Risk Information Issues and Needs: An Overview

Synthesis paper: An output of the First Technical Workshop on Standards for Hazard Monitoring, Databases, Metadata and Analysis Techniques to Support Risk Assessment, 10 - 14 June 2013, WMO Headquarters in Geneva, Switzerland

by

Manuela Di Mauro, UNISDR; Laurence McLean and Debarati Guha-Sapir, CRED; Angelika Wirtz and Jan Eichner, Munich Re; Maxx Dilley, UNDP

10 October 2013

1. **Introduction**

This paper surveys issues and needs for improving risk information, particularly hazard information. We divide risk information into two categories:

- information needed for calculation of the risks before disasters occur,and
- information documenting the losses after a disaster.

Hazard information is fundamental for calculating risks beforehand and for attribution of losses and damage afterwards.

Ex ante quantitative risk assessment combines information about hazards, exposure and the vulnerabilities of the exposed population or assets across various economic sectors and communities (e.g., agricultural production, infrastructure and homes, etc). Hazard analysis must be augmented with socio-economic data that quantify exposure and vulnerability in order to assess risks of adverse outcomes (e.g., casualties, construction damage, crop yield reduction and water shortages). Depending on the types of decisions (local, national, regional and global levels), this analysis requires different data resolutions (temporal and spatial). Risk assessments may also be tailored to address sectoral and inter-sectoral issues. Assessing *ex ante* disaster risk is inherently a probabilistic exercise, since it involves uncertainties associated with future states. Variables include the number of exposed people and assets, their vulnerability characteristics and future hazard behavior.

Ex post information on disasters, on the other hand, takes the form of historical loss and damage data – on killed, injured or missing people and/or loss and damage to physical assets. The latter can be converted to economic equivalencies using standard methods.[1]As many hazards – particularly climatic/hydro-meteorological events – are recurrent phenomena, historical loss and damage data provide input for assessing the risk of future loss and damage.

---

[1] http://www.eclac.cl/cgi-bin/getProd.asp?xml=/publicaciones/xml/4/12774/P12774.xml&xsl=/mexico/tpl-i/p9f.xsl&base=/mexico/tpl/top-bottom.xsl

Risk Information Issues and Needs: An Overview

Manuela Di Mauro, UNISDR; Laurence McLean and Debarati Guha-Sapir, CRED; Angelika Wirtz and Jan Eichner, Munich Re; Maxx Dilley, UNDP

Equipped with quantitative risk information, countries can develop risk reduction strategies through such measures as: (i) early warning systems to reduce casualties; (ii) medium and long-term sectoral planning and risk management (e.g. land zoning, infrastructure development, water resource management, agricultural planning) to reduce economic losses and build livelihood resilience, and, (iii) risk financing and transfer (e.g. insurance) to transfer and redistribute the financial impacts of disasters. This must be underpinned by effective policies, legislation and legal frameworks, and institutional coordination mechanisms as well as information and knowledge sharing, education and training.

Background

The 16th World Meteorological Congress in 2011, followed by the 64th session of its Executive Council, adopted the World Meteorological Organization (WMO) Disaster Risk Reduction (DRR) Work Plan 2012-2015. A critical deliverable of this work plan addresses the second strategic area of the WMO DRR Programme for development of guidelines and standards for hazard definition, monitoring and detection, databases and metadata and hazard analysis and forecasting tools, for weather-, climate- and hydrological hazards, building on the extensive work of the WMO technical commissions, a number of Members and key partners. WMO is establishing a DRR User-Interface Expert Advisory Group (UI-EAG) on Hazard/Risk Analysis to provide user input and guidance towards the implementation of these guidelines and standards by the WMO Technical Commissions. The first meeting of this UI-EAG will be held in 2014.

As part of the preparatory work to undertake this initiative, WMO hosted, the “First Technical Workshop on Standards for Hazard Monitoring, Databases, Metadata and Analysis Techniques to Support Risk Assessment,” in WMO Headquarters, Geneva, Switzerland from 10 to 14 June 2013 with the objectives to:

(1) Explore considerations and needs for hazard information to conduct risk analysis (particularly related to cascading hazards) and geo-referencing of damage and loss data;

(2) Document definitions and approaches of the participating Members, which are among good practices and to evaluate similarities and differences among their approaches;

(3) Review the mandate and related activities of the relevant WMO Technical Commissions related to the standardization of definitions, monitoring, detecting, as well as mapping and forecasting tools for different hazards;

(4) Explore challenges and opportunities for developing international guidelines, manual and standards in this area, and;

(5) Develop recommendations and priorities of action for consideration of the Management Groups of the WMO Technical Commissions for integration in their work planning and the first meeting of the EAG-HRA, which would be held in early 2014, particularly building on expertise of technical commissions and Members.

