Monitor – 2nd Edition. A guide to the cold calculus of a hot Planet*. DARA and the Climate Vulnerable Forum: Madrid, Spain.

Dilley, M., Chen, R. S., Deichmann, U., Lerner-Lam, A., Arnold, M., Agwe, J., Buys, P., Kjekstad, O., Lyon, B., and Yetman, G. (2005) *Natural disaster hotspots: A global risk analysis*. Disaster Risk Management Series n°5, The World Bank: Washington, D.C., USA.

Dracup J., Lee K., Paulson Jr E. (1980) *On the definition of droughts*. Water Resources Research 16(2), 297-302.

Field, C.B. (2012) Summary for Policymakers, in: Field, C.B., Barros V., Stocker T.F., Qin D., Dokken D.J., Ebi K.L., Mastrandrea M.D., Mach K.J., Plattner G.-K., Allen S.K., Tignor M., and Midgley P.M. (eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation : A Special Report of Working Groups I and II of the Intergovernmental

Panel on Climate Change. Cambridge University Press, Cambridge: UK, and New York, NY: USA.

Garrett Th., Sobel R. (2007) *The political economy of FEMA disaster payments.* Economic Inquiry 41 (3), 496-509.

Gayer M., Legros D. Formenty P., Connolly M. (2007) *Conflict and emerging infectious diseases*. Emerging Infectious Diseases 13 (11), 1625-1631.

Gertler P., Martinez S. , Premand P., Rawlings L., Vermeersch Ch. (2011) Impact Evaluation in Practice. The World Bank: Washington DC, USA.

Gertler P. (2004) Do Conditional Cash Transfers Improve Child Health? Evidence from PROGRESA's Control Randomized Experiment. American Economic Review 94 (2), 336–41.

Glave M., Fort R., Rosemberg C. (2008) *Disaster Risk and Poverty in Latin America. The Peruvian Case Study. Annex 1 : Comparison of SINPAD and Desinventar Databases*. RPP LAC – MDGs and Poverty – 04/2008,RBLAC-UNDP: New York, USA.
Guha-Sapir D., Hargitt D. Hoyois Ph. (2004) *Thirty years of natural disasters. 1974-2003 : the numbers*. Presses Universitaires de Louvain: Louvain-la-Neuve, Belgium.

Guha-Sapir D., Parry L., Degomme O, Joshi P, Arnold J. (2006) *Risk factors for mortality and injury: Post-tsunami epidemiological findings from Tamil Nadu*. CRED-UNISDR Report, CRED: Brussels, Belgium.

Guha-Sapir D., Vogt F. (2009) *Cyclone Nargis in Myanmar: Lessons for public health preparedness for cyclones*. American Journal of Disaster Medicine 4 (5), 273-278.

Guha-Sapir D., Hoyois Ph. (Forthcoming) *Disaster impact classifications : A review and a reassessment from EM-DAT data*.

Internaly Displacement Monitoring Centre (2012) Global estimates 2011: People displaced by natural hazard-induced disasters. Norwegian Refugee Council: Geneva, Switzerland.

IPCC (2012) *Managing the risks of extreme events and disasters to advance climate change adaptation. Special Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press: New York, USA.

Jeeyon J., Guha-Sapir D. (2012) *Famines in Africa: is early warning early enough?* Global Health Action 5, 18481.

Jennings S. (2011) Time's Bitter Flood. Trends in the number of reported natural disasters. Oxfam GB Research Report, Oxfam GB.

Jha A., Bloch R., Lamond J. (2012) *Cities and Flooding. A Guide to Integrated Urban Flood Risk Management for the 21st Century*. The World Bank: Washington DC, USA.

Kim J., Guha-Sapir D. (2012) *Famines in Africa: is early warning early enough?* Glob. Health Action, 5: 18481.

Kirschenbaum A. (2004) *Chaos organization and disaster management*. Marcel Dekker: New York, USA.

Kron W., Steuer M., Löw P., Wirtz A. (2012) How to deal properly with a natural catastrophe database – analysis of flood losses. Natural Hazards and Earth System Sciences 12, 535-550.

