PART I

MAIN CONCEPTS FOR MEASUREMENT

CHAPTER 1: INTRODUCTION

Background

1. In May 2014, ESCAP Resolution E/ESCAP/RES/70/2 on "Disaster-related Statistics in Asia and the Pacific", established the Expert Group on Disaster-related Statistics in Asia and the Pacific and requested it to develop a basic range of disaster-related statistics along with guidance for implementation.

2. The ESCAP Resolution 70/2, establishing this Expert Group, recognized better use of disaggregated data as a challenge for evidence-based disaster risk management policy in the Asia-Pacific region. The document stressed the importance of disaggregated data related to disasters in enabling a comprehensive assessment of the socioeconomic effects of disasters and strengthening evidence-based policymaking at all levels for disaster risk reduction and climate change adaptation.

3. Since 2005, there has been an international consensus on the need to "develop systems of indicators of disaster risk and vulnerability at national and sub-national scales that will enable decision-makers to assess the impact of disasters on social, economic and environmental conditions and disseminate the results to decision-makers, the public and population at risk." (UN Hyogo Framework for Action, 2005, p.9).

4. The demand for internationally comparable methods for producing statistical evidence for disaster risk reduction received renewed and increased attention internationally with the adoption by the UN General Assembly of the Sendai Framework for Disaster Risk Reduction and with prominent inclusion of disaster risk reduction targets within the UN Sustainable Development Goals (SDGs).

5. The 2030 Agenda for Sustainable Development established 17 Goals and 169 targets for the eradication of poverty and the achievement of sustainable development. In March 2016, the 47th Session of the United Nations Statistical Commission (UNSC) agreed to a Global Indicator Framework, specifying 230 indicators for measuring progress towards the Sustainable Development Goals. In the SDGs, there are 11 disaster-related targets, spanning many of the 17 goals, and covered by 5 indicators, including under Goal 1: "End poverty in all its forms everywhere", Goal 11 "Make Cities and Human Settlement, Inclusive, Safe, Resilient and Sustainable" and Goal 13 "Take Urgent Action to Combat Climate Change and its Impacts" The inter-agency expert group (IAEG) on SDG indicators, decided that the definitions for these indicators would align with indicators adopted for international monitoring of the Sendai Framework.

6. The Sendai Framework for Disaster Risk Reduction was adopted at the Third UN World Conference in Sendai, Japan, in March 2015. It is the outcome of stakeholder consultations initiated in March 2012 and inter-governmental negotiations from July 2014 to March 2015, supported by the United Nations Office for Disaster Risk Reduction (UNISDR) at the request of the UN General Assembly. After the adoption of the Sendai Framework, an intergovernmental process was established to reach agreement on terminologies and indicators for monitoring the targets of the Sendai Framework. This intergovernmental process completed and was endorsed by the UN General Assembly in December, 2016. To help ensure cohesion between

national compilations of official statistics with demands for global indicators, the terminologies used in the DRSF are aligned with this Report.[3]

7. The Sendai Framework contains a statement of outcome for 2030, which is to achieve a substantial reduction of disaster risk and losses, to lives, livelihoods and health and to the economic, physical, social, cultural, environmental assets of persons, businesses, communities and countries. The Sendai Framework establishes four priorities for action:

1) Understanding disaster risk;
2) Strengthening disaster risk governance to manage disaster risk;
3) Investing in disaster risk reduction for resilience; and
4) Enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation and reconstruction.

8. The targets for monitoring progress in the framework are:

1) Reduce global disaster mortality;
2) Reduce the number of affected people;
3) Reduce direct disaster economic loss;
4) Reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities;
5) Increase the number of countries with national and local disaster risk reduction strategies;
6) Enhance international cooperation; and
7) Increase the availability of and access to multi-hazard early warning systems and disaster risk information

9. A collection of 38 independent (including compound) indicators were adopted for global monitoring of all seven Sendai Framework targets. The Sendai Framework global monitoring indicators and associated terminologies were developed by governments and international experts through the Open-ended Inter-Governmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction (OEIWG). Two of the Sendai Framework Indicators: Deaths from disasters and direct economic loss from disasters are included in the SDGs.

10. At the 21st Conference of the Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC) in Paris (December 2015), a new agreement on accelerating and intensifying the efforts to combat climate change was made. The work to develop modules and procedures for the implementation of the Paris Agreement will utilize the rich experience with the reporting and review/analysis of climate-related information and data under the UNFCCC. The Paris Agreement requires all Parties to put forward their best efforts to address climate change through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. The Paris Declaration also refers to the Sendai Framework and the SDGs.

[3] A/71/644: "Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction"

11. UNISDR, as the custodian agency for international monitoring of the Sendai Framework indicators, has launched an international monitoring process and online tool, called the Sendai Monitor[4] for collecting figures for the agreed international indicators from official national sources, particularly NDMAs and NSOs.

12. UNISDR Technical Guidance for indicators reporting (UNISDR, 2017) was developed following adoption of global agreement on the indicators and associated terminologies (UNGA, 2015).

13. One of the main objectives of this handbook is to generate statistics that are used for calculating relevant international indicators for reporting to the Sendai Framework Monitor and SDGs global monitoring systems. This handbook complements the guidance on indicators by focussing on the underlying statistical infrastructure. In the case of disaster-related statistics, this requires integration from a diverse variety of data sources and many different government agencies. A framework is required to supply the basic data inputs used for calculating international indicators, as well as to meet other related, but often broader and more in-depth, information needs for policy at the national and local levels.

14. According to the Sendai Framework, a **disaster** is "a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." (UNGA, 2016).

15. For development of this handbook, the Expert Group on Disaster-related Statistics in Asia and the Pacific consulted with a broad spectrum of disaster risk reduction and statistical experts and with established groups and forums focussing on related topics, including: the UNECE Task Force on Extreme Events and Disasters, UN Expert Group on Statistical Classifications, the Advisory Expert Group on National Accounts, UN Expert Group on Environment Statistics, and the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM).

16. Each of the existing groups or initiatives and publications bring their own perspectives. This handbook is an attempt to create a harmonized description of statistical requirements and solutions with a focus on disaster risk management.

Demands for a statistical framework

17. Within this context of a globally agreed policy framework and global indicators monitoring systems, governments have put increased attention to development of nationally centralized databases for a basic range of disaster-related statistics. As development of centralized disaster-related databases is a new endeavour in nearly all countries, there is a strong demand for technical guidance and sharing of tools and good practices internationally.

18. Basic requirements for the international indicator monitoring systems include comparability of concepts and methods for measurement across disaster occurrences. Thus, these systems depend heavily on coordination and consistency at the national and local levels, which can be accomplished via the adoption and application of a commonly agreed measurement framework.

[4] https://sendaimonitor.unisdr.org/

19. Presently, countries have different practices for compiling data and preparing statistical tables related to disasters, which makes it difficult to make comparisons or conduct time series analyses covering multiple disasters. The DRSF has the potential to address challenges for creating coherence across data sources and to incorporate statistics related to all types of disasters (regardless of scale), towards a nationally centralized and internationally-coherent basic range of disaster-related statistics.

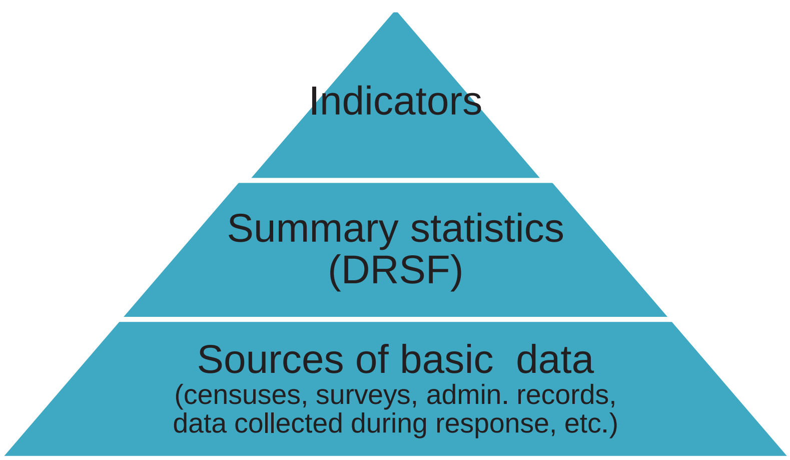
20. Statistical databases are summaries of collections of raw data gathered from many sources, including operational databases, surveys, censuses, monitoring systems, and administrative records.

21. Indicators are calculated from these databases for monitoring progress and to provide targeted information to policy-makers and the public to help inform disaster risk reduction. Where possible, indicators should be used to identify and encourage actions to reduce risk and create sustainable development before disasters occur. For example, indicators of disaster risk can be developed, based on variables measuring exposure vulnerability and coping capacity and can be used to unambiguously reveal progress with reducing overall risk of the population in a country or region. Such indicators are built upon integration of a very broad spectrum of data and multiple data sources, including population, social, economic and environmental data used for estimating probabilities of hazards.

22. A statistical framework thus rests in the middle of the theoretical information pyramid. The production of statistical tables inevitably involves some degree of aggregation and summary of basic microdata, but the statistics framework also needs to be relatively complete and flexible for calculating a broad range of indicators and for facilitating other types of analyses as well.

Figure 1.1

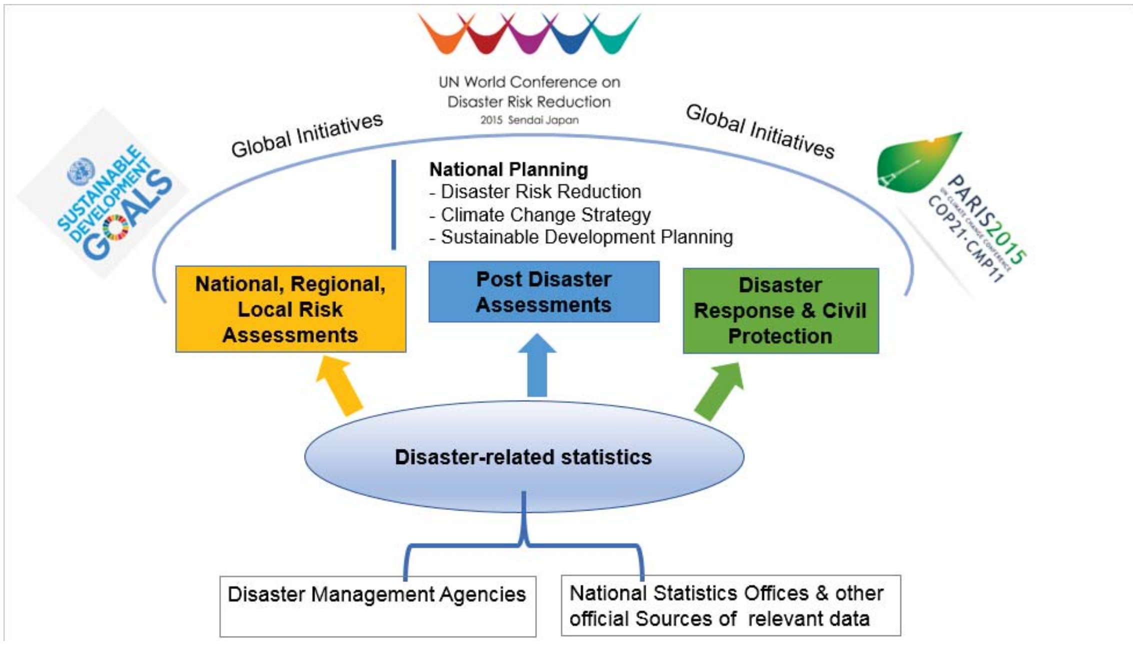
Information pyramid for disaster risk reduction



23. The goal of this framework is to produce statistical compilations that will assist applications designed for disaster risk reduction, especially in national and international indicators reporting, and statistical analyses as required for decision-making at national and local levels.

Figure 1.2

National and international applications for harmonized national disaster-related statistics



24. This statistical framework pertains strictly to measurement only, and does affect the existing policies or official duties of government agencies with respect to intervening in disaster risk management. However, implementation of the statistical framework should help national agencies to define and implement clear requirements, roles and responsibilities across government for collection and sharing of data, and for making statistics accessible for policy-relevant research and monitoring purposes.

25. The framework should also help to identify opportunities to utilize existing data sources within the national statistical system (NSS). In some cases, adaptions to the sources or to the way that data are shared between agencies are needed to fit the purposes for disaster risk reduction statistical analysis. It is usually more efficient and cost effective to adapt and reuse existing data sources rather than to establish new collections in response to each new policy question or indicator. Efficiency in the statistical system also needs to be balanced with the requirements consistency and other basic quality criteria of statistical outputs.

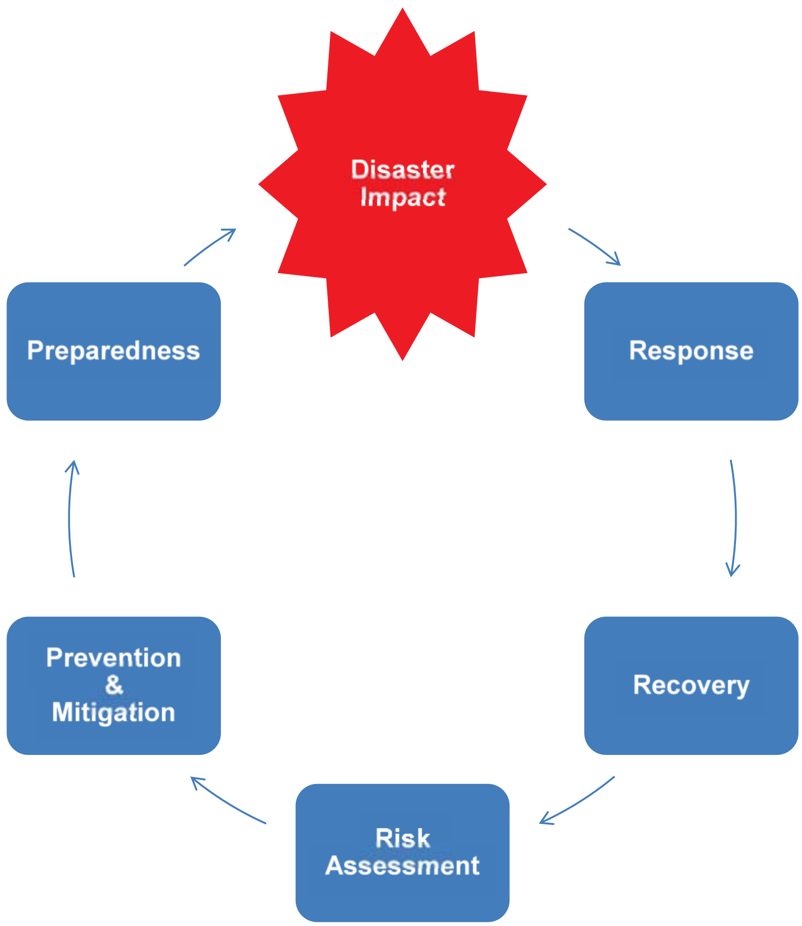
26. The UNECE Task Force on Measurement of Extreme Events and Disasters (TF-MEED)[5] produced a comprehensive report on the roles of national statistics office in close collaboration with the Asia-Pacific Expert Group on Disaster-related Statistics. A principle role for statistics offices and other government agencies is to provide the baseline (related) statistics, which are essential for disaster-risk management.