Doc 6

Risk Information Issues and Needs: An Overview

Manuela Di Mauro, UNISDR; Laurence McLean and Debarati Guha-Sapir, CRED; Angelika Wirtz and Jan Eichner, Munich Re; Maxx Dilley, UNDP

Purpose

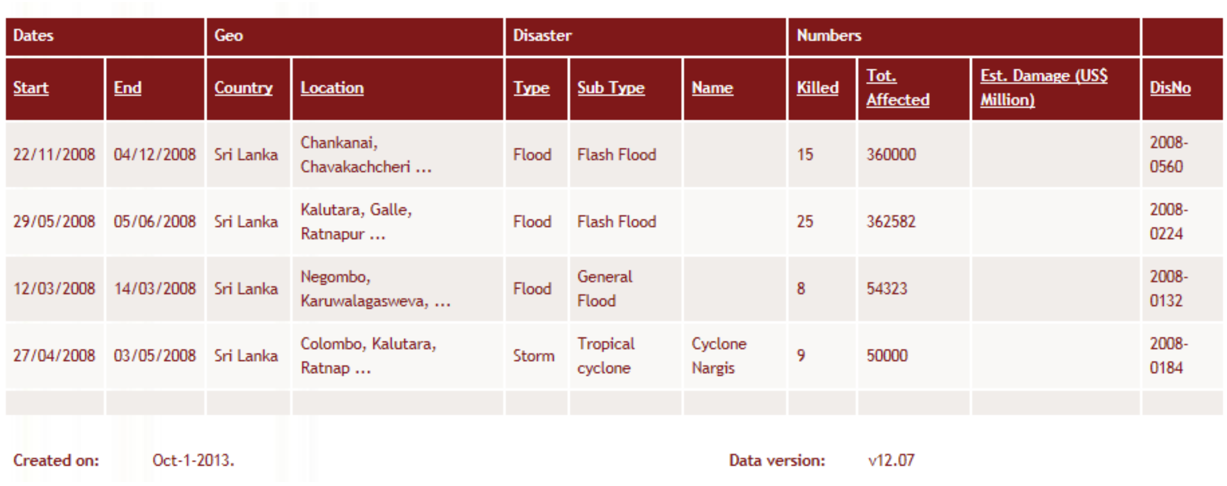
The present paper is a synthesis of issues, needs and recommendations by the invited Risk Experts concerning the further standardization of information on hazard events as an input to the formal estimation of their potential and actual consequences. In addition to summarizing selected requirements for hazard information for this purpose, the paper also broadly surveys selected other needs identified during the workshop concerning non-hazard-related risk information. The latter provides a consensus view of some key areas for improvement of non-hazard-related risk information that could be potentially taken up in parallel with the WMO DRR Hazard/Risk Analysis UI-EAG.

Despite its limited focus on hazard information, the importance of the WMO initiative cannot be overstated. Although some hazards – such as tropical cyclones and earthquakes – are reasonably well characterized with internationally accepted definitions and parameters for specifying magnitude, timing, location and duration, definitions of other major hazards such as drought and floods are notoriously arbitrary. Yet drought and flooding alone account for more loss and damage than all other hazards combined. Thus, although further progress in hazard standardization is likely to be a long process, more systematic and standardized characterization of hazard events is vital for improving risk information. A parallel effort to address non-hazard-related risk information needs would further increase the potential for significant improvements in the evidence base for risk management decision-making.

2. <u>Information about disasters: what it is and what it is used for</u>

Basic data about a disaster include the numbers of people killed, injured or affected, physical losses and damage across the social, infrastructure and productive sectors and their economic equivalencies, the geographic area affected, the time of the event and the characteristics of the hazard event that triggered the losses (table 1).

Table 1 Example disaster data from EM-DAT, the OFDA/CRED International Disaster Database



Dates		Geo		Disaster			Numbers			
Start	End	Country	Location	Type	Sub Type	Name	Killed	Tot. Affected	Est. Damage (US$ Million)	DisNo
22/11/2008	04/12/2008	Sri Lanka	Chankanai, Chavakachcheri ...	Flood	Flash Flood		15	360000		2008-0560
29/05/2008	05/06/2008	Sri Lanka	Kalutara, Galle, Ratnapur ...	Flood	Flash Flood		25	362582		2008-0224
12/03/2008	14/03/2008	Sri Lanka	Negombo, Karuwalagasweva, ...	Flood	General Flood		8	54323		2008-0132
27/04/2008	03/05/2008	Sri Lanka	Colombo, Kalutara, Ratnap ...	Storm	Tropical cyclone	Cyclone Nargis	9	50000		2008-0184

Created on: Oct-1-2013. **Data version:** v12.07

Risk Information Issues and Needs: An Overview

Manuela Di Mauro, UNISDR; Laurence McLean and Debarati Guha-Sapir, CRED; Angelika Wirtz and Jan Eichner, Munich Re; Maxx Dilley, UNDP

The number of systems for recording this information at different levels has grown rapidly in recent years. At global level, three long-established and well-known databases include EM-DAT, maintained by the Center for the Epidemiology of Disasters (CRED), NatCat SERVICE, maintained by Munich Re and Sigma, maintained by Swiss Re. An increasing number of disaster loss and damage databases have been, and are being, established at national and local level. A recent study by UNDP documents systems in approximately 60 countries and regions (UNDP 2013). Especially when local-level systems are taken into account the actual number may be considerably larger.

Driving forces behind this proliferation of datasets include that disaster loss data are essential for such fundamental exercises as:

- tracking loss trends over time
- identifying the geographic distribution of disaster occurrence
- obtaining breakdowns of historical losses by hazard
- assessing the impacts of losses on other variables, for example GDP
- assessing requirements for prevention, preparedness, recovery and insurance
- assessing the risks of future disasters.

The CRED, Munich and Swiss Re databases are widely regarded as authoritative and have benefited from rigorous and standardized data collection and reporting procedures sustained over decades. The quality and coverage of country- and local-level systems is highly variable and their diversity inhibits interoperability both among them as well as vertically, with global datasets. Yet, due to the fact that data quality is only as good as its primary source material, local sources are often better positioned to reflect the local picture. Downscaling to national and sub national level therefore can lead to improved data quality. And, disaggregated data with country- and local-level resolution is relevant for decision-making at country- or local-level where most risk management decisions are made.