Laframboise N., Loko B. (2012) *Natural Disasters : Mitigating Impact, Managing Risks*. IMF, Working Paper 12/245. International Monetary Fund: Washington, DC, USA.

Linden L., Banerjee A., Duflo E. (2003) *Computer-Assisted Learning: Evidence from a Randomized Experiment*. Poverty Action Lab Paper No. 5, Pratham: Mumbai, India.

Loayza N., Olaberría E., Rigolini J., Christiaensen L. (2009) *Natural Disasters and Growth : Going beyond the Averages*. East Asia and Pacific Social Protection Unit & Development Research Group. Policy Research Working Paper 4980. The World Bank: Washington DC, USA.

Maplecroft (2012) *Natural Hazards Risk Atlas and Climate Change and Environmental Risk Atlas*. http://maplecroft.com.

Marulanda M., Cardona O., Barbat A. (2010) *Revealing the socioeconomic impact of small disasters in Colombia using the Desinventar database*. Disasters 34 (2), 552-570.

Mendelsohn R., Emanuel K., Chonabayashi S., Bakkensen L. (2012) *The impact of climate change on global tropical damage*. Nature Climate Change 2, 205-209.

Mondal N.C., Biswas R., Manna A. (2001) Risk factors of diarrhoea among flood victims: a controlled epidemiological study. Indian Journal of Public Health 45(4), 122-127.

Moreira Cedeño J.E. (1986) Rainfall and flooding in the Guayas river basin and its effects on the incidence of malaria 1982–1985. Disasters, 10 (2), 107-111.

Neumayer E., Plümper Th. (2007) *The gendered nature of natural disasters : the impact of catastrophic events on the gender gap in life expectancy, 1981-2002*. Annals of the Assoc. of American Geographers 97 (3), 551-566.

Peduzzi P., Chatenoux B., Dao A., De Bono A., Herold C., Kossin J., Mouton F., Nordbeck O. (2012) *Global trends in tropical cyclone risk*. Nature Climate Change 2, 289-294.

Peduzzi P., Dao H., Herold C., Mouton F. (2009) *Assessing global exposure and vulnerability towards natural hazards : the Disaster Risk Index*. Natural Hazards Earth Syst. Sc. 9, 1149-1159.

Quiroz Flores A., Smith A. (2010) ., Wilf Family Department of Politics, New York University: New York, USA.

Ranja-Dash S., Mukhopadhyay A., Rodriguez-Llanes J., Degomme O., Guha-Sapir D. (2011) *Child malnutrition and recurrent flooding in rural eastern India: a community-based survey*. British Medical Journal Open 1: e000109.

Rodriguez-Oreggia E., de la Fuente A., de la Torre R. Moreno H., Rodriguez Ch. (2008) *The impact of natural disasters on human development and poverty at the municipal level in Mexico*. RPP LAC – MDGs and Poverty – 09/2008, RBLAC-UNDP: New York, USA.

Sarewitz D., Pielke R., Keykhah M. (2003) *Vulnerability and Risk: Some Thoughts from a Political and Policy Perspective*. Risk Analysis 23 (4), 805-810.

Strömberg D., (2007) *Natural Disasters, Economic Development, and Humanitarian Aid*. Journal of Economic Perspectives 21(3), 199–222.

Trenberth K. (2011) Current Extreme Weather & Climate Change, Climate Communication; Press Conference (September 2011) with K. Trenberth (National Center for Atmospheric Research, NCAR), J. Meehl (NCAR), J. Masters (Weatherunderground), R. Somerville (Scripps). http://climatecommunication.org/. Aspen Global Change Institute: Basalt, CO, USA.

United Nations (2011) *Global Assessment Report on Disaster Risk Reduction: Revealing risk, redefining development.* United Nations: New York. p.151

United Nations Development Programme (2004). *Reducing disaster risk: A challenge for development*. UNDP: Geneva, Switzerland.

United Nations International Strategy for Disaster Reduction (2009), *Global Assessment Report on Disaster Risk Reduction*.UNISDR: Geneva, Switzerland.
United Nations University, Institute for Environment and Human Security (2012) *World Risk Report*. Bündniss Entwicklung Hilft: Berlin, Germany.