[5] https://www.unece.org/stats/ces/in-depth-reviews/meed.html

27. The risk management cycle is a useful concept for understanding the demands for statistics, and the various perspectives of decision-makers at the national level, and their relationship to the data collection or analysis. While there are some overlapping statistical requirements to support decision-making across the different phases of the cycle of disaster risk management, there are also important differences.

Figure 1.3

Cycle of disaster risk management



Source: Diagram adapted from Thailand Department of Disaster Prevention and Mitigation (DDPM)

28. During an emergency, responding agencies have special requirements regarding timeliness, accuracy and level of geographic detail to serve operational purposes in a coordinated emergency response. The priority is to save lives and minimize other damaging effects on the population. In contrast to these operational uses of data, statistics are used in broader risk assessments or for monitoring impacts over time, in which case more time is available to give attention to accuracy, comparability between sources, consistency over time, or other qualitative characteristics of the information. Statistics are designed to provide summaries for analyses by regions or by groups of people or businesses and are never used for identifying specific individuals.

29. Table 1.1 provides an overview of issues faced by decision-makers and a sample of the demand for statistics in each phase of the risk management cycle.

Table 1.1
Statistics in disaster-risk reduction decision making

Typical issues in the different phases of disaster risk management	Typical decisions and plans to be made	Sample of use of statistics
'Peace time': Risk Assessment • **Disaster risks can be estimated but are not known** • **Development investments should be informed by risk profiles** • **Use of best available knowledge so that development does not exacerbate existing (and or create new) disaster risks**	• Prioritizing investments in risk reduction • How to invest in development while avoiding new risks • Guide policies for reducing exposure and for vulnerable groups (including, potentially, via relocation outside of hazard areas)	• Dynamic hazard profiles (magnitude, temporal and spatial distribution) • Vulnerability and baseline of exposure: (demographic and, socioeconomic statistics) e.g. baseline of exposure in areas prone to hazards and identifying vulnerable groups • Learning from experience of past disasters, e.g. effectiveness of early warning systems
'Peace time': Risk Mitigation and Preparedness • **Risk Profiles are changing as new information becomes available and development in potentially vulnerable areas takes place** • **Early warning systems and other monitoring systems, where available, are delivering information on risks and possibilities for mitigating impacts**	• Introduction of new measures to reduce disaster risk • Introduction of mechanisms to improve or ensure sufficient early warning and adequate preparedness • How to invest in risk reduction measures as an integrated part of the broader poverty reduction and sustainable development initiatives • Whether and how to discourage development in hazardous areas	• Scale, locations and other characteristics of investment in disaster risk reduction • Signals of slowly developing risks approaching thresholds to a potential disaster • Level of awareness, preparedness, and investment against disasters by households, businesses, and communities • Identifying factors that cause and or exacerbate disaster risks, e.g., environmental degradation, highly vulnerable infrastructure, or extreme poverty.
Emergency: Response • **Imperative is to act quickly and efficiently to save lives and mitigate unnecessary suffering** • **Sufficient scale of injection of resources to bring crisis under control** • **Urgent demand to meet overwhelming needs for places where vital systems and delivery of basic services were affected**	• Determine the geographic scale of the disaster and prioritize needs for emergency relief • How to make the response the most efficient • How to manage needs given impacts to local supplies of goods and services (how to address temporary interference to local services supply) • How to mount emergency response while also putting in place requirements for medium and long-term recovery	• Disaster occurrence, including temporal, and spatial spread of the event • Disaster type and characteristics of impacts, e.g., rapid or slow onset, intensive or extensive impacts. • Immediate indication of impacts on population, damage, losses, and disruption of basic services • Recovery needs, which potentially could be increasing • Disaster response: who, what, where, when, and how much

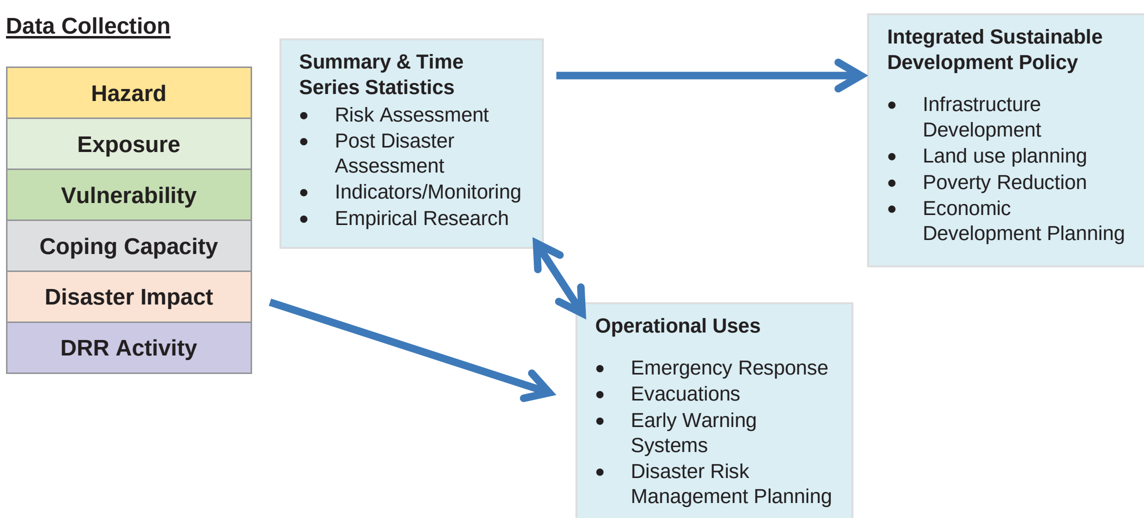
Typical issues in the different phases of disaster risk management	Typical decisions and plans to be made	Sample of use of statistics
Medium and long-term recovery • **Yet unaddressed humanitarian needs** • **Risk that fragile communities could regress into a new emergency crisis if recovery needs are not met** • **Less spotlight on initial response may translate to less resources for recovery** • **Often a normal development policy-planning cycle resumes with many requirements but, , with less available resources due to disaster**	• How to prioritize recovery of economic sectors and determination of appropriate scale of re-building effort in affected location • How to determine appropriate level of investment required for complete recovery from impacts for disasters: • Returning to consideration of future risk identification and mitigation (see risk assessment)	• Comprehensive and credible post-disaster accounting for damage, losses, and disruption of functions /services • Requirements for economic recovery, e.g., direct and economic losses. • Coping capacity of communities, localities and sectors • New post-disaster inputs for calculation of risk of future incidents

Reference: Developed by Asia-Pacific Expert Group in collaboration with the UNECE TF-MEED.

30. The scope for demands for a basic range of disaster-related statistics and indicators can be seen within a broader context, which also includes operational databases that are used for emergency response (Figure 1.3).

Figure 1.4

Uses of disaster-related data



31. Ideally, disaster-related statistics will become an integrated part of the broader sustainable development planning of the country at national and local levels. An example is the integration of disaster risk assessments into land use planning and building resilience to disasters as a part of the broader strategy against multi-dimensional poverty. For instance, areas identified as having high probabilities of exposure to a hazard could be imposed with restrictions on constructions or appropriate requirements for resilience of structures against hazards. Such interventions could further be designed or targeted in a way that also creates

additional benefits for poverty reduction in the relevant communities since reducing poverty can be an effective means at building resilience to disasters, and vice versa.

Use of this handbook

32. This handbook provides recommendations on methodologies for how to apply internationally agreed concepts and terminologies to production of official statistics. This includes technical recommendations on estimation for a basic range of disaster-related statistics used for multiple purposes, including calculation of indicators used for national and international monitoring. Not all recommendations are applicable in all cases and in some cases the demands for statistics require much more detail or a broader scope of measurement than what is presented here. Thus, the basic range of disaster-related statistics can be considered as a general target for the national statistics system for producing internationally harmonized statistics, noting that the disaster risk or policy context in each country will likely introduce special or additional requirements or potential measurement solutions that are specific to that country.

33. The remainder of Part 1 (Chapters 2-5) outlines the conceptual framework for a basic range of disaster-related statistics, applying and interpreting the concepts from the Sendai Framework and related references on disaster risk management for the practice of data collection and statistical compilations. Part 2 of this handbook (Chapters 6-9) provides guidance for implementation of the framework, including practical steps for organizing data and tools to support the process of national integration and harmonization across data sources, such as classifications, definitions, advice on measurement units, and summary tables as sample compilations of the complete basic range of disaster-related statistics.

CHAPTER 2: MAIN CONCEPTS FOR MEASUREMENT

1. A disaster is: "A serious disruption of the functioning of a community or a society due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." -UNISDR, adopted by the UN General Assembly via the Report of the OEIWG (2016).

2. For each disaster occurrence, there are at least three characteristics of the event that should be recorded in a centralized database for the compilation of basic statistics on impacts from the disaster. The three characteristics are:

a. Timing (date, year, time and duration of **emergency period**)
b. Location and geographic **scale** (regions/provinces/country(ies) and affected area in a GIS format, e.g. shapefile)
c. **Hazard type** (e.g. geological, meteorological)

3. In addition, each disaster occurrence has a unique identifier code for ease of reference and querying within a multi-disaster database. There are international initiatives for unique naming and coding of hazards, which can be utilized, where applicable, by the national agencies, such as the GLobalIDEntifier number (GLIDE) initiative.[6]

Box 1: Example Recording of Basic Characteristics of Disaster Occurrence

A simple example for recording a disaster occurrence, which is used as the basis for identifying impact statistics, can be demonstrated using a hypothetical example. Let us imagine the case of a sudden flood disaster affecting a specific area in Central Thailand. The hazard type (flood) is indicated within the alphanumeric code of this occurrence (FL).

Authorities in the affected area were surprised by the flood, caused by sudden intense rain, and they called for an emergency, which lasted for 4 days, at the beginning of May. Geographic reference or location of the disaster can be referenced according to official policy by a responsible agency in Thailand. In this example, the hypothetical flood disaster resulted in an emergency in one district and in one province of Thailand, called Samut Prakan. In addition, if available, a geospatial data file can be stored within the database for mapping and recording the spatial boundaries of the hazard area, e.g., inundation area, and/or impacts area, e.g., a contiguous area within which direct impacts were observed.

Code	Geo 1	Geo 2	Geo 3	Geo 4	Em. beginning	Em. End (d-m-y)
Fl2018-01-THA	Central Region	Chao Phraya River Basin	Samut Prakan	Central District	01-05-18	04-05-18

[6] The GLIDE is a project initiated and maintained by the Asian Disaster Reduction Center (ADRC) in collaboration with ISDR, CRED, UNDP, IFRC, FAO, World Bank, OFDA/USAID, La Red, and OCHA/ReliefWeb, http://www.glidenumber.net/glide/public/about.jsp

4. These characteristics of disasters are used for making connections between variables to develop time series statistics, such as, the long-term trends of impacts from disasters by hazard type.

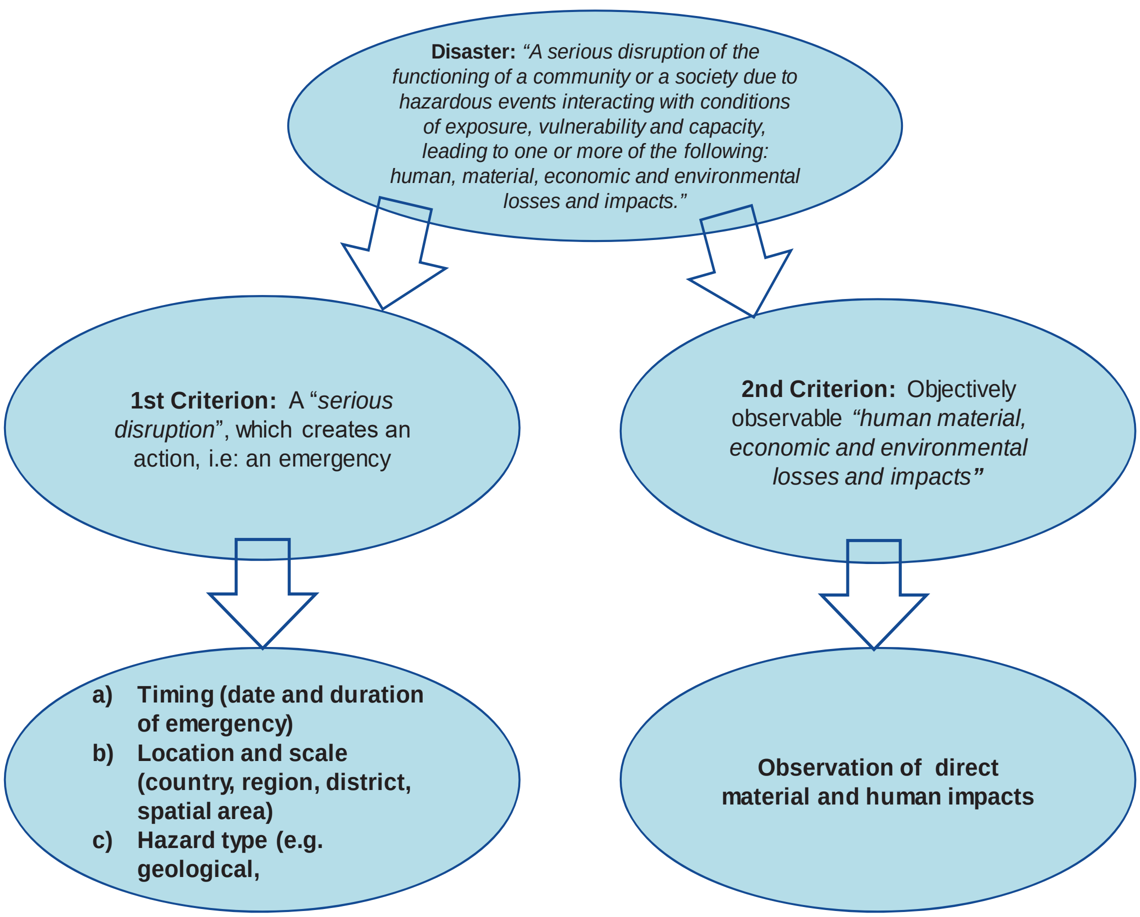
5. Each disaster is different, and the disaster risk context differs greatly across countries and regions. However, by applying common broad measurement principles for identifying and recording disaster occurrences, a degree of harmonization for the scope of measurement for impact statistics can be achieved.