The procedures for capturing and archiving disaster data are generically common to all such systems. Information on hazard event occurrences involving loss and damage is received by the institution that maintains the database. The institution creates an entry or entries for the event in the database and – according to the database's particular format – enters as many attributes about the event as possible, applying any relevant inclusion and quality control criteria. There are few, if any, universally-applied standards in this process. The determination of the hazard event with which the losses are associated, for example, may or may not have been made by a recognized authority. Often such decisions are taken by the database operator. Munich Re, for example, applies a hierarchy of "peril families" for assigning hazard typologies. Systematically collected primary loss and damage assessment data may or may not be routinely available from official sources. CRED applies a hierarchical policy for sourcing its data, for example, with priority given to data from UN agencies, USAID's Office of U.S. Foreign Disaster Assistance, governments, the International Federation of Red Cross and Red Crescent Societies, insurance and reinsurance companies, research institutions and the press.

Issues affecting country-level databases (UNDP 2013) include:

- Many parameters, some with unclear definitions ("affected," "victims")
- Inconsistent economic valuation of physical damages and losses
- Lack of differentiation between zero (no losses) and missing values (no information)
- Attribution of losses in localities to local secondary hazards without ability to aggregate losses associated with a larger-scale, primary hazard
- Lack of application of a standardizing indexing system (figure 1)

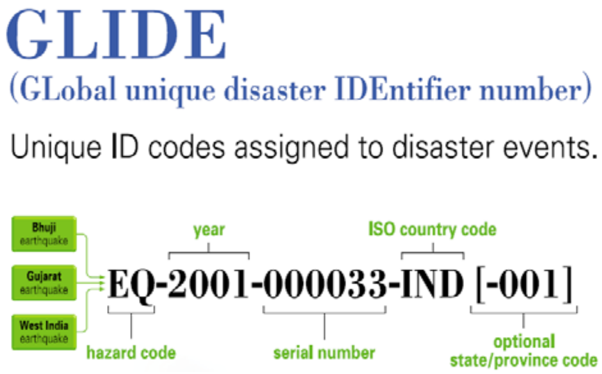


Figure 1 An indexing system for unambiguous identification of disaster events

The majority of country-level databases contain blank or zero values for the key parameters of deaths and economic losses for more than 80% of their entries and 30% or more entries for which all values are blank or zero. More than 50 % of the databases appear to contain data gaps (years for which no data was entered, most prevalent in the earlier years for which the databases contain entries).

This diversity results in differences from one database to another in terms of how events are classified, geo-coded, and the levels and types of associated losses and damages recorded. There is a lack of clear standardized data collection methodologies and definitions. Consequently it can be difficult to compare and cross-validate data from different databases both horizontally and vertically – i.e. between databases with global, national or local-level coverage. These complexities can be compounded in cases of events affecting multiple countries.

A more ideal situation would be a concentric system of disaster impact data collection – interoperable between sub-national, national, regional and global levels – using a harmonized set definitions and methods. A number of initiatives have been, or are, dealing with facets of this problem. The International Council for Science (ICSU) Integrated Research on Disaster Risk project, for example, has a working group to study issues related to the collection, storage and dissemination of disaster loss data. The working group has identified needs in the areas of user education, data comparability and accessibility, downscaling of loss data to sub-national geographies for policy makers and improved definition of what constitutes a loss and loss assessment methodologies. A recent report by the European Commission Joint Research Centre (De Groeve et al., 2013) makes technical recommendations for a European approach to standardization of loss databases. The current WMO-led initiative is unique, however, due to the fact that WMO is a global regulator and standard-making organization in the area of hydro-meteorological information.

3. Information about risk: what it is and what it is used for

"Risk" is a forward looking concept that implies an eventuality of something that can occur. Therefore, assessing risk means looking at what are the possible events that can occur, quantifying how likely they are to happen and appraising the potential consequences should they occur.

Assessing risk only based on past events (deterministic approach) does not provide information on the current state of the risk, for several reasons:

- Record of past events covers a limited amount of time, thus might not include many infrequent but severe hazards simply might not have occurred within the time covered by the catalogue
- Observed events do not include all the possible physical realization of the events; in fact, events are never exactly the same, thus basing the risk assessment only on past event might hide unobserved, but yet possible, consequences
- Record of past events do not usually provide temporal and spatial information about the event and detailed records of consequences, especially linked with the local severity of the hazard.

It is therefore important to use an approach that is built on past records, but also take into account events that can physically occur but are excluded in the catalogues or loss databases. Such approach not only allows a better coverage of the possible events, but also provide an improved estimation of the *probability of occurrence of each event and associated losses*. Decision makers use probabilistic risk assessment to know which events and losses can possibly occur, as well as their likelihood and frequencies of occurrence.

Although specific uses are strongly dependent on the scale of the assessment, probabilistic risk assessment is generally used for:

- Dimensioning risk reduction interventions, using probabilistic information on hazard intensities, exposure and vulnerability
- Disaster risk reduction financing and budgeting
- Cost/benefit analysis, comparing the cost of specific interventions with the reduction of losses following the implementation of these interventions

This section describes the general methodological steps and concepts for probabilistic risk assessments. The method described here provides the risk in terms of physical losses, e.g. economic damages to the physical environment as well as human losses in terms of fatalities. Other types of consequences (e.g. indirect losses) are not considered in this approach. Risk here is presented by taking into account its components: hazard, exposure and vulnerability. Each component, besides being necessary to assess the risk, has its own use in risk assessment and reduction. This section wants to be an introduction of the concept. For the details, the reader should refer to the extensive literature on the topic (as starting points we might suggest Nasim et al (2012), Dickson et al (2012), Kumamoto et al (2012), Cardona et al. (2008), Marulanda (2013)).