Venton P., La Trobe S. (2007) *Institutional donor progress with mainstreaming disaster risk reduction*. Tearfund and UN/ISDR, Tearfund: Teddington, UK.

Von Schreeb J. , Legha J.K., Niklas K. , Garfield, R. (2010) *Information for Action? Analysis of 2005 South Asian Earthquake Reports*. Posted on Reliefweb, Disaster Medicine and Public Health Preparedness, doi:10.1001/dmp.2010.36

Webster P. (2008) *Myanmar's deadly daffodil*. Nature Geoscience 1, 488-190.

Wirtz A., Kron W., Löw P., Steuer M. (2012) *The need for data: natural disasters and the challenges of database management*. Nat. Hazards, DOI 101007/s11069-012-0312-4.

ANNEX I COUNTRY CATEGORIES, DISASTER OCCURRENCES & DISASTER SENSITIVITY INDEX

Continent UN Region	Country	Level of income	# natdis 1961-2010	# years with droughts	DSI 1961-2010
AFRICA					
Eastern Africa	Burundi	LI	30	10	0
	Comoros	LI	12	1	1
	Djibouti	MI	16	11	2
	Eritrea	LI	6	7	0
	Ethiopia	LI	71	28	3
	Kenya	LI	56	21	0
	Madagascar	LI	55	12	2
	Malawi	LI	37	11	0
	Mauritius	MI	18	1	1
	Mozambique	LI	59	21	3
	Reunion	n.a.	9	0	n.c.
	Rwanda	LI	20	13	2
	Seychelles	MI	3	0	1
	Somalia	LI	46	16	4
	Tanzania Uni Rep	LI	52	14	0
	Uganda	LI	34	14	0
	Zambia	MI	21	6	0
	Zimbabwe	LI	16	16	1
Middle Africa	Angola	MI	31	11	0
	Cameroon	MI	18	5	0
	Central African Rep	LI	20	2	0
	Chad	LI	25	21	1
	Congo	MI	10	1	0
	Equatorial Guinea	HI	0	0	n.d.r.
	Gabon	MI	3	0	0
	Sao Tome et Principe	MI	1	3	0
	Zaire/Congo Dem Rep	LI	36	3	0
Northern Africa	Algeria	MI	69	4	2
	Egypt	MI	24	0	0
	Libyan Arab Jamah	MI	2	0	1
	Morocco	MI	39	7	0
	Sudan	MI	43	13	1
	Tunisia	MI	17	2	1

Continent UN Region	Country	Level of income	# natdis 1961-2010	# years with droughts	DSI 1961-2010
Southern Africa	Botswana	MI	14	11	1
	Lesotho	MI	14	10	0
	Namibia	MI	16	12	1
	South Africa	MI	77	10	0
	Swaziland	MI	11	13	1
Western Africa	Benin	LI	21	7	0
	Burkina Faso	LI	24	22	0
	Cape Verde Is	MI	9	11	1
	Cote d'Ivoire	MI	8	1	0
	Gambia The	LI	18	15	1
	Ghana	MI	18	5	1
	Guinea	LI	14	4	0
	Guinea Bissau	LI	11	10	0
	Liberia	LI	10	1	0
	Mali	LI	26	13	0
	Mauritania	MI	26	25	2
	Niger	LI	24	19	0
	Nigeria	MI	44	3	0
	Senegal	MI	26	18	2
	Sierra Leone	LI	10	0	0
	St Helena	n.a.	1	0	n.c.
	Togo	LI	15	3	0
AMERICAS					
Caribbean	Anguilla	n.a.	5	0	n.c.
	Antigua and Barbuda	MI	10	1	2
	Aruba	n.a.	0	0	n.d.r.
	Bahamas	HI	17	0	3
	Barbados	HI	10	1	0
	Cayman Islands	HI	7	0	1
	Cuba	MI	63	9	3
	Dominica	MI	12	0	3
	Dominican Rep	MI	49	1	4
	Grenada	MI	8	1	3
	Guadeloupe	n.a.	13	0	n.c.
	Haiti	LI	82	11	5
	Jamaica	MI	32	5	1
	Martinique	n.a.	13	0	n.c.
	Montserrat	n.a.	7	0	n.c.
	Netherlands Antilles	HI	2	0	2
	Puerto Rico	HI	22	1	1
	St Kitts and Nevis	MI	7	0	2