6. From the international definition of a disaster, two basic criteria are needed for measurement of disaster occurrences and impacts in alignment with the international indicators and Sendai Framework Monitor:

a. "*human, material, economic and environmental losses and impacts" (*i.e., observation of significant impact*)*) and
b. "*A serious disruption of the functioning of a community or a society" (*e.g., an emergency).

Figure 2.1

From disaster occurrence to disaster impact statistics collection



7. For Sendai Framework Monitor, no impact thresholds are placed for observation of disaster occurrences for compilation of the disaster impacts statistics used for monitoring the targets. The Sendai 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." (United Nations, 2015, paragraph 15).

8. An impacts threshold is an analytical tool used for analysis and comparisons. Thresholds are a form of filtering of the broader compilation of basic statistics, to meet certain analytical requirements or as a method of achieving some specific targeted quality characteristics of the datasets needed for a specific purpose. As mentioned, there is no specific threshold criteria global monitoring of the Sendai Framework indicators by UNISDR. But, threshold criteria may be useful in other cases. For example, within EMDAT, minimum threshold criteria were defined so that the compilations focus primarily on moderate to large-scale emergencies, of which EMDATs data sources are likely to have relatively better-quality statistics in terms of completeness and reliability. Such filtering of impacts thresholds can be useful for various analyses, but do not affect the original basic compilations of data, which should contain the complete and unfiltered data.

9. So, referring, for example, to our hypothetical case in Box 1 of a flood in Thailand (Fl2018-01-THA), if none of the EMDAT criteria[7] is met, then this flood occurrence and its consequences would be counted in the national database but not in EMDAT. Sendai Framework global monitoring also does not put any specific reporting requirements regarding geographic referencing or geographic scale. For other uses of the statistics, the geographic scale of the emergency could be a useful standard reference for characterising the geographic scale of the disaster occurrence.

10. Inconsistencies in scope of measurement for disasters, can come about because different countries face risks from a different group of hazards. Some hazards are common only in tropical or non-tropical climates, some affect only coastal areas or areas with hills or mountains. Thus, current national databases for classifying **hazards types**, vary from country to country. Many countries have an officially adopted list of hazard types and definitions inscribed into the national laws for disaster response. In these cases, the scope of official data collections (and metadata) should align with the scope and terminology from the national laws.

11. National agencies are encouraged to follow the scope of hazards defined for Sendai Framework monitoring. This recommendation is to report nationally aggregated statistics according to the overall coverage of IRDR Peril Classification and Hazard (IRDR, 2014), and for two additional categories of hazards defined for the Sendai Framework: environmental hazards and technological hazards (see Chapter 8 for complete discussion). For all cases, a formal **glossary of the hazard types** should be published as part of the core metadata alongside the statistics.

12. An **emergency** (at local, national or regional level) is a common signal or indicator of a disaster occurrence and its timing. Emergencies, whether declared or undeclared, can take a wide variety of forms depending on the type of hazard and laws and administrative policies of the responsible government. Standardization of emergency declarations policy is not necessary for the compilation of statistics. However, a general acknowledgement of an emergency situation by officially responsible agencies is usually the catalyst that triggers collection of official data on the impacts of an emergency situation. This aligns well with the

[7] EMDAT Criteria is: ten (10) or more people reported killed, or Hundred (100) or more people reported affected, or Declaration of a state of emergency, or Call for international assistance

concept of an acknowledgement of abnormal disruption, according the norms and standards of the country, and a basic criterion in the international definition for a disaster.

13. The UN World Health Organisation (WHO) defines an **emergency** as a managerial decision or response in terms of extraordinary measures. A "state of emergency" demands to "be declared" or imposed by somebody in authority who, at a certain moment, will declare a state of emergency. Thus, the emergency is usually defined in time and space, as … it implies rule of engagement and an exit strategy." (WHO Glossary). Thus, in contrast to a disaster occurrence, an emergency, if applicable, has a specific duration of time.

14. A characteristic that causes the nature of emergencies to vary is the situation of either a **sudden or slow-onset disaster** (see Chapter 8). Sometimes, for slowly evolving risks leading to a disaster, the emergency response may take the form of initiating collection of data for monitoring the situation, followed by implementation of a series of preventative measures (such as evacuations or other responses to boost coping capacity and minimize impacts). For other emergencies, especially sudden or unexpected hazards, there is more likely to be an explicit emergency declaration or request for rapid mobilization of resources for response.

Box 2: Sudden and slow-onset disasters

Recall, previously, in our hypothetical scenario, the central district of Samut Prakan, Thailand, experienced sudden flooding in May 2018 which also surprised the authorities. Meanwhile, imagine there is also an area of northeastern Thailand, which had not received rain for many months, causing significant hardship and significant losses to agricultural production in that region. By June, the hardships and risk caused local and national authorities to initiate an urgent programme to collect data on the current impacts and to analyze future risks.

Although there may not have been a specific emergency call, an unusual disruption was observed in Roi Et, and action has been taken to record observations on the impacts. Thus, the slow onset drought disaster can now be recorded and classified in official records in the hypothetical sample below.

Code	**Geo 1**	**Geo 2**	**Geo 3**	**Geo 4**	**Em. beginning**	**Em. End (d-m-y)**
Fl2018-01-THA	Central Region	Chao Phraya River Basin	Samuth Prakhan	Central District	01-05-18	04-05-18
Dr2019-01-THA	Northeast	Mekong	Roi Et		01-06-18	01-06-18

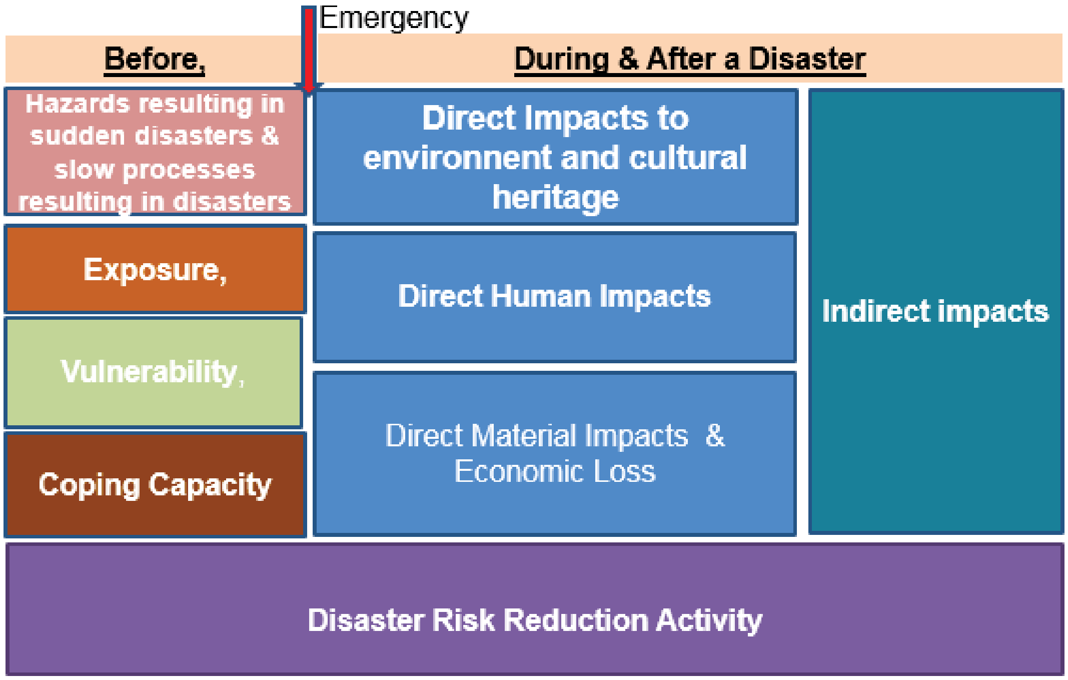
Basic range of disaster related statistics

15. Collection of statistics related to disasters is applicable for disasters of any scale or magnitude and there is a clear demand for a nationally coherent measurement framework for application at different scales. (UN, 2015, Paragraph 15, ibid).

16. Components of the basic range of disaster-related statistics are shown in Figure 2.2.

Figure 2.2

Components of the Disaster-related Statistics Framework (DRSF)



17. The boxes in this Figure 2.2 represent a useful way of broadly organizing the basic range of disaster-related statistics, but there are also data that have multiple uses in analysis and therefore may appear in multiple components. Since there are relationships between these components, there are advantages of having a centralized database that covers all components of disaster-related statistics.

18. Nearly all elements in Figure 2.2 can be measured, or estimated, from direct observation and incorporated into a centralized database of disaster-related statistics. One exception is the measurement of **indirect impacts** from disasters, which are characterized as consequences of a disaster. These need to be estimated via application of assumptions or other type of modelled scenario analysis to estimate a quantified range of values for indirect consequences to the economy or other changes to social conditions after a disaster.

19. The basic demands for disaster impacts statistics include reviewing the trends across occurrences for risk assessment, which may require analysis over a long period (perhaps 50-100 year trends). Thus, it is critically important that the counts and descriptive characteristics of disaster occurrences are produced consistently over time and across different occurrences.

CHAPTER 3: DISASTER RISK

Background

1. Improved utilization of official statistics for understanding disaster risk is the basic motivation for the development of a DRSF and its implementation in national statistical systems. Improved understanding of risk is also the number one priority of the Sendai Framework.

2. **Disaster risk** "is the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period, determined probabilistically as a function of hazard, exposure, vulnerability and capacity." (UNISDR, 2017).

3. Disasters are the outcome of present conditions of risk, including exposure to a hazard and the related patterns of population and socioeconomic development. (United Nations, 2015). These risks are geographically concentrated and unevenly distributed (Birkman, 2013). Measurement must account for extreme variability of risk with a broad coverage of the land and population while also producing disaggregated statistics for relatively high-risk hotspots.

4. Paragraph 6 of the Sendai Framework covers the issue of risk drivers: "More dedicated action needs to be focused on tackling underlying disaster risk drivers, such as the consequences of poverty and inequality, climate change and variability, unplanned and rapid urbanization, poor land management and compounding factors such as demographic change, weak institutional arrangements, non-risk-informed policies, lack of regulation and incentives for private disaster risk reduction investment, complex supply chains, limited availability of technology, unsustainable uses of natural resources, declining ecosystems, pandemics and epidemics."

5. Disaster risk is dynamic and its measurement is captured, in part, by common work of NSOs and other providers of official statistics at the national level. Areas of statistics covered include: demographic changes, poverty and inequality, structure of the economy, expenditure, economic production, conditions of ecosystems, and land management.

6. The focus in the DRSF is to clarify the role of official statistics and how they can be made as accessible as possible for risk assessments.

7. Two complementary types of risk assessment have been observed internationally (Bikman, 2013): risk indices and hotspots. Disaster risk indices (DRIs) can be developed for individual hazard types (e.g. for floods or cyclones) or multi-hazard risk, i.e. an index covering multiple hazard types. High risk areas will vary in geographic scale and do not align specifically with administrative boundaries used by governments. The hotspots approach thus follows a similar model that has been used in the domain of biodiversity and focuses on applying analyses at a more geographically detailed level, utilizing data that can indicate relatively high levels of likelihood for hazards overlain with geographic information on exposure and vulnerabilities.