Hazard

In a probabilistic risk assessment, the hazard is usually represented trough a stochastically generated set of all the events that could possibly occur, each associated with a frequency of occurrence. In this way the model is able to statistically represent the probability of events that have not yet occurred at a given location.

From the set of hazard events that are built for the probabilistic risk it is possible to reconstruct the *hazard curve*[2], which relates a value of intensity to the probability of exceedance of this value. This curve is necessary for developing local reduction strategies including, for example, building resilient infrastructures (e.g. roads, bridges etc.), land use planning (e.g. identify low risk areas in which to develop) and developing appropriate building codes. However, these applications require a description of the hazard with a good spatial resolution, subject to the quality of the input and the scale of the analysis. For example, to dimension an earthquake-resistant building, it is not sufficient having the magnitude of a possible earthquake at its epicentre, but it is necessary describing the way in which the seismic wave propagates and what is the actual “ground shaking” at the structure. Similarly, to dimension a bridge a hazard curve describing the rainfall height observed in a point of a catchment is not sufficient: we need to reconstruct how this rainfall translates into runoff and then into the river flow that propagates in different parts of the domain.

Dimensioning such interventions and infrastructures also requires knowing the intensity of the hazard that should be used as reference. For example, when building infrastructures in a flood prone area, we might ask questions as: how wide the bridge should be built? How many drainages are needed in a certain road? How far from the river should build a school? As different possible events correspond to different values of flood depth, we need to know the *expected* value of the flood depth in each point of the domain, as well as the *likelihood* that this value is surpassed.

In other words, dimensioning risk reduction interventions (as well as risk-proof infrastructures) requires the knowledge of the hazard’s spatial variability, in the form of the *probability of exceeding a certain value of intensity in each point* (or in specific points) of the domain. This information is needed with a resolution that varies between the few centimetres to the few hundreds of meters, depending on the different applications. This knowledge can only be achieved through reconstructing (modelling) the spatial variability of the hazard, for a stochastically generated set of events.

The hazard curve at each point of the studied (modelled) domain can be built by applying this stochastically generated set of events to the domain, each event linked with its probability of occurrence. As the events are considered independent and mutually exclusive, the resulting probability of exceeding an intensity *a* can be calculated as:

---

[2] This curve can take different names depending on the hazard and the application, e.g. “flood” or “flow” frequency curves (CEH, 1999; USGS, 1982), “intensity exceedance” curves etc.

$$p(a) = \sum_{i=1}^{N} P(A > a|e_i) \cdot f(e_i) \qquad (1)$$

Where: $p(a)$ is the probability of exceeding an intensity a, P is the probability of exceeding an intensity a, given the occurrence of the event e_i, $f(e_i)$ is the annual frequency of occurrence of the event e_i, and N is the total number of events e. Equation (1) implies that, for each event, the intensity in one point is expressed as a probability distribution. In this way the uncertainty in the estimation of each event e_i is integrated in the hazard curve. If only one value of intensity is available for the event e_i (i.e. $P(A>a| e_i) = 1$) and there is only one event that exceed the intensity a among those modelled, then the intensity excess rate $p(a)$ equals the annual frequency of occurrence of the event.

The inverse of the annual frequency of the event is the “Return Period”. The return period should be regarded as such, the inverse of the annual frequency of occurrence. For example, a return period of 1 in 250 years does not correspond to a loss that will happen exactly every 250 years, but to an event that has 0.4% of chances to occur in one year.

However, the sole hazard assessment is not sufficient to appraise the risk and dimension risk reduction interventions. In fact, such interventions, such as dimensioning structures to withstand risk or regulating land use planning, are “per se” costly. To appraise the direct benefits of risk reduction (e.g. in terms of investments’ return), it is fundamental to quantify the likely the losses should these interventions are not implemented, and compare them with the losses after the intervention is implemented. For this, a probabilistic hazard assessment needs to be paired with the full assessment of the risk, which includes taking into account of the impact of the hazard on the exposed elements.

Exposure and Vulnerability

To assess the impact of the hazard, the first step is to analyse and reconstruct the environment that can be affected. In general, exposure data identify the different types of physical entities that are “on the ground”, including built assets, infrastructure, agricultural and human exposure.

The characteristics of the exposed environment to be looked at depend on the scope of the analysis. If the risk is assessed in terms of losses to the built environment, structural types and construction characteristics are needed. If the risk assessment includes damages to agricultural land, types of crops and their seasonality has to be considered. An analysis on mortality risk will require socio-economic characteristics of the population.

The exposure data should contain the physical location of the asset but also the characteristics of the asset that influence its vulnerability and enable the assessment of the damage or loss to the asset. These characteristics typically can include:

- geographical locations of each exposed element
- structural characteristics
- replacement values

- human occupation/population density/number of people in each location
- socio-economic characteristics of the population at each location

The exposed elements are usually classified based on their typologies (for example, by building taxonomy, by age group, etc.). This classification is relevant to assign the vulnerability to each exposed element.

