# Flood Damage Survey and Assessment

## New Insights from Research and Practice

Daniela Molinari, Scira Menoni, and Francesco Ballio

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# PREFACE

In this book, state of the art methods and procedures for post-flood damage data collection and analysis are discussed, suggesting also best practices that may guide the reader toward the improvement of the quality and comparability of data and analyses across time and geographic areas.

The fact that better data are needed is a common plea put forward by researchers in many areas of investigation, including risk analysis. The call for better data on natural hazards impacts is certainly not new and has been on the agenda for a long time. So why bother now? Today the novelty stands at multiple levels to justify the proposal of such a thorough reflection proposed to the reader.

First, not only scientists are concerned about lack of data. It also has become a strategic issue for a variety of stakeholders, pertaining both to private and public sectors, who hold responsibility in different ways for disaster risk management. This explains why in the book contributions from a variety of actors can be found, ranging from institutions working at different spatial scales, to reinsurers, to practitioners. The reasons are varied and reflect specific interests and the mission of each actor. For governments, public administrations, and national and international organizations, the need to be able to compare events across time and space has become a prominent factor as the number and the extent of disasters have been constantly increasing over the last years putting at risk lives, public investments, and economic development. To fully appreciate the root causes of such an increase, there is the need first to be able to rely on the data related to the most obvious indicators, such as the number of victims, lost assets, and damages to items and systems.

Different studies suggest that such an analysis of trends over time and across geographic areas is not really possible given the low quality of available databases and the lack of agreed upon standards that are used to collect data when a disaster strikes and afterward. In front of the evidence of increased impacts and associated costs of repair and lost revenue, particularly in times of financial crisis, the need of programming investments in mitigation becomes key, in order to achieve the best results in terms of avoided damage at sustainable costs. However, such appreciation clearly requires that the background information on which such evaluations of potential investments is done be reliable at least at a minimal level, which apparently is not the case as for now.

It would be a mistake, however, to think that such concerns take into account only public bodies. Private organizations at large would greatly benefit from an enhanced capacity to estimate and prepare for damage before an event strikes. Insurance companies have relied until now on the large amount of data that is available in their databases. However, such data are very partial, of varied quality, depending significantly on the skills and time devoted to surveys by experts appointed to set the claims after an event. Such data are useful for identifying key variables benefitting from a very large number of surveyed values, but the data cannot account for extraordinary situations (linked for example to catastrophic events or whenever cascading effects are implied) or to appreciate the interaction of factors in very complex environments. As urbanized areas have grown exponentially over the last few decades so has the complexity of disasters. A variety of interdependent and tightly interconnected systems (including social, economic, built up, natural) have created the starting point for unanticipated damage that can be very costly. Gaining a finer understanding of how a variety of initial conditions in different environments produce larger and more complex ways to solve problems is becoming an issue also for insurance and reinsurance companies. In the meanwhile, studies [*Rose and Huyck*, 2016] have shown that the cost of collecting new and more data is fairly repaid by the possibility of better appraising how the emergency context affects businesses and what the factors are that provoke the highest impact on businesses' capacity to recover quickly.

The reasons for a growing interest by a variety of actors for enhanced disaster damage data that we have just discussed explain why now different initiatives at the national and international levels, such as the Working Group established by the European Union (EU) Commission, or the Sendai Framework for Action, have raised interest on the topic. At the heart of the reasons for such interest is certainly the recognition that data and information are the bricks of knowledge. It is not just a matter of accounting to better program resources to be allocated for disaster management or to evaluate trends of losses to identify the potential impact of climate or social changes leading to different patterns in the natural and the built environments. It is also an issue of identifying and selecting the most effective mitigation measures while gaining a better perspective on what the factors are of the risk function, hazard, exposure, and vulnerability, that have contributed most to the final outcome in terms of losses.

On the other hand, enhanced knowledge of natural hazards accomplished in the last decades is key for identifying what the most useful data are to collect. In addition, identifying the crucially missing information is key. Without both, a better understanding of how risk factors play in each context and better modeling capacity for forecasting damage before the event occurs will not be achieved.

The book is organized in five parts. Part I comprises two chapters that lead the reader into the international debate on loss data needs, discussing loss data requirements defined by the Sendai Framework and the main initiatives to meet such requirements.

Part II starts with a comprehensive overview of loss data storage at the global level, highlighting limits, strengths, and needs of available databases in order to accomplish the Sendai Framework requirements (Chapter 3). Then, the focus shifts to the national level with a critical discussion of flood loss databases in the United States of America (Chapter 4) and the German HOWAS21 database (Chapter 5), presented as a best practice of loss databases tailored to risk modeling needs.

Part III focuses on best practices of damage data collection, at both the meso and the local scale. As for the former, the experience gained in Germany after the Elbe flood in 2002 is analyzed (Chapter 7). In this instance, computer-aided telephone interviews were carried out to "survey" observed damage at residential buildings and firms. Such practice is now a standard in Germany after every flood event and could be considered for replication in other countries. As for the local scale, the survey experience gained in the Umbria region (Central Italy), after the 2012 flood, is discussed in Chapter 6. Such experience brought the development of a procedure for damage data collection, at the individual affected item scale, to be implemented every time a flood occurs in the region. The procedure has been designed to meet several user needs (i.e., emergency management, damage compensation, disaster forensic, and risk modeling) and includes specific forms for damage surveys.