Continent UN Region	Country	Level of income	# natdis 1961-2010	# years with droughts	DSI 1961-2010
	St Lucia	MI	17	1	4
	St Vincent and The Grenadines	MI	14	0	4
	Trinidad and Tobago	HI	12	1	1
	Turks and Caicos Is	HI	6	0	1
	Virgin Is (UK)	n.a.	2	0	n.c.
	Virgin Is (US)	HI	6	0	1
Central America	Belize	MI	17	0	4
	Costa Rica	MI	58	3	1
	El Salvador	MI	43	5	4
	Guatemala	MI	65	0	3
	Honduras	MI	64	11	3
	Mexico	MI	197	7	1
	Nicaragua	MI	55	4	3
	Panama	MI	41	1	0
Northern America	Bermuda	HI	5	0	1
	Canada	HI	91	7	0
	United States	HI	712	9	0
South America	Argentina	MI	85	2	0
	Bolivia	MI	61	11	1
	Brazil	MI	169	17	0
	Chile	MI	75	6	2
	Colombia	MI	143	1	0
	Ecuador	MI	62	4	1
	French Guiana	HI	1	0	n.c.
	Guyana	MI	10	4	1
	Paraguay	MI	29	10	0
	Peru	MI	122	8	1
	Suriname	MI	3	0	0
	Uruguay	MI	23	2	0
	Venezuela	MI	41	2	1
ASIA					
Central Asia	Kazakhstan	MI	13	0	0
	Kyrgyzstan	LI	20	1	0
	Tajikistan	LI	45	3	1
	Turkmenistan	MI	2	0	0
	Uzbekistan	MI	5	2	0
Eastern Asia	China P Rep	MI	606	26	3
	Hong Kong (China)	HI	124	6	4
	Japan	HI	209	1	1
	Korea Dem P Rep	LI	26	3	2
	Korea Rep	HI	90	0	4

Continent UN Region	Country	Level of income	# natdis 1961-2010	# years with droughts	DSI 1961-2010
	Macau	HI	4	0	0
	Mongolia	MI	21	3	1
	Taiwan (China)	n.a.	75	0	n.c.
South-Eastern Asia	Brunei Darussalam	n.a.	1	0	n.c.
	Cambodia	LI	22	7	1
	Indonesia	MI	344	10	2
	Lao P Dem Rep	MI	28	7	2
	Malaysia	MI	52	1	0
	Myanmar	LI	39	0	1
	Philippines	MI	439	10	5
	Thailand	MI	106	7	1
	Timor-Leste	MI	7	1	0
	Viet Nam	MI	159	6	4
Southern Asia	Afghanistan	LI	117	9	3
	Bangladesh	LI	256	5	5
	Bhutan	MI	7	0	1
	India	MI	468	17	4
	Iran Islam Rep	MI	170	4	5
	Maldives	MI	4	0	1
	Nepal	LI	74	8	4
	Pakistan	MI	140	5	3
	Sri Lanka	MI	67	11	4
Western Asia	Armenia	MI	5	1	0
	Azerbaijan	MI	12	1	0
	Bahrain	HI	0	0	n.d.r.
	Cyprus	HI	11	2	0
	Georgia	MI	14	2	0
	Iraq	MI	10	7	0
	Israel	HI	12	1	0
	Jordan	MI	13	2	1
	Kuwait	HI	1	0	0
	Lebanon	MI	6	0	0
	Oman	HI	7	0	1
	Palestine (West Bank)	n.a.	2	0	0
	Qatar	HI	0	0	n.d.r.
	Saudi Arabia	HI	12	0	0
	Syrian Arab Rep	MI	8	5	0
	Turkey	MI	117	0	3
	United Arab Emirates	HI	0	0	n.d.r.