Once the physical characteristics for each exposed element are defined, it is possible to establish and assign the likely damage, and subsequently losses to that element subjected to a specific hazard. This is done by defining relationships between a measurement parameter of the hazard (e.g. water depth in case of flooding or the spectral acceleration in the case of earthquakes) to the likely damage of the particular element (or type of elements). The damage might expressed in percentage, or as relative terms to their replacement value. The name of these relationships varies depending on the field of the analysis. In earthquake engineering, they are often called “vulnerability functions” (e.g. Rossetto and Elnashai, 2003); in flood and dam engineering, they are often referred as “fragility curves” (e.g. Vorogushyn et al, 2009); they might be also be found in literature as “damage functions” (e.g. Prahal et al, 2012).

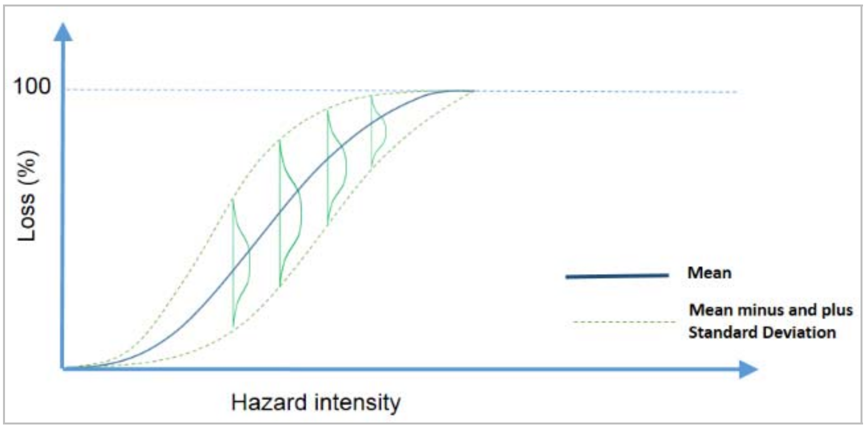


Figure2 Example of vulnerability curve

For each hazard and each elements’ typology, one vulnerability function is defined. For very detailed analysis, and for particular exposed elements that might not be classifiable into a general class (e.g. a specific dam), a bespoke vulnerability curve can be developed. Each point of the curve links a characteristic of the hazard to a mean loss value as well as the variance, representing the probability distribution of the losses that are likely to occur following the given hazard intensity.

Risk

Once the hazard is defined, it is then possible to calculate the losses related to each of the ‘possible’ events. To each point of the domain can therefore be associated a probability distribution of the hazard intensity for certain return periods. As each point of the vulnerability curve is itself a probability distribution, a different probabilistic distribution of damages is calculated in each point for each event and for each exposed element.

Therefore, in each point of the space, for each modelled event, and for each exposed element (or class of elements), we obtain a probability distribution of losses. For each value of losses X, the area underneath the probability curve represents the probability to exceed this value P(x > X).

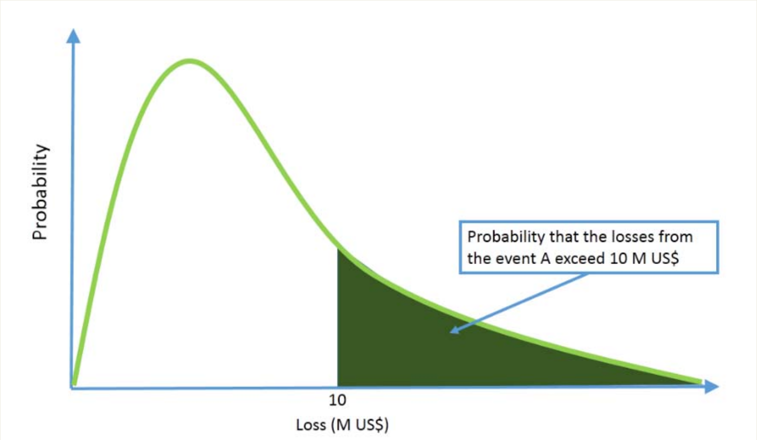


Figure3 Probability distribution of losses for one hazard event

The combination of all these distributions, for all the building classes and the points of the exposure database, produce the probability distribution of losses in the country. This distribution is what it is call a "loss exceedance curve", in other words the likelihood of having certain losses expressed in terms of their occurrence rate, usually expressed per year. The curve usually constitutes the key output of a fully probabilistic risk assessments.

Each point of the curve is not associated to a specific event, but it is the absolute probability of having a loss equal or higher than X ("Excess Rate") in each given year. Similarly than in the case of the hazard curve, as each of the events are considered independent and mutually exclusive, the resulting probability of exceeding a loss *x* (constituting one point of the loss exceedance curve) can be calculated as:

$$r(x) = \sum_{i=1}^{N} R(X > x | e_i) \cdot f(e_i) \qquad (2)$$

Where: $r(x)$ is the probability of exceeding an loss x, R is the probability of exceeding an loss x, given the occurrence of the event e_i, $f(e_i)$ is the annual frequency of occurrence of the event e_i, and N is the total number of events e.