Chapter 8 presents a comprehensive overview of the surveys carried out at the Centre For Disaster Studies Research (at James Cook University) on the occasion of 13 floods in Australia. Such an experience can be seen as a best practice situation to address issues that contribute to mitigation as well as to understand community experience in a disaster. The main results from the study are described in terms of communities' vulnerability and resilience. In Chapter 9, that closes the third section, the main advantages and limits of crowdsourcing as a reliable and complementary source of loss data are discussed. In detail, the authors, who are practitioners working within humanitarian organizations and community-based flood relief organizations, describe their own experience by presenting several case studies. The latter constitute the basis for illustrating the value of crowdsourcing but reflect also on how to ensure its effective integration into disaster response.

Part IV supplies examples of data analysis, of how collected and stored data can be used to support multiple objectives for which data are collected. Following *De Groeve et al.* [2013], objectives can be synthetically indicated as accounting, forensic analysis, needs assessment, and improved risk modeling capacity.

The first contribution to this section deals with the Post-Event Review Capability (PERC) methodology (Chapter 10). The methodology has been designed as part of the Zurich Insurance's resilience alliance as a process to evaluate what happened before, during, and after a disaster, to identify the critical gaps and successes in the overall disaster risk management system, and to present actionable recommendations. Then, the use of damage data to develop complete event scenarios after flood events is discussed, providing an application to an Italian case study (Chapter 11). Chapter 12 presents the experience gained by the Queensland Reconstruction Authority in Australia after the 2010–2011 floods. The chapter highlights how the knowledge of observed impacts allowed the definition of the most suitable strategies to build a more resilient Queensland. The final contribution to this section (Chapter 13) supplies insights on the use of collected and stored data to carry out a forensic investigation of flood damage at the industrial sector. In particular, the chapter discusses how disaster forensics can be used to understand damage cause and mechanisms and then to define proper risk mitigation measures.

The last section (Part V) includes best practices on the use of Information and Communication Technology (ICT) supporting data collection, storage, and analysis. Chapter 14 focuses on the use of satellite data to survey and assess damage at the global scale. In particular, the Copernicus Emergency Management Service (EMS) is described making reference to some case studies. Chapter 15 describes tools developed within the Italian project Poli-RISPOSTA for data collection and analysis at the local scale. Such tools consist of mobile applications for data survey, spatial databases for the storage of data, and a web-GIS application for data analysis and representation.

Conclusions close the volume and include recommendations, guidelines, and best practices starting from the experiences described in the book.

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# Part I
# Introduction

# 1

# Overview of the United Nations Global Loss Data Collection Initiative

**Julio Serje**


## ABSTRACT

The Year 2015 was marked by the emergence of three international agreements: The Sendai Framework for Disaster Risk Reduction, the 2030 Agenda for Sustainable Development, and in the Intergovernmental Panel on Climate Change (IPCC) Conference of the Parties (COP) 2015, a global legally binding agreement on Climate Change now known as the Paris Agreement.

All of these frameworks explicitly recognize the importance and usefulness of collecting and analyzing loss data in their corresponding implementations. The Sendai Framework, in particular, calls for the collection of data about disaster of all scales. It also calls for the collection of data about man-made, technological, environmental, and other hazards, with an emphasis on climate-related risks.

Most importantly, the Sendai Framework sets out seven targets, of which four relate to losses: mortality, people affected, economic loss, and damages to infrastructure. This implies that the coverage of national disaster loss data sets will have to be expanded to be global so that countries can report on these targets. This development represents a unique opportunity to build a bottom-up constructed global disaster loss database.

Many actors have collected national loss data for many years. For over a decade, the United Nations (UN) system has supported and promoted the construction of national disaster databases based on the Disaster Information Management System (DesInventar) methodology and software tools. Additionally, a number of countries have been collecting data with proprietary specifications and different levels of resolution. These include several countries that collect data at a localized level, for example, European countries where data are associated with compensation mechanisms.

DesInventar-based national data sets also cover small disasters, breaking down event data by municipality aggregates and using a rich set of indicators, which contain those that will be required to report against the Sendai Framework. The number of indicators implies bigger efforts may be required to build or retrofit and sustain these databases, which in addition can provide a clearer picture of damage trends and patterns at subnational scales and contribute to a better understanding of risk.

There are, however, methodological, conceptual, and practical challenges associated with a relatively localized data collection. These challenges may range from discrepancies in the perception of what an “event” is, to difficulties in the integration of multiple data sources, to the additional effort required to disaggregate information collected otherwise and the challenge of the economic valuation of the damage aggregates using a consistent and homogeneous methodology.


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Despite these challenges, the 2015 edition of the Global Assessment Report on Disaster Risk Reduction (GAR) by the UN features analyses using a consolidated, homogenized, and standardized data set covering 82 countries and several states in India, which includes a uniform economic valuation of damage. The United Nations Office for Disaster Risk Reduction (United Nations International Strategy for Disaster Reduction [UNISDR]) has been using this data set as a proof of concept of what a global database could look like. The UN Initiative, which started in 2005 when only 15 countries had these data sets, has continued to approach 100 countries in 2015. It will continue with renewed enthusiasm in the next few years, with the target of global coverage by 2020, as stated by the Sendai Framework.