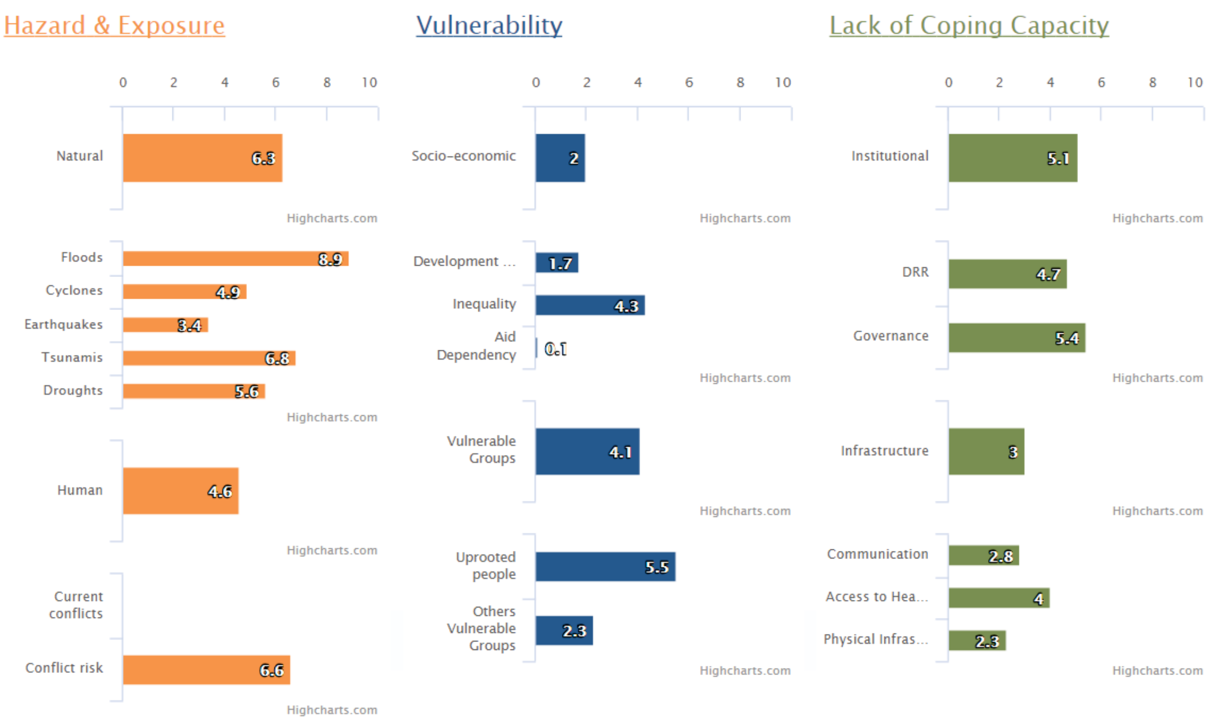
8. Example of risk indices ares the World Risk Index (WRI) of United Nations University World Risk Reports,[8] the Inform Index for Risk Management[9] (sample below), and UNDP's

[8] https://ias.unu.edu/en/

[9] http://www.inform-index.org/

Disaster Risk Index (DRI).[10] An example of a risk hotspot would be an area with relatively high probabilities of hazard coupled with specific vulnerabilities or low resilience in case of disasters.

Sample of National Scale IMPACT Index Score for Disaster Risk



Source: www.inform-index.org

9. Modern analyses of disaster risk incorporate both approaches through geographically disaggregated statistics and analysis using hazard profiles coupled with geographic information systems (GIS). An advantage of the GIS-based production of statistics for risk assessment is the potential to apply the methods to produce summary statistics at different geographic levels -e.g. at the global, regional or national level, and for hotspots.

10. Many interesting examples are emerging, for example the disaster management agency of Indonesia (BNPB), is tracking statistical information on exposure of population, as well as for economic activities (derived from local tax revenue records) and on children (from administrative records on enrolment in schools) in relation to the hazard areas of the country.

Scope of measurement

11. In the literature and current practice of many disaster management agencies, disaster risk is defined for measurement according to three core elements: exposure to hazards, vulnerability and coping capacity.

[10] http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/reducing-disaster-risk--a-challenge-for-development.html

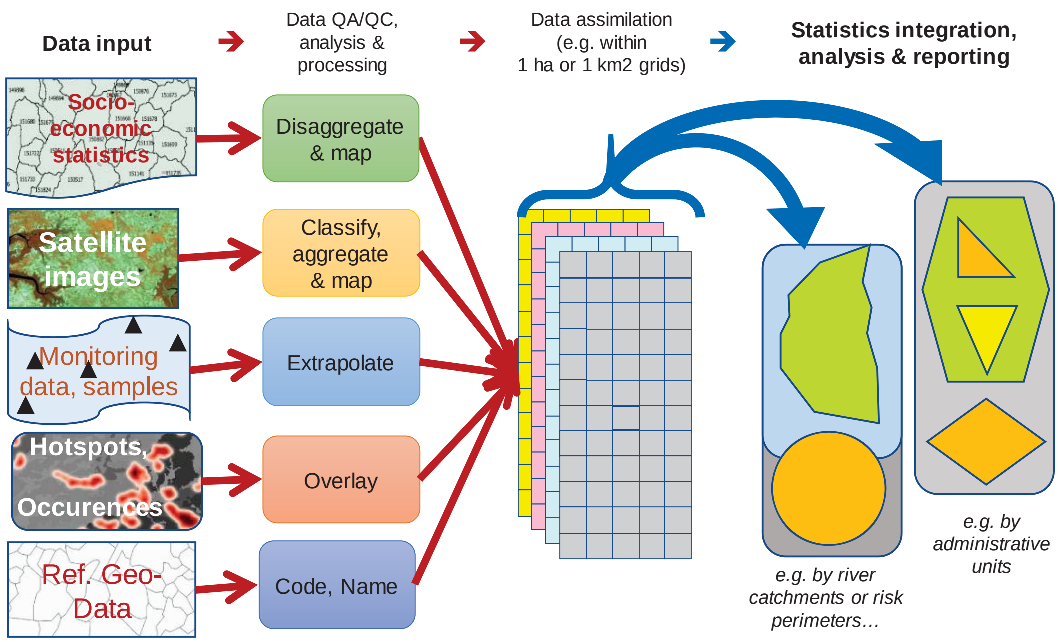
$$Risk = f(Hazard\ Exposure, Vulnerability, Capacity)$$

12. This basic definition for measurement of risk has also been known as the PAR model (Birkman, 2013). Risk of impacts from a disaster is not driven only by the **magnitude**[11] of the hazard (e.g. force of energy of the earthquake or category of storm) but also by social factors that create exposure, vulnerability and coping capacity (UNISDR, 2015).

13. Statistics for disaster risk assessment are developed by the assimilation of datasets in geographic information systems (GIS) and by integration of the relevant data sources for risk mapping. Risk maps are used to produce functional maps but also statistical tables summarizing risks faced for a given study area and to show relative degrees of risks across geographic areas. Integration and assimilation of data in GIS makes it possible to produce time series information in ways that were not previously possible, such as estimation of exposure to hazards.

Figure 3.1

Grid-based data assimilation



Source: Weber, CBD (2014)

Estimating exposure to hazards

14. There are two main elements to measuring exposure to hazards; These are:

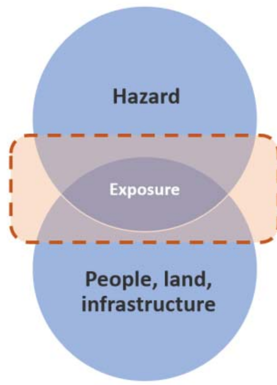
a. a probabilistic map of the hazard and
b. a complementary map of the population, critical infrastructure (and other objects of interest such as high nature value ecosystems) on the exposure side.

[11] Magnitude, as the term is used here, refers to the hazard (rather than disaster) and is distinctly different from the geographic scale of a disaster (discussed earlier) or the scale of impacts. Note, also, that neither information on magnitude of hazards nor on scale of disasters are relevant for international indicators reporting for the Sendai Framework Monitor.

15. The mapped area meeting of overlap is the exposure to hazards measurement. Producing statistics that can be used for estimating the exposure to various hazards is one of primary responsibilities of national statistics offices (particularly from national population and housing censuses).

Figure 3.2

Exposure to hazards



Hazard mapping

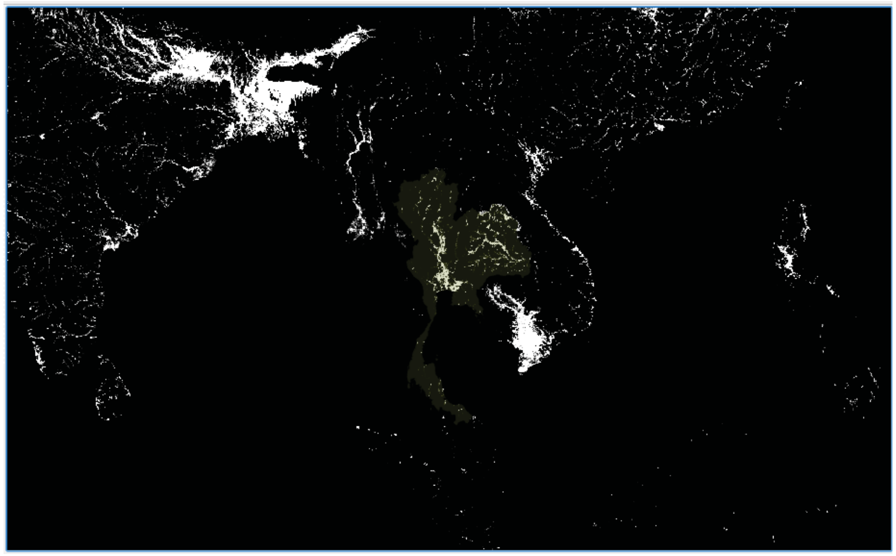
16. For hazard mapping, many variables can be relevant and are usually available from the official sources of disaster management, meteorological and geographic information for a country or region of a country.

17. A collection of the spatial, intensity, and temporal characteristics for a set of potential hazards is known as a **hazard catalogue**. There are various approaches to developing maps of potential hazards, depending on the type of hazard and the approach used to assess probabilities of a hazard occurrence.

18. Deterministic risk models are used to assess the impact of specific events on exposure. Typical scenarios for a deterministic analysis include examining past historical events, worst-case scenarios, or possible events that reoccur at different times. A probabilistic risk model contains a compilation of all possible "impact scenarios" for a specific hazard and geographical area. A goal for probabilistic hazard modelling is a convergence of results and for this a long-time series of input data is usually necessary. A simulation of 100 years of hazard events is usually too short to determine the return period for most hazard types, particularly infrequent hazards such as a tsunami.

19. Hazard mapping is usually the responsibility of disaster management and specialized scientific agencies monitoring underlying phenomena associated with different types of hazards, e.g., geological and hydrological authorities. There is currently a lack of international standardized approaches or guidance materials for hazard mapping. However, it is important that users of disaster-related statistics are aware of the basic methodologies and availability of hazard maps. Therefore, hazard mapping, particularly for use in producing statistics for disaster risk management is recommended for the DRSF list of topics for further study.

Sample for flood hazard frequency and distribution map for Thailand and surrounding areas

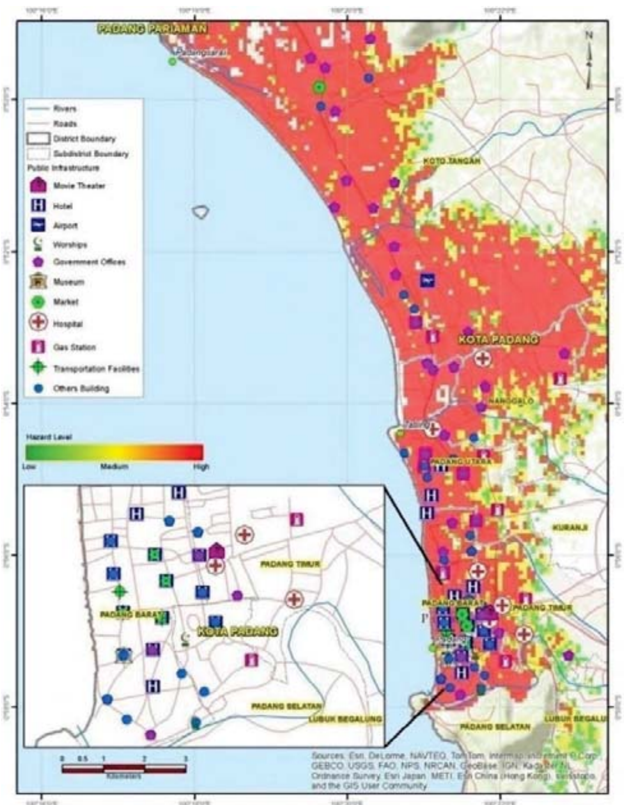


Reference: Center for Hazards and Risk Research - CHRR - Columbia University Center for International Earth Science Information Network - CIESIN - Columbia University. 2005. Global Flood Hazard Frequency and Distribution. Palisades, NY: NASA Socioeconomic Data and Applications Centre (SEDAC).

20. The above sample, part of a global map from Colombia University and NASA-SEDAC is based on a database on historical flood hazard occurrences. Building on this mapped information on past occurrences, hazard maps should be developed, incorporating a variety of predictive variables available as spatial datasets, such as digitized elevation models and average precipitation. National agencies have a crucial responsibility to produce and regularly update hazard catalogues for their countries at suitable levels of resolution for use in informing national and local risk reduction policies.

Box 3: Hazard and risk mapping example: BNPB-Indonesia *InaRISK*

The BNPB Indonesia example provides a good practice example of the types of data inputs likely to be needed for hazard mapping, such as:



a. Knowledge of the distribution of soil-type to model the spatial variation of ground acceleration from an earthquake,
b. Water supply and use balances and other statistical information used for tracking the hydrological cycle and use of water in the economy
c. Values for surface roughness to define the distribution of wind speed from a tropical cyclone;
d. A digital elevation model (DEM) to determine potential flood height or other hazard features.

InaRISK is risk analysis information for Indonesia covering each of the core risk factors: hazard exposure, vulnerability, capacity. The method employs data analyses across space, utilizing a gridded assimilation approach to predict probabilities for impacts from disasters, including: potential of losses life, financial losses, physical damage, and exposed natural resources. The assessments are conducted for 9 different types of hazards, with varying characteristics in terms of frequency and possibility of advanced warning.

Source: BNPB-Indonesia, 2016

21. There are a variety of software tools and other resources available for probabilistic hazard modelling software, by hazard type or for multiple hazards. The following were identified through the Expert Group's study:

- The Australian Government's Earthquake Risk Model, http://www.ga.gov.au/scientific-topics/hazards/earthquake/capabilties/modelling /eqrm
- BNPB Indonesia's InARisk, http://inarisk.bnpb.go.id/
- Probabilistic Risk Assessment Platform (CAPRA), http://www.ecapra.org/
- European Commission Joint Research Centre Flood Hazard Maps, http://data.jrc.ec.europa.eu/collection/floods
- European Plate Observer System (EPOS) Seismic Hazard Portal, http://www.seismicportal.eu/
- Institute of Remote Sensing and Digital Earth (RADI) and Chinese Academy of Sciences (CAS) Drought Mechanism
- Hazard elements in the Index of Risk Management (INFORM)

- UNISDR Global Assessment Report on Disaster Risk Reduction (GAR), http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php
- OpenQuake Platform, by the GEM Foundation, https://platform.openquake.org/
- Rapid Analysis and Spatialisation of Risk (RASOR), http://www.rasor-project.eu/
- U.S. Environmental Protection Agency's CAMEO, https://www.epa.gov/cameo

22. The outputs of hazard analyses include:

- Location and extent for geographical analysis of hazards,
- Frequency and duration for temporal analysis of hazards,
- Scale and intensity for dimensional analysis of hazards,
- Probability of occurrence of hazards, and
- Physical, economic, environmental and social vulnerability factors.[12]

23. According to IPCC, three changes are likely to be observed for climate-related hazards for some geographic regions because of rising global temperatures: increases in frequency, severity, and decreased predictability of hazards. Thus, climate change has contributed to the dynamic nature of hazards, as an input into the formula for assessing risk.