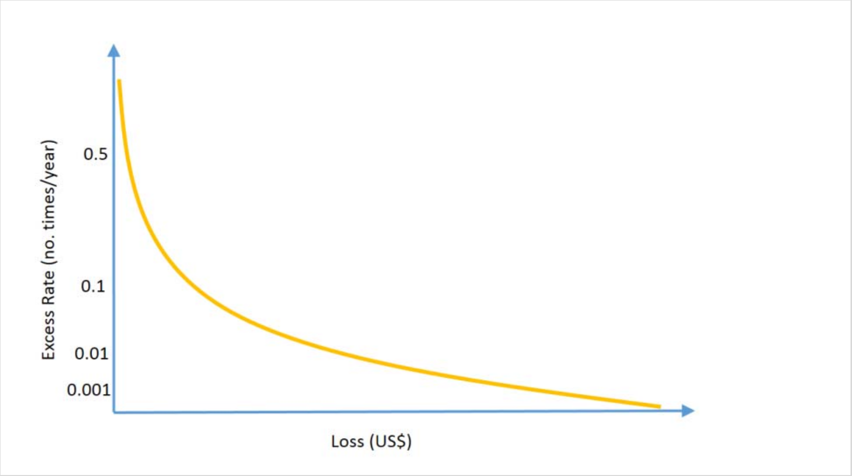


Figure4 Example of loss exceedance curve

The integral of the loss exceedance curve (the area underneath the curve) is the Annual Average Loss (AAL). The Annual Average Losses are the expected losses in every given year (averaged over a long period of time). For example, if the losses are expressed as monetary value, in terms of replacement cost of urban buildings. Thus these results provide a picture of the extent of monetary losses the countries are likely to face, on average, in one year.

Each point of the curve is what is usually called the "Probable Maximum Loss", which is the maximum loss that could be experienced in the occurrence of a disaster with a particular return period.

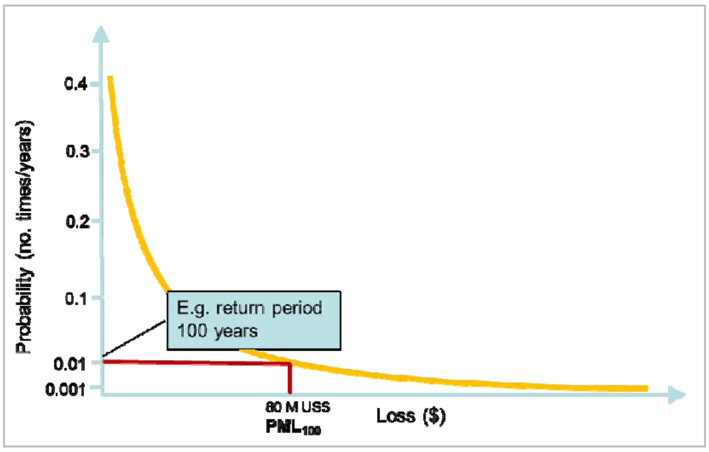


Figure5 Example of probable maximum loss

Although the probable maximum loss it is not related to a single event, this metric can be used as a proxy to assess losses should the design return period is exceeded, thus can provide a strong argument in terms of cost/benefit analysis of choosing specific return periods.

In general, the probable maximum loss represents the actual return period of losses, thus it is used to provide information on how to address the different level of risk: the risk corresponding to losses with high to medium probability to occur can be addressed through interventions such as prospective and corrective risk management measures (UNISD, 2009); this is, for example, the area where codes and norms are more effective. The risk corresponding to low probability and high losses might be addressed with risk transfer mechanisms (UNISDR, 2011). The risk represented by very high losses with very low probability of occurrence is what is called the “residual” risk that decision makers might not be able to address nor transfer. The decision on where to set the level of this “residual risk” can be economic but also political, going to the field of what it is sometimes call the “acceptable risk” (e.g. Manuele, 2010).

4. Documenting losses and assessing risk: issues and needs related to hazard information

Recommendations to improve hazard information to document the losses after a disaster

In the area of disaster loss and damage data we identify three broad areas that would benefit from further standardization. These include: 1) improved standards for identifying and characterizing different types of hazard events, 2) procedures for more systematic official designation of hazard events in real-time, and 3) the integration of hazard-related standards with other standards, such as of event indexing (e.g. GLIDE), standardization of core loss data parameters, economic valuation methodologies, etc. The current WMO-led initiative is an ideal vehicle for addressing the first two sets of issues, which primarily relate to hazard-related standardization mostly pertaining to hydro-meteorological hazards. A parallel initiative or set of linked initiatives should be mounted to explore means to further standardize the non-hazard-related items.

1) Standardization of hazard event identification and characterization

Being able to correctly attribute losses consistently to the particular hazards with which they are associated is critical for accurate accounting of hazard-related loss and damage. This exercise can be non-trivial, however, due to several complicating factors.

A principle one is that one hazard may trigger another, such as landslides triggered by heavy rainfall triggered by a hurricane. Ideally all losses associated with a particular hurricane should be aggregatable into a total loss for that event. Yet it is also essential to record information about locally-triggered hazards since these constitute proximate causal factors at local level. Different disaster database formats handle this issue differently. A universal standard or set of standards for addressing this problem, such as the Munich Re “peril families,” is needed.

A second issue concerns rigorous definitions of the various hazards for correct and consistent hazard event designation. A storm surge, for example, is different from a flood. Different types of floods can be – but not always are – distinguished from each other, e.g. flash floods versus riverine floods versus floods associated with heavy rain. Standardized definitions would address this problem.

All hazard events are by definition characterizable in terms of magnitude (intensity), duration, location and timing. Information for all these parameters for some hazards, such as tropical cyclones, is routinely provided in a standardized way. For other hazards, in particular drought, there is little if any standardization of any of these parameters. Thus the start and end dates of disasters and areas affected for many disaster loss database entries are arbitrarily set by database operators.

This leads to lack of comparability and inter-operability of data from different sources. A set of standards for hazard event characterization in terms of magnitude, duration, location and timing for all major hydro-meteorological hazards would help fill this important gap.