## 1.1. DISASTER RISK REDUCTION: A FRAMEWORK FOR ACTION

The concept and practice of reducing disaster losses and risk through systematic efforts to analyze and reduce the causal factors of disasters and therefore reduce its impacts is known today as Disaster Risk Reduction (DRR). Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction [*UNISDR,* 2009a].

Progress in reducing risk has been undeniable over the past decades. However, global models suggest that the risk of economic losses is rising as a result of a series of factors, including increases in exposure and vulnerability, exacerbation of hazards because of climate change, and the rapidly increasing value of the assets that are exposed to major hazards [*UNISDR,* 2015a]. In addition, a large proportion of losses continue to be associated with small and recurring disaster events that severely damage critical public infrastructure, housing, and production, which are key pillars of growth and development in low- and middle-income countries.

The long road of international agreements that started with the declaration of 1990–1999 as the International Decade for Natural Disaster Reduction (IDNDR) [*UNISDR,* 1999a], and which produced the Yokohama Strategy and Plan of Action, and the subsequent Hyogo Framework for Action, has shown the international continuous concern about the growing impacts of disasters.

## 1.2. THE SENDAI AND OTHER FRAMEWORKS OF 2015

On 18 March 2015, representatives from 187 United Nations Member States gathered in Sendai, Japan for the Third World Conference on Disaster Risk Reduction and adopted the Sendai Framework for Disaster Risk Reduction (SFDRR) (*UNISDR,* 2015). Later in the same year, the 2030 Agenda for Sustainable Development was also adopted, and to finalize a golden year in international agreements, countries participating in the Paris COP 21 reached for the first time a global legally binding agreement on climate change, now known as the Paris Agreement.

The international community made a big effort to align these three processes as much as possible. In its first page, the Paris Agreement welcomes "the adoption of United Nations General Assembly resolution A/RES/70/1, 'Transforming our world: the 2030 Agenda for Sustainable Development,' in particular its goal 13, the adoption of the Addis Ababa Action Agenda of the third International Conference on Financing for Development and the adoption of the Sendai Framework for Disaster Risk Reduction" [*United Nations Framework Convention on Climate Change (UNFCCC),* 2015].

The Sendai Framework, the first of these to be adopted, sets "the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries" as its main outcome. It also sets as its only goal to "prevent the creation of new risks and to reduce existing ones through different measures and thus strengthen resilience."

The 2030 Agenda for Sustainable Development embeds within its goals and targets all of the targets set by the Sendai Framework. Goal 11 Target 5 in particular comprises three of the seven targets of the Sendai Framework, all of them aiming at the reduction of human and economic losses [*UN,* 2015]. Targets in other goals, such as Goal 13 addressing climate change, also address similar challenges as those identified by SFDRR.

The Paris Agreement, in its Article 7 on adaptation, sets a global goal to increase adaptive capacity, strengthen resilience, and reduce vulnerability. This is the first time there is a formal agreement on a global adaptation goal. Article 8 on loss and damage (one of the problematic issues that delayed negotiations) includes reducing risk of losses and damages, early warning systems, emergency preparedness, and comprehensive risk assessment and management, all of which are aligned with the Sendai Framework Priorities for Action and Targets [*UNFCCC,* 2015].

## 1.3. THE SENDAI FRAMEWORK AND LOSS DATA COLLECTION

The Sendai Framework is structured around one main outcome and one goal, four priorities for action, seven targets and has a much wider scope than its predecessor, the Hyogo Framework for Action.

Priority 1. "Understanding disaster risk" states that disaster risk management should be based on a thorough understanding of disaster risk and losses in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics, and the environment. Such knowledge can be used for risk assessment, prevention, mitigation, preparedness, and response.

Priority 2, "Strengthening disaster risk governance to manage disaster risk" recommends clear vision, plans, competence, guidance, and coordination within and across sectors, as well as participation of relevant stakeholders and fostering collaboration and partnership across mechanisms and institutions for the implementation of instruments relevant to disaster risk reduction and sustainable development.

Priority 3, "Investing in disaster risk reduction for resilience" suggests public and private investment in disaster risk prevention and reduction through structural and non-structural measures, which are essential to enhance the economic, social, health, and cultural resilience of persons, communities, countries, and their assets, as well as the environment.

Priority 4, "Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation, and reconstruction" recognizes there is a need to strengthen disaster preparedness and ensure capacities are in place for effective response and recovery at all levels. The recovery, rehabilitation, and reconstruction phases are critical opportunities to build back better than before and opportunities to integrate disaster risk reduction into development.

Both the Sendai Framework for reducing disaster risk and its predecessor, the Hyogo Framework for Action, explicitly recognize the importance and usefulness of collecting loss data as one of the actions that will help countries to increase the knowledge about the risks they face. In particular, the Sendai Framework Priority 1, "Understanding disaster risk," suggests among other activities the following:

"(d) Systematically evaluate, record, share and publicly account for disaster losses and understand the economic, social, health, education, environmental and cultural heritage impacts, as appropriate, in the context of event-specific hazard-exposure and vulnerability information;

(e) Make non-sensitive hazard exposure, vulnerability, risk, disaster and loss-disaggregated information freely available and accessible, as appropriate";

The text of the Framework calls for its application to *disasters of all scales* and, as opposed to the Hyogo framework, it requests countries to address and therefore collect data about hazards that are not only considered of "natural" origin:

"15. This Framework will apply to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or man-made hazards, as well as related environmental, technological and biological hazards and risks".