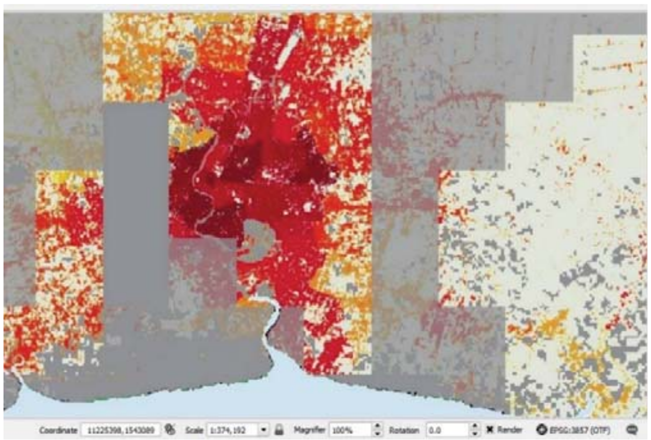
Exposure statistics

24. For the exposure side of hazard exposure estimation, the objective is to measure people, housing, buildings (or built-up areas), transportation facilities and other infrastructure, land use, production capacities and other potentially important variables located in the hazard areas, such as important ecosystems, crop areas and economic data for assessing exposure of economic assets and activities.

25. Exposure statistics have dual purposes. In addition to one of the three basic metrics for disaster risk, exposure statistics also are used as baseline statistics for assessing impacts after a disaster, (e.g. for estimating the value of economic impacts).

[12] European Commission (2010)

Box 4: Pilot tests for an approach to population exposure statistics



A methodology was developed and tested among Expert Group countries during 2016 and 2017 for estimating population exposure using the available population data from census authorities. A step-by-step manual was produced describing the steps to replicate the output statistics for any country (or region). Pilot tests of the methodology utilizing publicly available census data, processed satellite imagery in the form of a new product from the German Aerospace agency (DLR) called the Global Urban Footprint (GUF), and maps of land cover, and hazard maps found from various international sources on the internet. The data were integrated in GIS and used to produce test estimates for population exposure to hazards in 6 countries: Bangladesh, Fiji, Indonesia, the Philippines, Republic of Korea, and Thailand. This method was developed, and pilot tested among countries in Asia and the Pacific to demonstrate the possibilities for applying census statistics for estimating exposure to hazards for analysis at different scales, based on the available population data by administrative region (which can be accessed from national statistics offices at different scales, depending on the country).

The image reveals a sample output utilizing a hazard map (shaded areas) for floods produced by CIESIN/SEDAC (reference above) combined with the ESCAP pilot gridded population density estimates (yellow-orange-red) based on population census from Thailand National Statistics Office and the GUF. See the Expert Group website (https://stat-confluence.escap.un.org/x/1oL2) for complete description of methodology and the manual.

26. The same basic principles of assimilation of data with hazard maps with population and social data (see, e.g., Box 4) apply to information about the physical infrastructure. Geospatial data on location of critical infrastructure and land cover, including agricultural areas by type of crops and various types of ecologically important areas, e.g., protected areas are fundamental inputs used for assessing exposure to hazards before a disaster and as baseline referencing for assessing impacts after a disaster.

27. Hazard exposure statistics can be presented in the form of maps that can be simply converted into standardized statistical tables, such as in the example shown in DRSF Table B1a (see Annex).

Vulnerability

28. The Sendai Framework recommendations adopted by the UN General Assembly in 2016 defined **vulnerability** as "the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards."

29. If the statistics used in vulnerability assessments are gathered and updated on a regular basis by geographic regions, and specifically for hazard areas within countries, disaster management agencies would have *a priori* information on extent and specific locations (among

other characteristics) of vulnerability for developing targeted disaster risk reduction or response strategies at local and national levels, in alignment with the overarching objective of SDGs and of not leaving anyone behind.

30. There are many social-economic factors affecting vulnerability such as age of a person at the time of the disaster, or persons with disabilities which can be significant in situations where physical fitness is necessary for survival. Gender can be a factor, for example due to emergence of violence and sexual abuse after disasters. Poverty, which correlates with less healthy and less safe environments and poor education is another possible factor.

31. There are also many forms of disaster vulnerability that are derived from the context of the infrastructure or other characteristics of the built landscape. For example, poor access to freshwater and to adequate sanitation facilities are factors of disaster vulnerability and an area where basic services will be urgently required for restoration and recovery after a disaster. These factors may be particularly significant for women and girls.

32. Vulnerability is an extension of initial exposure statistics by adding statistics on relevant characteristics, or disaggregation of the population, infrastructure or land uses exposed to a hazard, such as the elements in tables B1a and B1b (see Annex), i.e., by sex, age, income, and disability.

33. A short list of basic variables likely to be factors for vulnerability measurement in risk assessment, should include:

- Median household disposable income;
- Education enrolment, by age group and level of achievement and by male and female heads of households;
- Information on assets of households, such as type of dwelling;
- Other human development statistics, by age group, including evidence related to nutrition and childhood health;
- Type of employment, e.g., identifying households engaged in agriculture or fishing; and
- Urban versus rural distribution of affected or exposed areas

34. A variety of characteristics of individuals may combine in complex ways to create vulnerabilities to a disaster where it otherwise might not have existed. Thus, it is important to produce statistics the basic social and demographic characteristics of populations, especially in high risk areas. An important example of an element of complex (or intersectional) sources of vulnerability is gender.

Gender and disaster vulnerability

Gender intersects with a range of other socio-economic factors affecting vulnerability. Gender refers to the social norms that shape the behaviours and roles that women and men, girls and boys, are expected to play in any society. The expectations, power and influence of women and men differs between societies, and typically changes over time. Gender is therefore an essential factor to be considered in how people experience and are affected by disasters. It often interacts with other factors, such as socio-economic status, to increase or decrease vulnerability. For example, in some settings, women and children may be more vulnerable than men to the impacts of disasters because of having less access to and control of resources or a lesser role in decision-making before, during and after an event.

35. Gender must be a key determinant in any disaster related vulnerability assessment However, sex-disaggregated data on the effects of natural hazards on mortality and morbidity are currently available only for a small number of cases, mostly from research literature. Adequate monitoring of the impacts on the lives of women and men may require that some data disaggregated by sex and age are recorded for smaller areas of a country. Therefore, sex and geographic disaggregation is an important area for further development of disaster-related statistics by NSOs and NDMAs.

36. Disasters have different effects on women, men, girls and boys. Gender roles and norms also play an important role in the aftermath of disasters, including in terms of access to livelihoods and participation in reconstruction efforts.

37. Additional dimensions associated with gender that impact vulnerability status include safety and security associated with increases of the prevalence of sexual and physical violence and harassment in situations of instability, such as post disaster settings, and barriers to participating in decision making. Climate-change related drought is known to drive increases in child marriage rates among the most vulnerable communities, as parents are more likely to choose to marry their daughters off much earlier in exchange for dowries for survival.[13] Exposure to violence may render women survivors physically and psychologically unable to fully engage in disaster recovery. Prevalence of sexual or physical violence and the presence of gender inequalities in post-disaster recovery processes are perpetuated partly due to women's limited participation in decision making, including for designing and shaping public governance institutions and recovery plans that involve women in assessing risk and setting up inclusive prevention strategies.

38. Children are more vulnerable than adults because they are dependent and less skilled to deal with the physical, emotional and psychological impacts of disaster. Young girls may be particularly at risk during times of disaster as they are often more dependent or protected than boys and may be seen as an asset or a liability depending on the circumstances. Older women and men are also vulnerable due to dependency and have needs that must be considered in disaster risk management. Evidence suggests that women live longer than men, and in ageing societies, the population affected by a disaster is likely to compose of elderly women in larger numbers. Studies of ageing populations have revealed location and type of residence can be a good reference for assessing vulnerability for the elderly, especially in cities.

39. Explanations of the differences between female and male mortality during the 2004 tsunami, for example, have been formulated in terms of gender. Women's and girls' higher vulnerability was associated with lower access to information, the lack of life skills such as swimming ability, constrained mobility outside their home, and the increased vulnerability of women staying home with children at the time of the sea-level rise. Gender differences were not the only factor. The physiological attributes of females and males at different ages have a substantial impact on vulnerability during tsunamis. For example, a quantitative assessment of sex and age differences in mortality based on a longitudinal survey before and after the tsunami in Indonesia showed that some of the explanation lies in differences in physical strength,

13 *https://www.theguardian.com/society/2017/nov/26/climate-change-creating-generation-of-child-brides-in-africa*

stamina and running and swimming ability. Overall, prime-age males were the most likely to survive the tsunami because they were the strongest. Their presence in the household at the time of tsunami also had a protective effect on the survival of wives and children. [14]

40. In some contexts, women's ability to cope after disasters may also be less than that of men because of their limited economic empowerment. Evidence shows that women are less likely than men to own productive assets, including land and machinery and are therefore more dependent on natural resources, which might be compromised because of disasters. They are less likely than men to have a bank account and access to financing, which limits their flexibility in responding to financial constraints. In single-headed households, women are more likely to have custodianship of children and therefore incur in additional expenses and responsibilities.

41. Household survey data indicates that in four of every five households (80 per cent) without water on premises, it is women and girls who oversee water collection, and a large share of them also bear the burden of collecting firewood and fodder[15]. In addition, in heavily agriculture-dependent areas in Africa and Asia and the Pacific, women are much more likely than men to work in the agricultural sector. When water sources, land and forests are affected byf natural disasters, women and girls are more likely to see their livelihoods compromised and are often forced to spend more time carrying out these tasks, which impinges on their available time for paid employment, education and leisure.

Physical vulnerability

42. Vulnerability applies not only to individuals or households, but also infrastructure, which is sometimes called "**physical vulnerability**". In most cases, physical vulnerability also stems from other social-economic or environmental problems. Relatively poor households often have little choice other than to accept relatively less resilient shelters in their dwellings or work places. Moreover, poorer communities, such as **slums**[16] or lower income areas of urban sprawl, are often the most likely to be situated in areas with high exposure to hazards.

43. Physical vulnerability also applies to descriptions of land and water bodies. Although pollution in water bodies is generally considered an environmental problem, in the context of disaster risk, pollution also causes social and economic vulnerability because, in the case of a disaster, it can lead to significantly worse impacts to human lives and health and to the economic costs of recovery.

44. The 2010 World Development Report (World Bank, 2010), focusing on climate change, stated that "natural systems, when well-managed, can reduce human vulnerability". Examining and supporting cases of positive synergies between environmental protections, also called 'pro poor environmental policies' is one of the objectives for the United Nations Poverty and Environment Initiative (PEI). Wherever environments are heavily polluted or degraded, it is often the relatively poor populations that are more likely to be disproportionately affected and, therefore, more vulnerable in the event of a disaster.

[14] Oxfam International, 2005 for India and Indonesia

[15] UN Women's SDG report on gender, page 105 (analysis from MICS and DHS surveys)

[16] A slum household suffers: lack of access to improved water source, lack of access to improved sanitation facilities, lack of sufficient living area, lack of housing durability or lack of security of tenure (UN-Habitat,2016)

45. Population density and geographic location are the basic dimensions of exposure measurement, but they also can be factors for vulnerability. Many rural communities face marginally higher vulnerabilities due to the generally poorer access to transportation, health facilities, and other types of critical infrastructure or support services. The largest share of people living in poverty also tends to be in rural areas in developing countries. On the other hand, other facets of rural communities, such as informal community support systems, can be sources of resilience.

46. High population density is the defining characteristic of the urban centres, particularly in the high-population megacities, many of which are in coastal zones or otherwise hazardous locations. This is particularly the case in Asia and the Pacific, where high population density is common. While there are social benefits to having large groups of people concentrated within small geographic areas, such concentrations can be inherently vulnerable to impacts from hazards, especially in urban slums.

47. There are also macroeconomic vulnerabilities including, diversity of the economic structure, and importance of particular sectors, such as agriculture or fishing.

Coping capacity

48. **Coping capacity** is reflected in many factors related to the resilience of households, businesses, communities, social-ecological systems, and whole countries against external shocks in the form of a disaster. This is the ability of households or businesses or infrastructure to recover from external shocks without sustaining major permanent negative impacts, and instead moving towards opportunities for improvements in the future, e.g., “building back better”.

49. Many strategies for coping with disasters are informal and not managed by governments, and therefore difficult to measure. For example, one of the coping mechanisms in the case of drought or other types of climate or hydrological-related hazards is migration, either permanently or temporarily, in search of a livelihood outside the worst affected areas. Population movements that correspond with a disaster can sometimes be captured via statistics from population censuses or population administrative records. It is more difficult to attribute movements specifically to hazards or a past disaster.