Finally, unlike disaster loss data, again with the exception of tropical cyclones, little hazard data is systematically archived by relevant authorities. This is a vital gap for conducting research on the relative contributions to disaster causality of hazards, exposure and vulnerability. For example, accurate, complete and consistent historical hazard event data, when combined with data on associated losses and exposure, would make it possible to isolate the contribution of vulnerability to disaster causality, a key current gap in disaster reduction research.[3] Guidelines on the preparation of historical hazard databases would address this need.

2) Official real-time hazard event designation and archiving of hazard event data

A related issue to standards is the real-time application of those standards by an appropriate authority when a hazard event (or chain of events) occurs. The naming convention for tropical cyclones is an example of how this can work, but most hazard events come and go without official recognition. Thus database operators – at local, national and international levels – may all draw different conclusions as to the hazard or hazards to which to assign the associated losses. There is a need for guidelines in the application of those standards to guide official designation of hazard events in near real-time. These would address such issues as who the designated authority is in a country, how the designations are to be framed (i.e. hazard names, numbers or other conventions), how the information is made public, how discrepancies are retroactively corrected, reconciliation of designations across borders during hazard events affecting multiple countries, etc.

3) Integration of hazard-related standards with non-hazard-related standards

Due to the fact that the vast majority of disasters are associated with hydro-meteorological hazards, the current WMO-led initiative, should it successfully address the above areas, would make a major contribution to the improvement of risk information. As previously noted, however, there are additional issues affecting disaster data quality and usability that are beyond the scope of hazard standardization. These include, but are not limited to:

- Adoption of a standard indexing system for disaster events, such as the GLIDE
- Standardization of the number and definitions of core parameters, such as sex- and age-disaggregated mortality, physical asset losses and damages and their economic equivalencies, etc.
- Standards for loss assessment and reporting (i.e. primary data collection)
- Standardized methods for the estimation of economic losses
- Standards governing data access, and

---

[3] A full discussion of the theory of disaster causality in terms of hazards, exposure and vulnerability appears below.

- Quality control standards.[4]

These clearly go beyond the scope of the WMO UI-EAG on hazard and risk assessment. Unfortunately there is no parallel for WMO – a duly constituted authority for global regulation and standard setting in the area of hydro-meteorological information – for standard setting across this broader set of issues. In the absence of such authority the plethora of projects, working groups and one-off analyses attempting to address these issues has mostly led to better articulation of the problems but, with the arguable exception of the GLIDE, little progress towards widely accepted solutions. Moreover WMO has a second important asset with respect to the implementation of standards, namely, its direct connection to the primary users of the standards, National Meteorological and Hydrological Services. No single universally recognized governing body currently exists for the welter of government departments, NGOs, research institutes and private sector corporations engaged in disaster data collection and maintenance.

Thus a consultative processes in needed to identify a mechanism or mechanisms through which standards could be developed and applied for addressing the non-hazard-related issues identified above. Importantly, the WMO initiative at least offers an anchor to which cooperation to address these extended issues and needs could be linked.

Recommendations to improve hazard information needed to calculate the risks before disasters occur

To design a good risk assessment, it is necessary first to identify the questions we are trying to answer, thus the specific scope of the risk assessment. This will inform in the choice of the best resolution and scale of the analysis. These factors are also dependent on the time, resources and type/resolution of the data available at the moment of the analysis. The choice of the hazard(s) to include in the analysis might be depend on the context of the specific assessment (i.e. the above-mentioned questions), but also by the resources available: in this case, a pre-assessment of the risks in the area is necessary to prioritize which hazards should be included in the analysis.

Carrying out a probabilistic risk assessment requires a considerable amount of data that will be the input to build hazard, exposure and vulnerability. In general, it is of course important that those input data are collected/measured, and made available to risk modelers.

Usually, “hazard information” (e.g. from Met Offices) are used as input to hazard models. These models are needed to reconstruct the intensity of the hazard with its **spatial variability** and **probability.** Although the data requirements strongly depend on the scope and scale of analysis, some general recommendation can be drawn:

---

[4] In addition there are issues related to so-called “slow onset” (that is non-event-based) climate change related losses and damages that currently go beyond the scope of disaster-related losses generally.

Risk Information Issues and Needs: An Overview

Manuela Di Mauro, UNISDR; Laurence McLean and Debarati Guha-Sapir, CRED; Angelika Wirtz and Jan Eichner, Munich Re; Maxx Dilley, UNDP

1) Guidelines and standards for probabilistic hazard and risk assessments should be developed

Risk assessment is one of the key indicators of progress for the Hyogo Framework for Action. However, there are currently no general indication for assessing the quality of a probabilistic hazard and risk assessment, nor for identifying the minimum requirement for such assessment. Without such information, resources can be devoted to produce sub-standard or uninformative risk assessments. Such guidelines would require extensive consultation with various institutions.

2) Baseline data produced, updated and made available for hazard modeling

Baseline data, such as topographic, land cover or bathymetric data have to be systematically produced and updated, with different spatial resolutions and information on their accuracy, and made available for hazard and risk modeling.

3) Time series of hydro-meteorological data systematically collected and stored, following standardized (or quality-controlled, consistent) formats

Time series of hydro-meteorological data (e.g. rainfall, flow discharges, wind gusts etc.) should be systematically and continuously collected, as they should cover a good temporal span to be used in the analysis. To enable that different time series are usable for the analysis, it is also important to ensure coherence in the way the data are collected/measured (for example among stations in different sub-basins), as it creates a harmonization issues that oblige the modeler to discard a whole time series. For that, such data collection should follow coherent formats and method.