To support the assessment of global progress in achieving the outcome and goal of the framework, seven global targets were agreed upon. Most importantly, out of these seven targets, four are related to losses and impacts.

These targets will be measured at the global level and will be complemented by work of the Open Ended Intergovernmental Working Group (OEIWG), tasked with the responsibility of developing appropriate indicators, with all the details and precise definitions that will be required, and defining the rules regarding how those indicators will be used to compute the targets [*UNISDR,* 2015]. The seven global targets, in summary form, follow:

(a) Substantially reduce relative (per capita) global disaster mortality.

(b) Substantially reduce the relative number of affected people globally.

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP).

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities.

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.

(f) Substantially enhance international cooperation to developing countries.

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments.

There are several consequences to the wider scope of the framework, the explicit recommendations of Priority Action 1 on loss data collection and, in particular, to the fact that Targets (a) to (d) are based on loss indicators. One is that countries are strongly encouraged to systematically account for disaster losses and impacts for a wide spectrum of disaster scales and a large set of hazards. This accounting must take into account an expectedly large number of loss indicators defined by the OEIWG, including human, infrastructure, and economic indicators. This set of indicators will allow, on one hand, the monitoring of the outcomes of the framework, reduction of losses, and the progress in achieving the targets, and on the other hand, it will allow improvement of the understanding of risk and the impacts of disasters in member states.

The work of the OEIWG has defined a relatively manageable but still numerous and complex set of indicators to

**Table 1.1** Set of Indicators Agreed Upon by the OEIWG in Geneva.

| | |
|---|---|
| Target A: Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020 and 2030 compared to 2005 to 2015. | |
| A-1 | Number of deaths and missing persons attributed to disasters per 100,000 population. (This indicator should be computed based on indicators A-2, A-3, and population figures.) |
| A-2 | Number of deaths attributed to disasters per 100,000 population. |
| A-3 | Number of missing persons attributed to disasters per 100,000 population. |
| Target B: Substantially reduce the number of affected people globally by 2030 with the aim of lowering the average global figure per 100,000 between 2020 and 2030 compared to 2005 to 2015. | |
| B-1 | Number of directly affected people attributed to disasters per 100,000 population. (This indicator should be computed based on indicators B-2 to B-6 and population figures.) |
| B-2 | Number of injured or ill people attributed to disasters per 100,000 population. |
| B-3 | Number of people whose damaged dwellings were attributed to disasters. |
| B-4 | Number of people whose destroyed dwellings were attributed to disasters. |
| B-5 | Number of people whose livelihoods were disrupted or destroyed, attributed to disasters. |
| Target C: Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030. | |
| C-1 | Direct economic loss due to hazardous events in relation to global gross domestic product. (This indicator should be computed based on indicators C-2 to C-6 and GDP figures.) |
| C-2 | Direct agricultural loss attributed to disasters. *Agriculture is understood to include the crops, livestock, fisheries, apiculture, aquaculture, and forest sectors as well as associated facilities and infrastructure.* |
| C-3 | Direct economic loss to all other damaged or destroyed productive assets attributed to disasters. *Productive assets would be disaggregated by economic sector, including services, according to standard international classifications. Countries would report against those economic sectors relevant to their economies. This would be described in the associated metadata.* |
| C-4 | Direct economic loss in the housing sector attributed to disasters. *Data would be disaggregated according to damaged and destroyed dwellings.* |
| C-5 | Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters. *The decision regarding those elements of critical infrastructure to be included in the calculation will be left to the member states and described in the accompanying metadata. Protective infrastructure and green infrastructure should be included where relevant.* |
| C-6 | Direct economic loss to cultural heritage damaged or destroyed attributed to disasters. |
| Target D: Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including developing their resilience by 2030. | |
| D-1 | Damage to critical infrastructure attributed to disasters. (This index should be computed based on indicators D-2 to D-5.) |
| D-2 | Number of destroyed or damaged health facilities attributed to disasters. |
| D-3 | Number of destroyed or damaged educational facilities attributed to disasters. |
| D-4 | Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters. *The decision regarding those elements of critical infrastructure to be included in the calculation will be left to the member states and described in the accompanying metadata. Protective infrastructure and green infrastructure should be included where relevant.* |
| D-5 | Number of disruptions to basic services attributed to disasters. (This indicator should be computed based on indicators D-6 to D-8.) |
| D-6 | Number of disruptions to educational services attributed to disasters. |
| D-7 | Number of disruptions to health services attributed to disasters. |
| D-8 | Number of disruptions to other basic services attributed to disasters. *The decision regarding those elements of basic services to be included in the calculation will be left to the member states and described in the accompanying metadata.* |

measure these targets [*UNISDR,* 2015b]. Among the indicators considered, several are oriented to capture human losses, including those required to measure mortality and people affected, concepts that require very precise definitions and therefore precise indicators. A larger number of indicators will be required to measure direct economic losses and damages to critical infrastructure referred in Targets (c) and (d). At the time of writing this text, the OEIWG has put forward more than 20 indicators for consideration by the member states [*UNISDR,* 2015b], indicators that are deemed the minimum necessary for these measurements.