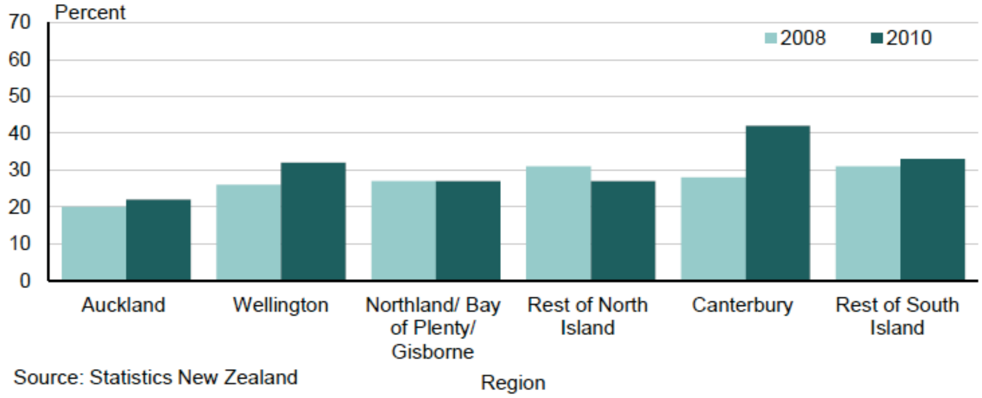
50. There also are coping mechanisms which can be captured by statistics based on government records, e.g. expenditures or from surveys of preparedness of households or businesses in potentially exposed areas.

51. Household preparedness to disasters can be measured from household surveys, for example. After major earthquakes struck the Canterbury province of New Zealand, survey results revealed significant increases in disaster preparedness of households. e.g., rationing emergency food and water storage. The New Zealand General Social Survey[17] asked New Zealanders about a range of factors of basic preparedness for disasters and found significant differences in results for the factors studied across regions and over time.

[17] http://archive.stats.govt.nz/browse_for_stats/people_and_communities/well-being/nzgss-info-releases.aspx

Figure 3.3

Households with household emergency plan, by region, 2008 and 2010



Source: Statistics New Zealand

52. Disaster management agencies need to consider the best available risk information to design and implement activities to reduce the impacts of disasters, including through educational programmes, early warning, systems, and other methods for strengthening resilience through improved preparedness.

53. People are not equally able to access the resources and opportunities (or knowledge and information about hazards). The same social processes involved in the disadvantages of poverty (or other sources of vulnerabilities) can also have a significant role in determining their level of preparedness and access to information and knowledge. (Wisner et al., 2003).

Example Statistics on percentages of households attending training or simulations in hazard areas

Type of Training and/or Simulation Attended	Yes (%)	No (%)
(1)	(2)	(3)
Earthquake	96,1	3,9
Earthquake and Tsunami	80,5	19,5
Flood	14,3	85,7
Volcanic Eruption	2,6	97,4
Drought	2,6	97,4
Tidal Wave	2,6	97,4
Landslide	1,3	98,7
Tornado	1,3	98,7
Land and Forest Fires	1,3	98,7

Source: BNPB-Indonesia, 2013

54. The example above comes from a study of disaster preparedness in Padang City of Indonesia. These types of statistics should also be disaggregated, where feasible, by sex, age, income groups, disability and for urban and rural areas. Table B3 (Annex) is a sample list of relevant statistics by geographic regions for coping capacity assessment.

CHAPTER 4: IMPACTS STATISTICS

Background

1. The Sendai Framework Monitor and associated Technical Guidance (UNISDR, 2017) provides explanatory guidance and the scope of reporting requirement for inputs into aggregated analyses and monitoring of progress for indicators on disaster impacts at the international level.

2. Other references and tools preceded the global Sendai Framework Monitor, and they complement it as related references or additional sources of statistics, such as: DesInventar[18], the European Union-JRC Working Group on Disaster Damage and Loss Data[19], UNISDR Global Assessment Reports (GAR)[20], EMDAT[21], SIGMA from Swiss Reinsurance and NatCat from Munich Re[22], and IRDR Guidelines on Measuring Losses from Disasters (IRDR, 2015).[23].

3. Post disaster needs assessments (PDNAs) are a form of post-disaster analyses, designed to provide information and the overall picture of costs and estimated needs for recovery, especially following large disasters.

4. Impacts statistics are the inputs for conducting post disaster assessments and for computing indicators, brought together in common compilations, commonly known as loss and damage databases.

5. The objectives in the DRSF are to synthesize and elaborate, where relevant, current international guidance and provide recommendations or suggested good practices to improve coverage and consistency in the collections of basic statistics across and for all types of disasters.

Attribution of impacts

6. The classic challenge for producing impacts statistics is the attribution of particular data to a disaster. This is a direct causal relationship, and statistical reference to a disaster. For example, a fatality can be attributed as death from a disaster if it was caused by one of the nationally identified hazard types. Not all cases will be equally clear attributions, therefore a minor statistical error can be expected in disaster impact statistics due to challenges with attribution.

[18] Under transformation into Desinventar-Sendai, see: https://www.desinventar.net/

[19] European Commission-JRC (2015)

[20] GAR is a series of assessment reports released by UNISDR, see: https://www.unisdr.org/we/inform/gar

[21] A database of disasters and disaster impacts with global coverage and covering the period from 1900 to present, www.emdat.be

[22] Sigma and NatCat Armenia proprietary datasets available through paid subscription

[23] IRDR (2015), *Guidelines on Measuring Losses from Disasters: Human and Economic Impact Indicators (IRDR DATA Publication No.2*), Beijing: Integrated Research on Disaster Risk

7. Traditionally, data on direct impacts focussed on observations in the disaster area immediately after a disaster. However, direct impacts can take a variety of forms, including sudden and immediate impacts but also delayed consequences, (e.g. buildings collapsing or demolished several weeks after an earthquake, persons dying from injuries weeks or months after the event). Modern statistical systems can produce statistics on a much broader range of impacts and do not depend only on what could be observed and recorded during or immediately after an emergency.

Core sources for impacts statistics

8. A general checklist of steps or methodological approaches can be summarized for impacts statistics as observed from current practices in national statistical systems:

a. Initially, disaster management agencies observe and assess direct impacts during and immediately after an emergency as a part of the disaster response. These initial observations can be summarized and converted into statistics, e.g. aggregated by geographic area.

b. Baseline, or background, statistics for the location of the disaster, such as basic characteristics of infrastructure and population known prior to the hazard can be used to complement the initial observations by disaster management agencies and assist in the production of complementary metrics used for impacts statistics. Background statistics provide contextual information to convert some of the initial observations of damages or other disruptions into comparable units of measurement, to develop appropriate aggregations and disaggregation.[24]

c. Review of the outputs of monitoring instruments, like remote sensing imagery from satellites or local tracking of basic services or other economic activities is one of the important types of background statistics, particularly for disasters. Interpretation of remote sensing imagery is a crucial tool for assessing impacts, including estimating the extent of losses and for deepening the understanding of how risk factors contributed to the disaster. Other types of monitoring systems, such as collections of reports to response or to insurance agencies may be a source of data on disruptions to basic services.

d. Not all impacts can be observed directly, thus another crucial step involves compilations of regular sources of time series statistics within the national statistical system, such as the population and housing census, business surveys, and compilations of other records of economic activity, which can be used to evaluate trends (before and after the disaster) and estimate statistics on the impacts. This includes trends for estimating indirect impacts, such as effects on GDP or for analyses of links with population movements.

Damage and loss database structures

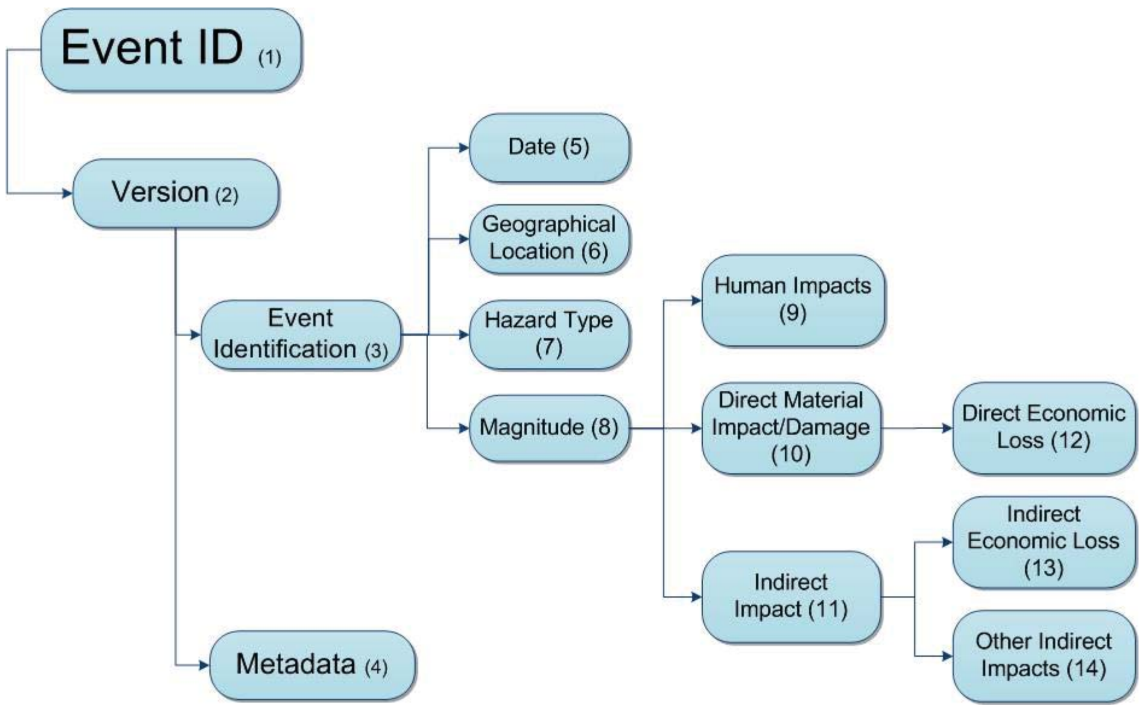
9. National databases need to adopt a clear and specific structure for organizing the components of impacts and related signifiers or metadata. Figure 4.1 is a version of a database model from the European Commission-JRC (2015). This model demonstrates the recommended general approach for structuring the integration of multiple datasets related to disaster impacts across disaster occurrences in a centralized national database.

[24] For example, baseline statistics on the economy in the affected area, like average values of agricultural production, are used to estimate economic loss

10. In this modified presentation of the European model, each box constitutes an individual compilation of data and metadata, which are linked to the unique event ID and therefore may be instantly queried according to the basic characteristics of disasters, i.e., timing, location, geographic scale of emergency, and hazard type.

Figure 4.1

Database model for disaster impacts statistics



Source: adapted version of a diagram in European Commission-JRC (2015)

Time series aggregation

11. The recommendation for compilation of impact statistics used for producing indicators or in time series analysis is to make compilations on an annual basis, at minimum (see also IRDR, 2015), and the Sendai Framework Monitor is collecting impacts statistics as annual aggregations for each year within its scope.

12. Aggregation for time series analyses, or for analyses by hazard types or location, means the statistics are no longer attached to a specific disaster occurrence, but the basic data are retained within the nationally centralized database according to the basic structure in figure 4.1, for potential other future use in research (e.g. comparisons of impacts between two individual occurrences).

13. For assessing trends over time, a long-time series of impact statistics is required due to the inherent randomness over space and time of exposure to hazards. For example, for the Sendai Framework Monitoring, governments specified 10-year periods of 2020-2030, as compared with 2005-2015 for the affected population indicators.

Geographic aggregation

14. Statistics on disaster impacts can be presented according to hazard types and according to geographic regions within the country, as shown in the example DRSF impacts tables (C, D, E, F & G tables – see Annex).

15. Geographic aggregation of location specific information or geo-referenced statistics can be easily customized, according to specific uses, with GIS. For the purpose of the Sendai Framework aggregations, observations related to specific disaster occurrences are reported for the national scale or for other smaller administrative regions within the country, e.g., districts, municipalities, provinces – Admin. 03, 02, 01 or other types of defined regions, like river basins.

16. Impacts statistics are recorded according to a specific disaster occurrence and, sometimes, a disaster area (or 'disaster footprint') is defined for a specific event.[25]

17. A simple three-category system (small moderate, and large disasters) is a common practice of national agencies for indicating and grouping the scale of impacts from a disaster. There is no requirement or instruction. The geographic scale of the administration of an emergency response and recovery effort, e.g., local, national or regional scale is recommended as a simply proxy measure for categorizing scale of disasters. While categorizing the scale of disaster areas is not relevant for the international monitoring of Sendai Framework indicators, this information may be useful for other purposes given the differences in associated risks.

18. **Large disasters** are disasters in which the emergency is at a national (or higher) scale and have special characteristics of interest for analysis because they are relatively rare but have extensive and long-term effects on sustainable development. Large disasters tend to generate more data compared to small disasters and they are often covered by post- disaster assessment studies[26]. The impacts of large disasters often cross administrative boundaries, including international borders, and therefore recordings of statistics for large scale events are usually applicable to multiple reporting regions.

19. **Medium and small-scale disasters** refer to emergencies at smaller than national geographic scales. On aggregate, across disasters, the small and medium disasters tend to cause greater impacts to a country or region because they are more frequent than large disasters. This distinction is related to the concept of **intensive and extensive risk** from disasters developed in UNISDR (2015). "Extensive risk is used to describe the risk associated with low-severity, high-frequency events, mainly associated with highly localized hazards. Intensive risk is used to describe the risk associated to high-severity, mid to low-frequency events, mainly associated with major hazards." Small disasters have impacts limited to relatively small local areas, for example concentrated severe storms. Medium-scale disasters are defined by a threshold of impacts causing emergency reaction from authorities from multiple administrative regional authorities – such as from multiple, villages, districts or provinces.

[25]. Currently, there is no internationally standardized methodology for tracing a 'disaster footprint'. However, it is recommended to define disaster areas, where feasible, as tracing the contiguous areas where direct impacts could be observed. It is further recommended to identify with standard geographic referencing the lowest level of administrative region (usually Admin 03) for which basic background statistics on the population are available.

[26] such as Cyclone Evan that caused major economic destruction in Fiji (Government of Fiji, 2013) and Samoa (Government of Samoa, 2012)

Human impacts

20. Three tables (C1, C2, and C3) are shown in the Annex of tables for organizing the list of basic range human impacts elements according to geographic regions, hazards types, or demographic and social categories

21. Some data and statistics relate to both the human and material categories of impacts. For example, the same data sources that are used for accounting for damaged or destroyed dwellings (and Sendai Framework Target C for economic loss) should also be applicable for estimating the number of people whose houses were damaged due to hazardous events (a Sendai Framework indicator under Target B for affected population).