Continent UN Region	Country	Level of income	# natdis 1961-2010	# years with droughts	DSI 1961-2010
	Yemen	MI	42	5	2
EUROPE					
Eastern Europe	Belarus	MI	7	0	0
	Bulgaria	MI	36	3	0
	Czech Rep	HI	30	0	0
	Hungary	HI	26	3	1
	Moldova Rep	MI	12	2	1
	Poland	HI	38	0	0
	Romania	MI	74	2	2
	Russia	MI	128	4	0
	Slovakia	HI	26	0	0
	Ukraine	MI	24	0	0
Northern Europe	Denmark	HI	14	1	0
	Estonia	HI	2	0	0
	Finland	HI	3	0	0
	Iceland	HI	13	0	0
	Ireland	HI	18	0	0
	Latvia	MI	6	0	0
	Lithuania	MI	10	2	0
	Norway	HI	9	0	0
	Sweden	HI	10	0	0
	United Kingdom	HI	68	0	0
Southern Europe	Albania	MI	23	3	0
	Azores	n.a.	5	0	n.c.
	Bosnia-Hercegovenia	MI	17	2	0
	Canary Is	n.a.	6	0	n.c.
	Croatia	HI	18	1	0
	Greece	HI	73	1	0
	Italy	HI	101	2	2
	Macedonia FRY	MI	14	1	0
	Malta	HI	0	0	n.d.r.
	Montenegro	MI	18	0	0
	Portugal	HI	33	4	0
	Serbia	MI	24	0	0
	Slovenia	HI	6	0	0
	Spain	HI	69	11	0
Western Europe	Austria	HI	42	0	0
	Belgium	HI	46	1	0
	France	HI	126	4	0
	Germany	HI	77	0	0
	Luxembourg	HI	11	0	0

Continent UN Region	Country	Level of income	# natdis 1961-2010	# years with droughts	DSI 1961-2010
	Netherlands	HI	28	0	0
	Switzerland	HI	47	0	0
OCEANIA					
Australia and	Australia	HI	201	16	1
New Zealand	New Zealand	HI	52	1	1
Melanesia	Fiji	MI	44	2	4
	New Caledonia	HI	11	0	0
	Papua New Guinea	MI	52	4	1
	Solomon Is	MI	24	2	4
	Vanuatu	MI	37	0	2
Micronesia	Guam	HI	10	5	4
	Kiribati	MI	3	1	0
	Marshall Is	MI	2	0	0
	Micronesia Fed States	MI	7	1	2
	Nauru	n.a.	0	0	n.d.r.
	Northern Mariana Is	HI	1	0	0
	Palau	n.a.	0	0	n.d.r.
Polynesia	American Samoa	MI	7	0	2
	Cook Is	n.a.	8	0	n.c.
	French Polynesia	HI	6	0	0
	Niue	n.a.	3	0	n.c.
	Samoa	MI	12	0	4
	Tokelau	n.a.	4	0	n.c.
	Tonga	MI	13	0	3
	Tuvalu	MI	5	0	1
	Wallis and Futuna Is	n.a.	4	0	n.c.

[1] n.a. means "not available". The two categories "Upper Middle Income" and "Lower Middle Income" of the World Bank have been aggregated for legibility of the figures in the text.

[2] Numbers of years during which, at least, one drought was reported, in the period 1961-2010

[3] n.c. means "non-computed": population & GDP data are unavailable

[4] n.d.r. means "no disaster reported" for the period 1961-2010

Box 1: DROUGHTS

Drought are complex phenomena and different types have been defined (Dracup *et al*., 1980): meteorological related to precipitation deficits affecting water supply; hydrological resulting from low stream flows with impact on water resources management systems; agricultural consecutive to soil moisture decreases, which are always the consequence of prolonged periods of precipitations significantly below normal levels and/or increased evaporation; directly, in affected regions or, indirectly, in regions upstream.