Systematically accounting for losses translates, in technological terms, to the creation of national disaster loss databases that are capable of recording the large number of loss indicators for disasters, at all scales, in a disaggregated manner, which is in agreement with the spirit of Priority Action 1 of the framework (see above). Priority 1 recommendations go even further, suggesting that these databases and information should be publicly accessible.

Table 1.1 compiles the set of indicators that have been agreed upon by the OEIWG in Geneva in the Third Session held in November 2016. This list of indicators is available in the United Nations General Assembly Resolution A/71/644.

## 1.4. WHERE WE ARE: BASIC PRINCIPLES OF THE UNITED NATIONS INITIATIVE

Although there are a few global disaster loss databases such as the Emergency Events Database (EM-DAT) [*Centre for Research on the Epidemiology of Disasters (CRED)*, 2011], NatCat from Munich Re, Sigma from SwissRe, and others, it is important to note that any reporting process to the Sendai Framework monitoring system has to be based on *officially endorsed data*, ideally collected and authenticated by national governments. These data should comply with the requirements of the framework, that is, it should address small- and large-scale disasters, slow and rapid onset events, it should cover a large number of hazards, including technological and man-made hazards, and most importantly, it should record a larger number of indicators not currently available in these global loss databases. Furthermore, if the recommendations of the framework are to be applied, databases should be built gathering disaggregated data that have to be usable at a subnational scale. Data should be disaggregated, at the minimum, by hazard, by event, and at a certain level of geography. For internal purposes, countries are encouraged to pursue even higher levels of disaggregation, for example, by recording human impacts in a gender-sensitive way or to collect data at asset level.

All of these minimum requirements imply that current national disaster databases will have to be expanded to reach global coverage once consolidated. Additionally, many existing databases and loss data collection systems will have to be retrofitted so that data sets contain all of the required indicators and comply with disaggregation requirements (see Chapter 3).

From the UN perspective, this situation represents a unique opportunity to build a bottom-up constructed global disaster loss database, allowing the process of global consolidation of data required to assess the progress in achieving the targets.

### 1.4.1. A Bottom-up Approach to Build a Global Database

The building of a global scale disaster loss database is not just the provision of a mechanism to measure Sendai Targets. Robust, official, systematic, and homogeneous measurements of losses will be a major contribution to the implementation of the Sendai Framework, and in general to disaster risk reduction, climate change adaptation, and sustainable development strategies.

National disaster loss databases will increase the capacity of countries to understand their risks and will provide a solid evidence base upon which to help countries to assess and address their disaster losses and impacts, particularly those associated with climate and weather-related hazards.

More specifically, loss databases will significantly improve the understanding of how disasters and risks affect the most vulnerable, and the databases could be used to better understand how climate variability impacts are trending and their true magnitude.

In those countries where no loss data are collected, or where information is kept only as paper archives, the UN has been proposing the use of a common simple but effective tool that implements the minimum requirements for the Sendai Framework. This effort, its challenges and achievements, and its future will be described in detail in the following sections.

In summary, this UN initiative has been implementing national disaster loss databases that comply with the following requirements:

- Data are collected for every hazardous event that has any type and level of damage registered, therefore, allowing the collection of information for disaster on all scales. Damage registered can be either quantitative (a number) or qualitative (a yes/no marker or a textual description of the damage).
- For each hazardous event, a set of indicators that is very similar, if not the same, as those discussed in the OEIWG for Sendai Targets are collected and recorded. Each indicator collected has precise definitions and even

recommendations on data collection issues and problems [*UNISDR,* 2011b].

• For each hazardous event, the main and triggering hazards (from a local perspective) are recorded. The list of hazards used in the initiative is also standardized as much as possible; the IRDR[1]-suggested definitions of perils [*IRDR,* 2014] have been adopted by the initiative.

• For each hazardous event, summary loss indicators are collected and recorded separately for each of the geographic units affected; geographic units are in general equivalent to a municipality. It is important to note that collecting loss data at asset level has not been encouraged (but neither discouraged) given its level of complexity and the repercussions on data privacy, legal, and financial liabilities and other factors.

The initiative has been using the "DesInventar" free open source software and methodology [*UNISDR,* 2011b]. In addition to implementing the above criteria for data collection and storage, the software tools provide basic analysis and reporting tools without which the data collection itself would not be as valuable.

It has to be recognized though that several other countries follow different approaches to collect data. The recent studies of the Joint Research Centre (JRC) Working Group [*JRC,* 2013; *JRC,* 2014; *JRC,* 2015] show that within the European continent there are disparities in the types of data indicators, thresholds, hazards, and resolution of the data collected (which may range from building or asset level to national aggregates), and in those mechanisms that trigger data collection. In particular, it has been found that a number of European countries collect data at building/asset level for purposes of compensation, be it from official funds [the case of Spain, for example, *Defensa Civil Española,* 2014] or from insurance policies [the case of France, for example, *Observatoire,* 2015].

In these cases, the United Nations, in collaboration with countries, intends to build automated interfaces to consolidate the information up to a level equivalent to municipality. Such data sets will be aligned and compatible with the products obtained in the rest of the world, in a common resolution. Most importantly, data aggregates will avoid privacy and data protection problems that could prevent the data from being made publicly available.

Active work is also happening in Europe to standardize and adopt similar hazard/peril classifications as the IRDR and to ensure the consolidation process will render the set of indicators proposed and defined by the OEIWG (see Chapter 2 in this book).