22. Besides statistics on the various forms of impacts from disasters on people, there is also a demand for aggregated counts of the "affected population" after a disaster, for example as an indicator for international monitoring of the Sendai Framework (UNGA, 2015). There is also a need to produce disaggregated statistics on people affected by disasters for a full understanding of post-disaster recovery needs and for use in future risk assessments.

Demographic and social disaggregation

23. Disasters affect groups of people differently. There has been a strong call from expert groups working on SDG and Sendai Framework indicators for disaggregation of disaster impacts for assessment of relevant vulnerabilities. The ESCAP Resolution 70/2 of May 2014, establishing the Asia-Pacific Expert Group emphasized the importance of disaggregated statistics for "enabling a comprehensive assessment of the socioeconomic effects of disasters and strengthening evidence-based policymaking at all levels for disaster risk reduction and climate change adaptation".

24. Technical Guidance in the Sendai Framework Monitoring (UNISDR, 2017) calls for disaggregation of people by hazard, geography, sex, age, disability and income.

25. The Sendai Framework Monitor collects age disaggregated statistics according to three groups: 0-15, 16-64 and 65+. In addition to meeting this minimum grouping for international reporting purposes, collection of impacts to infant children (0-5 years old) is also recommended, since children at this age are dependent on a parent, or other guardian, in an emergency.

26. Statistics disaggregated by social and demographic categories will become progressively more available and simpler to estimate for future disaster occurrences through increased experience with compiling summary statistics before and after disasters, and via linking datasets.

Deaths or missing persons

27. Each country defines deaths and missing persons differently according to their own national laws. For example, countries may use different time periods and procedures for missing persons including the reclassification of cause of death. The statistics will reflect the national legislation and policies. It is not expected that these differences will significantly affect the analyses or comparisons of statistics in the long-term because the basic concepts remain the same across countries.

28. The general framework for attribution of death or missing persons includes two broad types of scenarios:

a. Deaths or missing persons occurring during an emergency period (or deaths caused by an injury or illness sustained during an emergency) and believed to be caused by a hazard, and
b. Indirect fatalities associated with a hazard. An example is deaths from illnesses caused by consequences (poor access to water and sanitation, exposure to unsanitary or unsafe conditions) resulting from a hazard.

29. Deaths or missing persons are typically reported by different levels of local and national government and usually at some stage are shared in official reports to the public via the press. Commonly there is a need to revise original reported counts on deaths (and other human impacts) following the emergency and after there has been sufficient time to assess the sources and to verify data collected. The revised estimates must be stored in the centralized compilations of disaster impacts statistics across occurrences and utilized for calculating indicators.

30. A key consideration of compilation of revised figures is to ensure that the final official counts of deaths after a disaster are also incorporated into the broader official system of administrative records (i.e., the civil registration system) and statistics, which is also the source used for the long-term official statistics on mortality and health of the population (See Chapter 9).

Injured and ill

31. Aside from death, the two-other main physical impacts from disasters to humans are injuries and illness. The relative importance of injuries or illnesses will vary depending on the characteristics of the underlying hazard as well as on social factors, especially the vulnerability factors of the population in an affected area and the seriousness of the illness or injury.

32. In Bangladesh, for example, illness is a more frequently occurring impact from disasters compared to injuries, overall. But, the frequencies for injuries or illnesses vary by hazard type and depending on the age and gender of the exposed population. (Bangladesh Bureau of Statistics, 2016)

Displacement

33. For all types of movement of the population that are a direct consequence of a hazard, including evacuations and permanent relocations of people due to a disaster, the suggested term is **displacement**.

34. The Open-Ended Intergovernmental Working Group (OEIWG) decided to exclude displacement statistics from indicators on affected population for the Sendai Framework Monitor. Developing consistent approaches of measurement on displacement is difficult because there are many different types of displacement of people during and after a disaster. Therefore, the concept is only relevant for existing statistics that may be used in analyses and national or local levels, in accordance with the Sendai Framework paragraphs 28 (d) and 3(h).

35. In the adopted terminology for the Sendai Framework (UNGA, 2015), **evacuation** is defined as: "moving people and assets temporarily to safer places before, during or after the occurrence of a hazardous event in order to protect them." Data on evacuations could be used for assessing impacts to population, but evacuations are also a method of disaster risk reduction. Both analytical perspectives can be accommodated in statistics if observations of evacuations are accessible in the database.

36. The nature of displacement (and its measurement) varies according to length of time (e.g. temporary or permanent) and whether displacement was arranged (or ordered or financed) by governing agencies. Sometimes movement of people related to a disaster is a matter of voluntary and self-funded choice. There are also cases, especially for large disasters, in which governing authorities order and provide support for evacuation or relocation of populations in designated affected areas. The latter case is more easily measured, but both could be important for tracking impacts of disasters, and the responses of people, over time.

37. Population movements that correspond with a disaster can sometimes be captured via statistics from population censuses or population administrative records. It is more difficult to attribute movements specifically to hazards or a past disaster without posing a specific query in census or survey questionnaires.

38. A common cause of displacement after a disaster is damaged or destroyed dwellings, which, is data that can be reutilized for multiple perspectives in statistical tables, starting with the accounting of material impacts variables (below). There are also cases where the dwelling structure may have received negligible damages but due to the changes of circumstances regarding the location of the dwelling, the area is deemed unsafe for continued residential occupation. Most broadly, displacement statistics can be summarized according to permanent or temporary displacement.

Impacts to livelihood

39. Impacts (or disruptions) to livelihoods is a concept from the internationally adopted recommendations for the Sendai Framework monitor (UNGA, 2015). UNISDR guidance defines livelihoods as: "the capacities, productive assets (both living and material) and activities required for securing a means of living, on a sustainable basis, with dignity." The concept is broad and the OEIWG deferred o national practices for measurement for Sendai Framework indicators.

40. A core factor for sustainable livelihood for which impacts are measured in some countries is impacts to employment. For measurement units, impacts to employment can be measured similarly with disruptions to basic services (see last section in this chapter), i.e., in terms of number of people affected and length of time affected.

41. Utilizing a specially designed household survey, the Bangladesh Bureau of Statistics reported statistics (see Box 5) on impacts to employment (and other basic factors of livelihood like access to water and sanitation) across the affected population, according to numbers of individuals affected by geographic regions and as a distribution of the number of days missed.

Box 5: Utilizing household survey for collecting data on human impacts

Where feasible, household surveys are a potential good option for collecting data on direct and indirect impacts from historical disasters by posing specific questions to households in areas that recently experienced a disaster. A well-documented example is available from the Bangladesh Bureau of Statistics, which collected and published extensive statistics on effects of disasters on the population through a national sample household survey though the Impact of Climate Change on Human Life (ICCHL) Programme.

Included within the scope of the national survey in Bangladesh was statistics on impacts to livelihood, including temporary losses in education and employment.

Number of households missing work due to disasters by hazards and distribution by number of days missed, 2009-2014

Hazard Type	Number of households mising work	Number of non-working days missed (%)					Average no. working day
		Total	1-7	8-15	16-30	31+	
Drought	325242	8.16	3.61	2.69	1.47	0.39	12.
Flood	1071377	26.93	4.98	10.62	9.39	1.94	17.
Water logging	442145	11.12	4.88	3.23	2.05	0.96	14.
Cyclone	762788	19.17	12.05	4.51	1.95	0.66	9.
Tornado	129754	3.27	2.65	0.45	0.14	0.03	5.
Storm/ Tidal Surge	316257	7.95	4.92	1.5	1.06	0.47	10.
Thunderstorm	253272	6.37	3.73	2.14	0.46	0.04	7
River/ Costal Erosion	143973	3.62	1.23	1.13	0.92	0.34	16.
Landslides	2019	0.05	0.04	0.01	0	0	5.
Salinity	60064	1.51	1.18	0.24	0.08	0.01	6
Hailsotrm	2998410	7.51	6.29	0.76	0.34	0.12	5
Others (Fog, Cold wave etc.)	173708	4.37	2.91	1.16	0.26	0.04	7.
Total	**3979008**	**100**	**48.46**	**28.44**	**18.12**	**4.98**	**12.**

Bangladesh Disaster-related Statistics, "Household distribution of number of non-working days due to last natural disaster by categories, 2009'-14". (ICCHL; BBS; SID; Ministry of Planning , 2016)

http://www.bbs.gov.bd/site/page/76c9d52f-0a19-4563-99aa-9f5737bbd0d7/Environment--Climate-Change-&-Disaster

42. Physical human impacts (deaths or missing, injuries, and illnesses) always happen within the geographic area of the disasters. Impacts to livelihood, however, which are indirect effects, could potentially happen to people outside of a geographic area defined by the physical or material impacts from the hazard.

Material impacts

43. Direct material impacts are equivalent to "damages" as the term is used in many other related references (EU-JRC, FAO, PDNA)[27]. DRSF uses the term "direct impacts" for consistency with UNISDR (2017) and to avoid confusion between damaged and destroyed assets.

44. Direct material impacts constitute the scope for valuing **direct economic loss** according to the definition adopted for the Sendai Framework Monitor. Material impacts to the environment and cultural assets are distinguished due to differences in measurement units and valuation for economic loss measurement.

[27] PDNA, FAO, and JRC use the terminology of damages and losses. Physical Damages to infrastructure are contrasted to losses, which is equivalent to indirect impacts in the Sendai Framework and DRSF.

45. Regarding measurement units, direct observations of material impacts from a disaster are compiled, initially, in physical terms, (e.g. in terms of area (sq. m), or counts of units or buildings by type) that are damaged or destroyed (see measurement units menu in Chapter 7).

46. Material impacts can also be represented in relation to the numbers of people exposed or affected by the impacts. This includes, where possible, disaggregated statistics, e.g., by gender or by income categories) on populations exposed to material impacts of disasters. **Disruptions to basic services** are caused by material impact, with direct consequences on affected people.

47. The observation of impacts, initially in physical terms, is critical inputs for estimating the scale of the impacts of the disaster from an economic perspective, both in volume terms[28], and in terms of money. For developing systems for compiling time series in monetary terms, (i.e. economic losses), it is crucial that the basic data in physical terms is compiled in national databases following a defined structure. (see Annex of tables and Classification of Objects of Impacts in Chapter 8).

48. The difference between **direct** and **indirect** impacts is an important concept for the Sendai Framework targets and indicators. Direct impacts include physical (partial or total) damage. **Indirect economic loss** is "a decline in economic value added as a consequence of direct economic loss and/or human and environmental impacts." (UNISDR, 2017) Direct impacts tend to be relatively more immediate impacts of a disaster and they are the objects of emergency response. Indirect impacts affect individuals, businesses, and the public in proximity of the disaster area and sometimes these effects will continue for years or possibly even for decades after a disaster. Examples of indirect impacts include depressed demand for goods and services, and other effects to prices, increased debt or dependence on imports, disruptions to supply chains for products or for services like education, and so on.

49. The scope of measurement for the direct material impacts is defined according to the stocks of physical objects (see list of objects of direct material impacts in Chapter 8) that were damaged or destroyed as direct result of a specific disaster occurrence. Especially important for disaster impacts statistics is **critical infrastructure** and agricultural crops.

50. **Critical Infrastructure** is "the physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society." (UNISDR, 2017). A list of critical infrastructure types is presented as a sub-group of the broader classification of the objects of direct material impacts in Chapter 8.

51. In addition to damages to critical infrastructure and other components of the built-up landscape, another important form of direct material impacts is damage to the land and other natural resources, especially agricultural land, destruction of trees, and damages to the conditions of important ecosystems such as forests and water bodies.

52. The System of Environmental-Economic Accounting (SEEA) 2012 – Central Framework is an internationally agreed standard for producing comparable statistics on the environment and its relationship with the economy, following a similar accounting structure as the SNA. According to SEEA, **environmental assets** are "the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity."

[28] See definition of measurement in volume terms measurement from System of National Accounts 2008

53. Land and natural resources are also economic assets and are included within the SNA assets boundary, and therefore, in principle, a part of the overall scope of national asset accounting. However, some of the natural benefits from ecosystems that are recognized in SEEA are beyond the scope of SNA and are not currently valued in monetary terms. An example is the natural protections against hazards provided by vegetation. Natural ecosystems provide a natural barrier, and thus a boost to coping capacity in the form of natural protection along coastlines or upstream. These benefits are recognized as ecosystem services in the SEEA Experimental Ecosystem Accounting Framework.

54. Environmental assets are a potentially important component for the basic range of disaster-related statistics. Generally, these assets were not included within the scope of the Sendai Framework Monitor. However, some items, such as trees or agricultural land are counted in Sendai Framework Indicator C2 "Direct agricultural loss attributed to disasters", depending on the nature of the objects that have been lost.

Impacts to agriculture

55. In economic terms, impacts to agriculture are often among the most significant after disasters. This is partly because, as a land intensive activity, agriculture faces a relatively large exposure to hazards.

56. To capture the full impact of disasters on the agriculture sector, the Food and Agriculture Organisation of the United Nations (FAO) has developed a methodology for damage and loss assessment, which is integrated, through a collaborative process with UNISDR, into the Sendai Framework Monitoring Process within the structure of indicators for direct economic loss. The FAO methodology distinguishes between damage (total or partial destruction of physical assets), and loss (changes in economic flows arising from a disaster).[29]

57. Impacts to each subsector of agriculture can be divided into two main components: production and assets. Production damage is measured in terms of the value of destroyed agricultural inputs (seeds, fertiliser, feed and fodder) and outputs (stored produce). Production loss is measured in terms of the value of agricultural production lost from the disaster. Assets damage is measured in terms of the value of the destroyed facilities, machinery, tools, and key infrastructure related to agricultural production. The monetary value of damaged assets is calculated using the replacement or repair cost. This allows for an estimation of the extent and value of damage and loss for all components in each subsector.

58. Table F (see annex) was developed by FAO following the basic format of the DRSF basic range tables and describes the key components of the damage and loss assessment methodology for agriculture.