Because of the prolonged period of low precipitation before their occurrence, droughts are disasters with slow onset. Their recognition depends on alert thresholds that must be locally defined, were long-standing based on empirical estimations and may evolve with socio-economic changes in the concerned regions. Several expensive early warning systems have been established in developing countries since the Sahel famines of 1984-85, most of which provide early warnings of impending food shortages. But as the recent Horn of Africa famine illustrated, when such systems are not linked to response mechanisms they are simply expensive and not effective (Kim and Guha-Sapir, 2012).

In EMDAT, a complex exercise in reworking the definition of drought changed substantially the records retained in the database. Definitional issues such as start or end of the event or the scope of its impact are particularly problematic for droughts. The EMDAT team together with Munich Re has developed a convention to address these parameters (Section on EMDAT)

As it appears in EMDAT, droughts commonly affect large regions, sometimes for several years. In the database 454 droughts were registered for the period 1961-2010, of which 20 (4.4 %) were multi-country, 174 (38.3 %) multi-year and 22 (4.8 %) multi-country and multi-year disasters.

A total of 39% of droughts occurred in Africa, but this share is 45 % for multi-country droughts and 64 % for multi-year ones. In the 1980s, one drought affected 15 countries in Western Africa, some of them during 6 years; in the 1990s, another drought affected 10 countries in Eastern and Southern Africa, lasting at least 5 years in two of them.

The span in space and time of many droughts make the evaluation of their human impacts difficult because these are most often indirect, unless they lead to the devastating famines that we witnessed in the early 1970s and mid 1980s and, more recently, in the Horn of Africa. In some regions of the world, droughts are also frequently complicated by civil strife and it is virtually impossible to disentangle the effects of one from another. Finally, because of their environmental and ecological impacts, droughts may worsen the risk of floods and wildfires.

Regarding direct impact, available data registered in EMDAT show that numbers of people killed are reported for less than 10% of droughts and may vary between 1.5 million in India in 1965 to 2 people in Somalia in 2005. To estimate the number of people affected seems easier and is often based on population numbers of affected provinces. Information is available for 65% of droughts, even though the variation of numbers may again be extremely large, covering different realities. For three droughts in 1965, 1972 and 1982 in India, the number of people reported to have been affected was at least 100 million, and about 300 million were affected by two other droughts in 1987 and 2002. Inversely, for the period 1961-2010 worldwide, around 20% of droughts affected less than 100,000 people.

Damages are reported for 58% of droughts occurring in High Income Countries but for only 12% of those occurring in Low Income Countries. Forty-one (26 %) droughts with reported damages caused losses exceeding US$1 billion in 2011 (for comparability losses have been estimated at 2011US$ value and therefore adjusted for inflation), of which one was in a Low Income Country and four in Lower-Middle Income Countries. Moreover, multi-year droughts make damage estimations more complex. More than one third of droughts with reported damages lasted more than one year.

In spite of these limitations, droughts appear as disasters of large magnitude and considerable impact. When considering available data, computations show that they are over-represented among disasters positioned in the highest quintiles, for people killed, people affected, damages, people killed per 100,000 inhabitants, people affected per 100,000 inhabitants and damages as a percentage of GDP.

Box 2: DISASTER SENSITIVITY INDEX

DISASTER SENSITIVITY INDEX (1961-2010): First computation & mapping

To compute a disaster sensitivity index, synthesizing the impact of disasters on the population and economy of each country, the 50 years period of the study was divided into 5 decades $d_{1...5,}$ with $d_1 = \{y_t, ...Y_{t+10}\}$ where y_t = year 1; … $d_5 = \{y_t, ...Y_{t+10}\}$ where y_t = year 41

For each country or territory c[1] and for each decade d, three indexes were computed: Kp_{cd}, Ka_{cd}, L_{cd} with c = {1…193} and d = {1…5}

$Kp_{cd} = ((\sum_{y=t...t+10} K_y)x100.000)/(\sum_{y=t...t+10} P_y)$

where Kp_{cd} = Number of people killed per 100,000 inhabitants in the country during the decade, with K = number of people killed during the year t and P = total population for the year t