Despite the initial expectations that rich-information countries could easily comply with all of the requirements for Sendai Framework monitoring, it has been seen that not all databases in developed countries contain all of the indicators required. The Sheldus database, for example, in the United States (US) [*Cutter et al.,* 2005; Chapter 4 in this book] only contains a subset of the indicators proposed, and a similar situation has been found in some European countries. For instance, no indicators are collected around critical infrastructure or people affected in many of these databases. However, it is expected that the amount of digital data, the diversity of data sources, and the abundance of resources will result in a coherent integration of all the information required for monitoring the framework.

The final consolidated global data set will be, therefore, a feasible possibility within a few years from now, because it must be finished by 2020 in accordance with Sendai Framework requirements. See Box 1.1 for sample output of consolidated data for South American countries.

UNISDR already has been conducting consolidation exercises with data from a growing number of countries to build the data sets used for analysis posted in the Global Assessment Report (GAR). The data set started with 12 countries in the 2009 edition of GAR, then 21 in the 2011 edition of GAR, followed by 56 in the 2013 edition of GAR, and with the latest edition of GAR in 2015 featuring a consolidated data set containing data for 82 countries and 2 Indian states [*UNISDR,* 2015c].

This data set, of more than half a million records, was used for several research activities and as a proof of concept of the possibilities of consolidation of relatively homogeneous data sets. As documented in Annex II of the GAR 2015 Report, this consolidation was successful although it faced several challenges and some manual work.

Most of the problems faced were related to homologation of hazards, not only because of differences due to the particular context of the participating countries, but also because of linguistic and translation issues. Another area in which a careful examination of the data was required is quality control because some of the raw data still contained rogue or invalid values that had to be removed from the main body of data.

### 1.4.2. Economic Assessment of Direct Losses– United Nations Methodology

A major challenge faced while building the proof-of-concept data set was the lack of consistent, homogeneous, and documented evaluations of economic loss assessments of the impacts of disasters. As documented in several studies [*Dilley et al.,* 2013], all disaster loss databases register economic losses in a very poor manner.

*[1]Integrated Research on Disaster Risk (IRDR) is a decade-long research programme co-sponsored by the International Council for Science (ICSU), the International Social Science Council (ISSC), and the United Nations International Strategy for Disaster Reduction (UNISDR).*

## Box 1.1 Sample output of consolidated data for 10 countries in South America.

Integration of data across boundaries is a feasible exercise if the data sources are compatible not only in format but also conceptually. This map shows the spatial distribution of the frequency of disasters associated with extreme precipitation at the second administrative level (municipality). Data from Brazil exists, and it is expected to become publicly available in the near future. Similar data sources exist for practically all countries in Central America and North America, meaning that for the first time, a continental view of the historical distribution, trends, and patterns of disasters can be readily obtained.