Such data should be collected providing an appropriate spatial coverage to enable the modelers to produce a usable description of the hazard.

4) Data quality, resolution and uncertainty provided together with the datasets

The input data for risk modelling should also be provided with information on their quality. If this information is lacking or cannot be assessed, it is difficult to evaluate the uncertainty related to the input data, therefore to calculate the propagation of this uncertainty to the output.

5) In case of flooding, conduction of post event surveys to record water depths (and possibly velocity) in different points of the affected areas.

Vulnerability curves are mostly based on laboratory experiments and validated with real data.Recorded flood depths (and velocity, although more difficult to assess) in different point of the affected areas is extremely important to validate hazard models, but also to validate/develop vulnerability curves, if coupled with the damages/losses at the same point and the physical characteristics of the damaged element.

Issue regarding exposure and vulnerability data, not related to the scope of the workshop, are presented below.

- Exposure data should be systematically collected and updated, including structural characteristics

Spatially-distributed socio-economic data (population, age bands, income levels, etc.) are generally collected through countries' censuses. Buildings' censuses including structural characteristics of buildings and infrastructures are usually less common or not used/available in risk assessment. Exposure data should include spatially-distributed location of building and infrastructures, structural characteristics, replacement values (or characteristics that allow reconstructing it, such as building use, etc.). These data are fundamental of quantify losses and prioritize interventions, and given the potential sensitivity issue on such data, they should be collected at governmental level but made available to risk modelers.

- Vulnerability curves should include uncertainty levels

Models' results are quite sensitive to the adopted vulnerability curves and their uncertainty. At the same time, these curves often embed a high level of uncertainty. For instance, these curves are potentially dependent on the construction techniques used in the analysis and therefore might be area-specific. Also, structural characteristics of the exposed elements are complex to assess as they requires detailed information on the design, building codes, construction techniques etc. that might not be available or assessable with precision. In this sense, the level of uncertainty in the vulnerability curve should be appropriately represented.

- Practitioner's forums could be created to share and validate vulnerability functions

Physical vulnerability data are often not available. It would be important that practitioners share such curves and jointly contribute to their improvement and validation. For this, libraries with structural vulnerability curves should be created, to share and improve the knowledge-base.

- Further research should be devoted in developing and validating vulnerability curves, especially regarding human vulnerability

The characterization of the human vulnerability is an open research question. While the physical vulnerability or the consequence to building collapse might be more easily assessed, factors such as early warning are mode difficult to estimate, while at the same time they are extremely relevant to determine the mortality to some hazards.

References

CEH, 1999 Flood Estimation Handbook, 5 volumes and associated software. Institute of Hydrology, Wallingford

Cardona, O. D., Ordaz, M. G., Yamin, L. E., Marulanda, M. C. and Barbat, A. H., 2008, Earthquake Loss Assessment for Integrated Disaster Risk Management, Journal of Earthquake Engineering,12:1, 48 — 59

De Groeve, T., Poljansek, K. and Ehrlich, D., 2013. Recording Disaster Losses, Recommendations for a European Approach. JRC Scientific and Policy Reports, European Commission

Dikson, E., Baker, J., Hoornweg, D. and Tiwari, A., 2012, Urban Risk Assessment: understanding disasters and climate risk in cities. The World Bank

Kumamoto, H. and Henley, E. J., 1996, Probabilistic Risk Assessment And Management For Engineers And Scientists, IEEE Press, ISBN 0-7803100-47

MarulandaFraume, M. C., 2013, Modelacionprobabilsita de perdidaseconomicasporsismo para la estimacion de la vulnerabilidad fiscal delestado y la gestion dinancieradelriesgosoberano, PhDthesis for the UniversitatPolitecnica de Catalunya, availableathttp://www.tdx.cat/bitstream/handle/10803/116424/TMMF1de1.pdf?sequence=1

Manuele, F. A., 2010, Acceptable Risk, Professional Safety, v. 55, 5, 30-38

Nasim Uddin, Alfredo H.S. Ang. (eds.), 2012, Quantitative risk assessment (QRA) for natural hazards, American Society of Civil Engineers CDRM Monograph no. 5

Prahl, B. F., Rybski, D. Kropp, J. P., Burgho, O. and Held, H., 2012, Applying stochastic small-scale damage functions to German winter storms, Geophysical Research Letters, 39

Rossetto, T. and Elnashai A., 2003, Derivation of vulnerability functions for European-type RC structures based on observational data Engineering Structures 25 1241–1263

Vorogushyn, S., Merz, B. and Apel, H., 2009, Development of dike fragility curves for piping and micro-instability breach mechanism, Natural Hazards and Earth System Science, 9, 1383–1401

UNDP, 2013. A Comparative Review of Country-level and Regional Disaster Loss and Damage Databases. Bureau for Crisis Prevention and Recovery. United Nations Development Programme.

UNISDR, 2009, Terminology on disaster risk reduction, Geneva, Switzerland. http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

UNISDR, 2011. Global Assessment Report on Disaster Risk Reduction: Revealing Risk, Redefining Development. United Nations International Strategy for Disaster Reduction. Geneva, Switzerland: UNISDR. http://www.preventionweb.net/gar

USGS, 1982, Guidelines for determining flood flow frequency, Bulletin 17B of the Hydrology Subcommittee, Interagency Advisory Committee on Water Data