$Ka_{cd} = ((\sum_{y=t...t+10} K_y)x100)/A$

where Ka_{cd} = Number of people killed per 100 square kilometers in the country during the decade, with K = number of people killed during the year t and A = country area

$L_{cd} = ((\sum_{y=t...t+10} Dam_y)/(\sum_{y=t...t+10} GDP_y)) \times 100$

where L_{cd} = Losses as % of GDP in the country during the decade, with Dam = damages reported for the year t (in 2011 US$)

and GDP = GDP for the year t (in 2011 US$)

For each index, taking into account only values of K_p, K_a and L > 0, three V4, thresholds for the fifth quintile were computed which take the values of 0.779 for $K_{p,}$, 0.728 for K_a and 1.524 for L. Three new binary indices $Kpq5_{cd}$; $Kaq5_{cd}$; $Lq5_{cd}$ were then created. For all value of the underlying index > V4 the new indices equate 1; otherwise 0.

For each country and each decade, a Disaster Sensitivity Index ($DSI_{cd)}$ was computed according to the following rule:

$Kpq5_{cd}$	$Kaq5_{cd}$	$Lq5_{cd}$	DSI_{cd}
0	0	0	0
1	0	0	1
0	1	0	1
0	0	1	1
1	1	0	1
1	0	1	1
0	1	1	1
1	1	1	1

This rule takes into account, first, the fact that $Kpq5_{cd}$ and $Kaq5_{cd}$ are two alternative measures of the impact of disasters on a population and, secondly, possible double counting of some disasters because of their large impact on the population and the economy of a country.

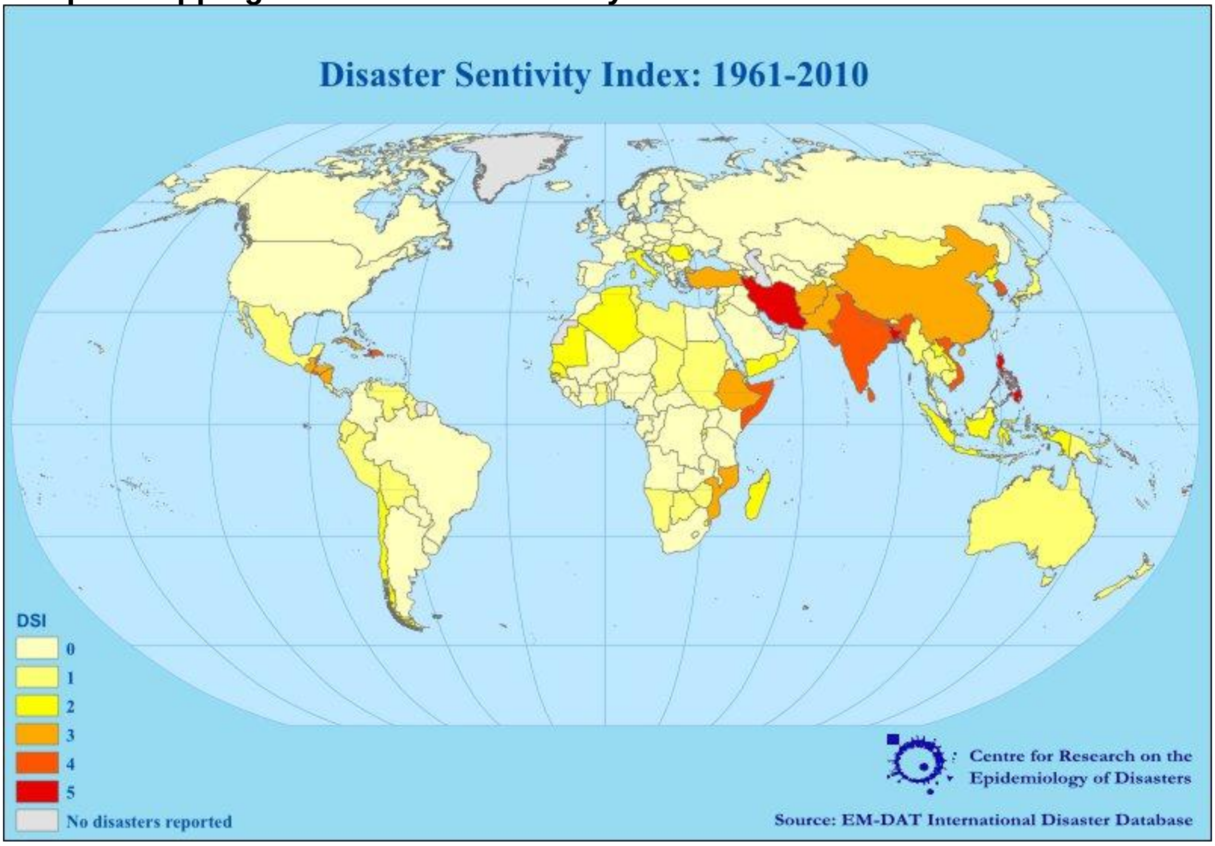
Finally, a global DSI_c was computed for each country, by summing the 5 $DSI_{cd..}$ Each DSI_c varies between 5, the highest disaster sensitivity rank, and 0. This last value does not mean that the country never suffered from disasters but that the impacts were never so large that they affected significantly the entire population or economy of the country. Such countries are only less sensitive to disasters because of the size of their population, the strength of their economy or the smaller severity of the disasters they experience.