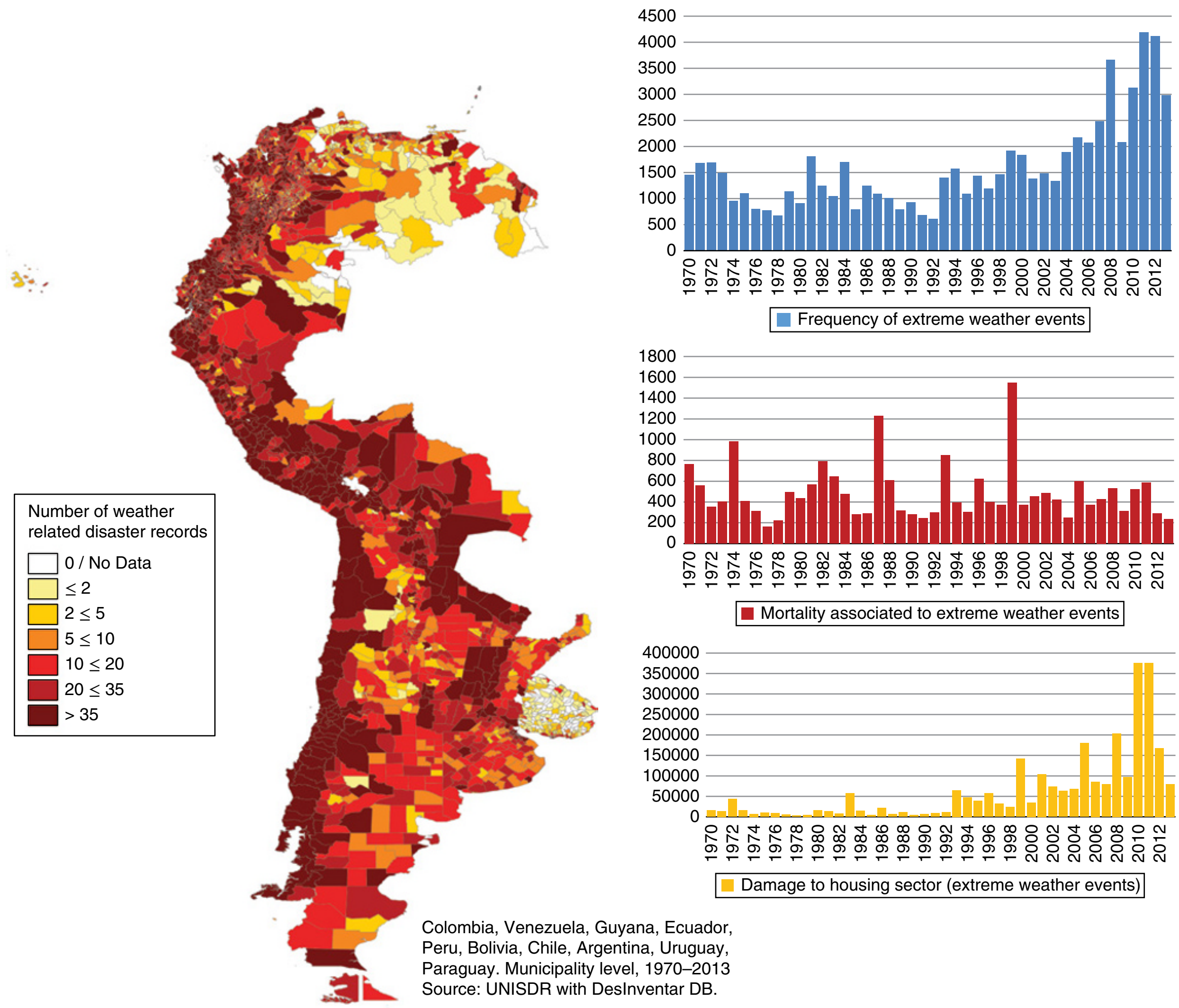


**Figure 1.1** Consolidated extreme precipitation related disasters in South America (1970–2013).

A good manifestation of this issue is the extremely low coverage of data on economic losses, a problem that is common to most disaster loss databases, with the possible exception of insurance databases, where insured losses are operational assets and total losses are inferred using indexes such as market penetration. The well-known EM-DAT (see Chapter 3 in this book) only contains 25% of records with an economic assessment figure. Existing national databases contain 20% or even fewer records with dollar figures. Additionally, in all of these cases, national and global, methodologies and parameters used to estimate the economic loss are undocumented, if not unknown, and at the minimum, are not homogeneous or inconsistent given the disparity of the actors, contexts, and the circumstances in which the measurements were taken.

Target (c) of the Sendai Framework puts additional pressure on the requirements to collect loss data by requesting countries to assess "direct economic loss" defined as the value of the assets lost as consequence of disasters (loss of stock, in economic terms).

By applying a systematic and relatively simple approach to calculate direct economic loss, the GAR research team found it was possible to estimate a large portion of total direct losses recorded in the 82 countries for which data were available in the consolidated GAR data set of 2015.

Using a simple and consistent pricing methodology for indicators of losses in houses, roads, agriculture, schools, and health facilities, it was possible to estimate a significant part of total direct economic loss [*GAR,* 2011, 2013; *Velásquez et al.,* 2014]. However, this estimation still doesn't take into account damages to other sectors such as industrial and commercial, and costly infrastructure in cases of large disasters. However, the methodology proposed to the OEIWG will address many more of these missing sectors and will address known weaknesses of the GAR methodology.

In particular, the methodology addresses each sector separately, proposing methods to assess the economic value of direct damage using a replacement value methodology.

For all of the sectors that refer to built environment (i.e., housing, health, education, commercial, industrial facilities), the methodology is quite simple, estimating the price using the value of construction as a base. The Economic Commission for Latin America and the Caribbean (ECLAC) methodology suggests that the value of the physical damage to buildings can be calculated based on the following:

- the size of the building
- the price per square meter of construction
- the damage to furniture and equipment contained in the building (as a percent of the value of the building)
- the associated infrastructure (utility networks, access roads, landscaping, as a percent of the value of the building)

In turn, the values of the equipment and associated infrastructure are estimated as a percentage of the value of the construction, a percentage that varies on each sector. In the case of houses, for example, the equipment contained is suggested to be 25% of the value of the house; this percentage is much higher in health and industrial sectors.

For transportation infrastructures, the methodology uses rehabilitation costs per lineal meter, extracted from common projects in the sector.

Agricultural damage is estimated as a proxy value calculated based on the output of the crops. The underlying principle is that direct losses (seeds, fertilizers, pesticides, labor, and other costs that comprise what farmers invest in their crops) can be estimated as a percentage of the expected yield of crops.

It may be possible in the future to better estimate direct and total losses, based on conclusions from rigorous economic assessment of disasters conducted by the UN using the economic assessment methodology developed by ECLAC and the World Bank, which showed that direct losses represent statistically between 50 and 80% of total losses with this percentage higher in geological events [*ECLAC,* 2012]. In a subsequent phase, wider impact and macroeconomic losses could also be estimated if the quality of the data is high and adequate methods are developed.

Annex II of the GAR Report 2015 showed that direct losses calculated with this methodology are statistically well correlated and are usually close to the figures evaluated by UN-ECLAC, World Bank Damage and Loss Assessments (DaLA) and UN-PDNA (Post-Disaster and Needs Assessments). The report suggested that by extrapolating the figures found in these 82 countries, real economic losses could be significantly higher than losses reported by global data sources such as EM-DAT or NatCat from Munich Re, also taking into account losses in other sectors such as industrial and commercial sectors that were still to be accounted for.