A DSI of 3 or higher (which means that in 3 decades out of 5, the numbers of people killed and/or of damages were in the highest quintile) is found in 8 % of high-income countries, 22 % of middle-income countries and 20 % of low-income countries. Results for each country are presented in the country list (Annex 1).

Note: Because of changes in the reporting of numbers of affected during the 1980s, which may alter some countries' profiles, these numbers were not used in computing this first DSI. However, this approach may minimize the weight of droughts for some countries. Indeed, numbers of people affected are the impact data most often available for this type of disaster, but assessment issues lead us to consider these numbers as rough estimates of disaster human impact rather than exact quantifications. Pending future refinements of the DSI, we added in the country list (Annex 1) the number of years each country experienced drought during the 1961-2010 period.

[1] For this analysis, we used the World Bank population and GDP data and, for lacking data, UN Stat, IMF stat and US Bureau of Economic Analysis data. However, on a total of 208 countries or territories, 15 had no available population and GDP data and therefore only 193 countries or territories were considered.

Map 1: Mapping the Disaster Sensitivity Index



BOX 3: RESEARCH DIRECTIONS - USING DISASTER DATA FOR MODELING THE FUTURE

The vast amount of global data held in EMDAT and in complementary datasets such as in Munich re as well as disaster aid potentially allows for useful predictive modelling exercises and risk factor analyses. Such analyses would not only use the data available to its best advantage but also inform policy using persuasive statistical evidence base. There are many key research questions that could be addressed by the systematic use of this data. A couple are suggested below.

First, can we detect any **statistically significant long-run trends in the effects of natural disasters that go beyond a graphical inspection of the data?** If we conclude that natural disasters have increased over the years, then we need to establish some factors that explain this increase. More frequent extreme weather, more systematic reporting and population growth are amongst the factors that are often considered to explain these trends.

Second, can important socio-economic factors be identified that render some countries more vulnerable to the effects of natural disasters when these occur? Some studies have already done analysis of this type (Peduzzi *et al*., 2009; Strömberg, 2007; Chou *et al*.? 2004; Anbarci *et al*., 2004). Factors often considered include differentiating low-income from high-income countries, GDP per capita, economic inequality, population levels, and other indicators that measure the level of good governance in terms of effectiveness and democracy. Population density would be an important indicator to include.

Overall, the understanding of factors that affect the vulnerability of countries and any reduction (or increase) in this vulnerability over time is still weak. The longer-term consequences for economic growth, development and poverty reduction need to be examined using data beyond what is available in EMDAT. Better understanding of the relationship between disasters and aid flows will also inform development and preparedness policy. Finally assessing the usability of the models for exploring future disaster scenarios using different approaches such as panel data methods, fixed effect models.

Foresight
1 Victoria Street
London SW1H 0ET
www.foresight.gov.uk
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