To address some of the weaknesses of this methodology, the Secretariat of the OEIWG has proposed extending the loss indicators to cover industrial and commercial sectors and has developed a more detailed methodology that could take advantage of better local construction prices and asset average size data, to produce more accurate economic assessments [*UNISDR,* 2015e]. This methodology also opens the door to using very detailed data in countries where data collection is done at asset level or at intermediate levels of details that would greatly improve the accuracy of the assessment.

In all cases, the Secretariat is proposing, as a best practice, that all of the physical damage indicators are collected and kept by countries as important information asset. Physical damage indicators will allow the future connection of loss data with risk assessments or disaster forensics. It will make the Sendai Framework assessment of direct losses more transparent, and will allow, among other things, the incremental improvement of the assessment as countries develop better methodologies and as countries collect better and more comprehensive baseline data.

## 1.5. WHERE DO WE GO? EXPERIENCE FROM THE PAST INDICATES CHALLENGES FOR THE FUTURE

In 2008, when the first Global Assessment Report was being prepared to be launched in one year, approximately 15 countries were found to be using the DesInventar methodology. Most of the countries were in Latin America and, more incipiently, in several of the countries that were affected by the tsunami of December 2004. A first consolidated data set was assembled, aiming to look deeper into the real extent and importance of small and medium disasters. A sample of data from 12 countries was used to define, for the first time in numerical terms, the concepts of "Extensive" and "Intensive" risk. It was estimated that the number of countries with national disaster loss databases by 2008 was less than 30 [Global Risk Identification Program (*GRIP*), 2008], from which 90% were using the DesInventar methodology.

Since then, the number of countries covered by a DesInventar standardized electronic system for loss data collection has increased to over 90, under concerted efforts of the UN mainly represented by United Nations Development Programme (UNDP) and UNISDR, and other organizations including the European community and the World Bank. As stated before in this chapter, the GAR edition for 2015 contained a consolidated data set for 82 countries and 2 Indian states, and another set of countries joined the initiative during 2015, which is now approaching 100 countries in total.

Building more than 60 new data sets in a period of seven years has resulted in a wealth of experience and an important data asset.

### 1.5.1. Challenges and Achievements of National Databases

The next few sections of this chapter summarize the achievements, but especially the challenges, that countries and the UN system have faced while building a large number of disaster loss databases in the past decade.

Is important to underscore that the majority of this work has been done in developing countries, some of which are even classified as Least Developed Countries (LDC), and in many Small Island Developing States (SIDS), which are, of course, the focus of the development and humanitarian work of the UN. Only recently, the initiative has welcomed countries from the developed world, where a very different set of challenges occur.

Achievements of the initiative can be seen at national and global levels. The contribution of the group of Latin American countries that started the initiative under the umbrella of LA RED (LA RED de Estudios Sociales en Prevención de Desastres en America Latina[2]) has to be recognized as a pioneer work that brought to Sendai and other frameworks important ideas and hypothesis about the nature and significance of small and medium disasters, among other things.

[2]*The Network for Social Studies on Disaster Prevention in Latin America. See http://www.la-red.org*

It would be difficult to condense all of the achievements and products outcome of the initiative within countries in a few paragraphs. A few examples of loss accounting systems that are truly institutionalized and embedded into the national risk reduction mechanisms are the cases of Sri Lanka,[3] Indonesia,[4] Turkey,[5] Ethiopia, Cambodia, and Panama, among many other countries.

The Secretariat of the Pacific, a regional intergovernmental body, has developed and maintains Pacific Damage and Loss (PDALO), a data set covering 22 SIDS, many of which have very little capacity to maintain the system by themselves. Analysis of their data has been issued as documents in the Pacific Disaster Network, and loss data analysis is used as one of the inputs for the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) system [South Pacific A*SPC/SOPAC,* 2014].

There are many examples of disaster loss data usage for policy analysis. Good examples are the applications in Latin American countries, where governments have adopted policy recommendations based on the impacts of the El Niño phenomenon [*LA RED/ENSO,* 2007]. In Tunisia, Niger, Mali, and several other African countries, disaster loss databases are providing, for the first time, evidence-based results of risks historically faced by these countries, which in some cases challenges the current perception of risks of governments. For example, in Mali, the impact of insect infestations was confirmed to have similar or greater impacts than floods.

More and more, loss data are used as input, calibration, validation, and complement of risk assessments and as linking data with climate change processes. Lebanon has recently produced a flood risk assessment that contains historical mapping and measures of impact of past flood disasters.

Data from the initiative have been crucial in shaping the current discourse of UNISDR in risk reduction. Four consecutive editions of the Global Assessment Report have strong basis, reflected in entire chapters and annexes devoted to the topic, on the findings arisen from the analysis of individual and consolidated data sets.

The ongoing work of JRC aimed at producing a recommendation for loss data collection to Member States [*JRC,* 2013, 2014, 2015] has gathered, perfected, and adopted many of the ideas, best practices, and lessons

[3]*See www.desinventar.lk. System includes subnational profiles for districts, public awareness, and education sections and publications.*

[4]*See http://dibi.bnbp.gov.in. Data Informasi Bencana Indonesia (DIBI) system is decentralized, with provincial subsystems. The data are linked, and the open source software has been reused for a poverty eradication project system and other applications.*

[5]*See https://tuaatest.afad.gov.tr/map.jsp. The Turkish system is coupled with a DRR knowledge base system.*