59. The assessment of production loss should be done for all primary crops. Primary crops are those that come directly from the land without having undergone any real processing, apart from cleaning. Primary crops are divided into annual and perennial crops. Annual crops are those that are both sown and harvested during the same agricultural year, sometimes more than once; perennial crops are sown or planted once and not replanted after each annual

[29] This FAO terminology ("damages" and losses") corresponds with several other references, as noted above, and essentially corresponds with the direct impacts and indirect impacts distinction from the Sendai Framework and utilized in DRSF.

harvest. Annual primary crops include cereals, pulses, roots and tubers, sugar crops, some oil-bearing crops, some fibre crops and vegetables, tobacco, and fodder crops. Perennial primary crops include fruits and berries, nuts, some oil-bearing crops and spices and herbs.

60. There are basic differences in approaches to valuation of losses for seasonal crops and perennial crops (or livestock or other types of multi-use assets). These differences are necessary because of differences of nature of the losses. Destruction of seasonal crops can be assessed as a one-time loss, which hopefully can be recovered over time and will not directly affect the next harvest, whereas losses of perennial crops relate to expected future returns that would have extended beyond the season in which the disaster happened.

61. For annual (or seasonal) crops, loss is measured as the anticipated (but unrealized) market value of the finished product for the affected crops. However, production loss for perennial crops is measured in terms of the discounted expected yield.

62. Livestock, forests (both cultivated and non-cultivated forests are recognized as assets for forests), aquaculture and forestry are included in the FAO methodology and in Sendai Framework Monitor for direct economic loss.

63. These resources, and the perennial crops, are assessed for calculation of monetary indicator terms in relation to the discounted expected yield, which requires the following statistics:

a. Pre-disaster value of perennial crops or animals killed by the disaster;
b. Replacement cost of fully/partially damaged assets, at post-disaster price;
c. Difference between expected and actual value from survived animals and perennial crops in a disaster year; and
d. Discounted expected value from dead animals until full recovery and/or replacement of livestock.

64. Impacts to the land itself, or to land improvements, should, in principle, also be included. Damaged or destroyed buildings and machinery used by agricultural enterprises are valued according to replacement costs, as generally recommended for direct economic loss measurement in the Sendai Framework Monitor (see below).

Economic loss

65. It is important to consider the multiple ways economies are affected by disasters because some of these economic impacts are difficult to attribute with a causal relationship with the disaster, and therefore could be missed. Direct material impacts tend to be more explicitly observable, but there is still usually a need for estimations or to utilize multiple data sources for valuation of thes impacts. The agriculture case (above) is a good example of the challenges, stemming from the need to adopt conventions for handling monetary valuations of different types of impacts differently, e.g., perennial and annual crops.

66. Economic loss statistics must be built on a clear and consistently applied concept of measurement, to avoid mixing figures incoherently (e.g. mixing stock with flow measures) or double-counting. Some types of economic losses are implicitly included in national accounts and other economic statistics, but they are not easily disentangled as impacts variables and,

due to accounting rules, some values will appear as positive contributions to key indicators like GDP and investment.[30]

67. One of the economic responses after a disaster emergency period and recovery is a short-term boost in construction activities, which can give a misleading impression of resilience and economic growth because the losses of assets, to which the construction is replacing, do not affect the computation of GDP directly. However, there are also indirect effects to GDP, which are more difficult to measure, and it is important to develop a complete description, as much as is feasible, of the overall effects of disasters on the economy.

68. Reducing "direct disaster economic loss" by 2030 is target C in the Sendai Framework and a target under multiple sustainable development goals – in relation to poverty reduction (Goal 1), sustainable cities and human settlements (Goal 11), and climate change action (Goal 13). **Direct economic loss** is defined for international monitoring of Sendai Framework and SDG targets as "the monetary value of total or partial destruction of physical assets existing in the affected area."

69. **Assets** are defined in the System of National Accounts (SNA) as stores of value "representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of transferring value from one accounting period to another. "(SNA 2008, para 3.30). In other words, assets have an intrinsic value represented by their expected benefits to owners and this value can be lost or reduced directly by a disaster.

70. Proposed for direct economic loss measurement for the Sendai Framework and SDGs monitoring in UNISDR (2017) is the cost for replacement (e.g. reconstruction/restoration) of damaged or destroyed assets, which is a different concept compared to measuring changes to the values of assets (see box 5 on economic loss and the SNA). Replacement or reconstruction costs (although they may be estimated) represent actual flows of financial resources that were necessary to restore the physical assets back to its previous condition before the disaster. Thus, the statistics used in the Sendai Framework and SDGs economic loss indicator are also a metric of investments for post-disaster recovery.

71. Use of replacement costs for measuring direct economic loss is practical for several reasons: (a) the values are relatively easy to interpret for analysis, (b)they are a part of the broader productive activities of the economy and thus can be compared directly with GDP, and, (c) the values are also a component of disaster risk reduction expenditures accounting (next chapter).

72. Although the definition provided for the Sendai Framework Monitor refers to assets, also for consideration for measurement of direct economic loss are "household consumer durables", a class of product, such as private owned cars, which technically are not included as assets in the SNA, but have a value in their own final use by households.

[30] For example, reconstruction or repairs of assets after a disaster are productive and income-earning activities, thus contributing positively to GDP in periods after a disaster. Research after disasters in the United States has shown that a short-term increase in GDP and employment can be commonly observed at the local level in areas after a disaster. In part, this is an effect of efforts for recovery of direct economic losses, according of the Sendai Framework definition.

73. Several primary sources for estimating the value of replacement costs for damaged or destroyed assets can be utilized in a complementary way.

a. Governing agencies responsible for the relevant types of infrastructure (roads, buildings, agricultural land etc.) may conduct an assessment as part of the immediate disaster response and recovery, which could include estimated replacement costs based on existing (pre-disaster) statistics on average per unit costs by infrastructure type in the affected region.

b. Estimation based on average costs, as proposed in UNISDR (2017), noting that such estimations could be prone to inaccuracies, depending on the variance in costs across space. When using average per unit costs or other proxies for estimating replacement costs, there will always be a degree of uncertainty, which should be quantified and included in the metadata.

c. Direct observations of expenditures for recovery will be available for some s from reports or surveys of businesses or reports of expenses by the government agencies, e.g., Ministry of Transport for the case of roads, or from reports from records of insurance claims covering a disaster. [31]

74. By combining data sources, a reasonably reliable and coherent picture of expenses for recovery of assets should be feasible and compiled into tables like E1A (see Annex), and for producing an estimate for aggregated expenditure for recovery.

75. Although the basic measurement objective for the Sendai Framework direct economic loss indicator is to quantify the recovery of the affected physical assets, of course not all damaged or destroyed assets will be recovered. There may not be precisely a replacement of the assets that existed before the disaster. Some assets will simply be written off whereas others will be replaced by different new assets. The costs of "**build back better**", for example, are different from the costs of recovering losses. These additional costs, represented by structural measures with a purpose of disaster risk mitigation, e.g., seismic resilience of buildings are also useful statistics, and an important component of the overall economic investment in disaster risk reduction (see next Chapter).

76. In the System of National Accounts (SNA), there is a recording for changes to the value of a country's stock of assets caused by **catastrophic losses.**[32]

[31] Note that not all replacement expenditures can be observed (or even take place), not all assets will have been insured, and suitable proxies (e.g. average per unit costs for affected assets) are not always available. Thus, some combination of compilation of these statistics with estimation based on proxies is a common practice across disasters for compiling replacement costs.

[32] "The volume changes recorded as catastrophic losses in the other changes in the volume of assets account are the result of large scale, discrete and recognizable events that may destroy a significantly large number of assets within any of the asset categories. Such events will generally be easy to identify. They include major earthquakes, volcanic eruptions, tidal waves, exceptionally severe hurricanes, drought and other natural disasters; acts of war, riots and other political events; and technological accidents such as major toxic spills or release of radioactive particles into the air. Included here are such major losses as deterioration in the quality of land caused by abnormal flooding or wind damage; destruction of cultivated assets by drought or outbreaks of disease; destruction of buildings, equipment or valuables in forest fires or earthquakes." [SNA 12.46]

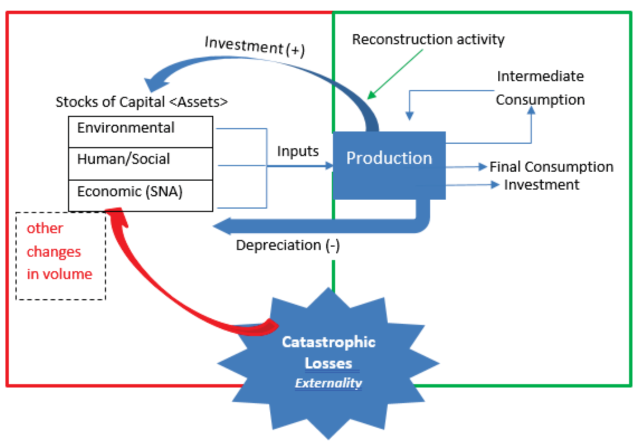
Box 6: Economic loss and the SNA

The costs associated with replacement of direct impacts are already incorporated implicitly within the SNA as productive (i.e. positive) activities. Indirect impacts will implicitly affect GDP in the year of the disaster (and subsequent years after). The total (direct and indirect) effects of a disaster on GDP are ambiguous within the national accounts.

However, as there is a strong demand from policy-makers and researchers, many statistics offices and/or national accounts authorities produce analysis, especially after very large disasters, utilizing national accounts and the sources of national accounts statistics to estimate the indirect effects of a disaster, and thus produce an unambiguous assessment of the effects of a hazard on economic activities by sector and for the whole economy. Several important references can be noted, e.g.: Escobar, C-G (2011), USBEA (2009), and Statistics New Zealand (2012b).

In principle, values for the direct impacts to assets, valued in terms of losses to value of the asset base, are already included, in this case explicitly, in the SNA, through a special recording called catastrophic losses. These losses are represented as a special type of change ("other changes in volume") to the national balance sheet for physical assets. This is a change in the stock of assets, which has no direct or explicit effect on the flows portion of the accounting framework, such as production and income.
The figure below is a simplified representation of the relevant stocks and flows according the SNA, including the recording for catastrophic losses on the left side, which represents changes to stocks of assets and with the flow variables on the right side, which includes activities like reconstruction.

Catastrophic Losses in the SNA



The direct impacts from disasters recorded in the SNA Other Changes in Volume to Asset account cover losses in asset values from relatively large-scale occurrences (see definition from SNA), and therefore should be appended with estimates of the costs of damages from smaller scale events as well.

The valuation of catastrophic losses in the SNA matches with the approach developed by FAO for measuring losses to perennial crops and livestock (see Impacts to Agriculture), i.e. by assessing the change in asset values (discounted expected return).

77. For many disasters, especially large disasters, the indirect economic impacts are likely to be much larger in value compared to the values for destruction of assets and there is a strong interest for measures of indirect economic losses from disasters, for example to produce estimates of the effect of disasters on GDP growth. However, an initial focus on reliable measurement of direct economic costs is a sensible priority because the input data are also

basic building blocks upon which assessments and modelling of indirect economic impacts can be developed later.

78. In summary, while there is a strong international demand for internationally comparable indicators for direct economic loss, there is also an interest to produce multiple related figures, where possible, in order to meet different purposes of economic analysis, including assessments of the indirect economic impacts of disasters, and accounting for costs of expenditure for the post- disaster rebuilding and the broader measurement of disaster risk reduction expenditures, including costs for building back better.

Economic loss and poverty

79. The demand for direct economic loss from disasters measurement goes beyond the aggregate losses by country or for regions within a country. Although there is no requirement for disaggregation of economic losses by individuals (or types of individuals) for the Sendai Framework Indicators. There are other national or local-scale analytical purposes for providing disaggregated statistics for focused analyses for risk reduction, e.g., for people in vulnerable situations. This can be accomplished, to a certain extent, via disaggregation by income of human impact statistics, in particular households affected by damages to their dwellings or other assets, and by rigorous mapping of vulnerabilities before and after a disaster.

80. Another important link for understanding this relationship with poverty reduction is statistics on financial support to households during and after a disaster. For example, statistics should be compiled, where feasible, after each disaster on households receiving financial or other support by geographic regions and also compile summary statistics on coverage of insured losses versus uninsured losses.

81. If a poor household's dwelling is destroyed, the replacement costs are very small from the perspective of GDP, but extremely large from the perspective of that household, especially if the impacts were uninsured. The indirect impacts, e.g., displacement, loss of employment or reduced income could be even worse. It is important to compile and retain the basic data and metadata on material impacts and the people affected to allow for the possibility of disaggregated analyses focussing on poverty and leaving no one behind.

Disruptions to basic services

82. Disruptions to the functioning of a community or a society is one of the defining elements of disasters (UNGA, 2015). These disruptions are typically connected with material impacts from disasters and sometimes statistics on disruptions can be produced based on the same basic data inputs used for assessing material impacts after a disaster.

83. The measurement of disruptions to basic services was one of the issues discussed by the OEIWG to develop suitable recommendations for international monitoring of indicators. The OEIWG concluded that the international monitoring of indicators could be accomplished via the counts of relevant numbers of critical infrastructure types, as the disruptions are consequences of material impacts to critical infrastructure.

84. In addition, to help guide compilation of statistics for these indicators, UNISDR developed a list of the basic services that could be disrupted by disasters as follows:

- Health Services (CPC 86: “Human health services”);
- Educational Services (ISIC 85);
- Public Administration Services (CPC 91 “Administrative services of the government”);
- Transport Services (ISIC 49: “Land transport and transport via pipelines”, ISIC 50 “Water transport”, ISIC 51: “Air transport”);
- Electricity and Energy Services (ISIC 35: “Electricity, gas, steam and air conditioning supply”);
- Water Services (ISIC 36: “**Water** collection, treatment and supply”); and
- ICT Services (CPC 4 “Telecommunications, broadcasting and information supply services”)

85. The portions of these services provided by government are included as part of the UN Central Product Classification (CPC rev 2.1), within Section 9: “Community, social and personal services” and in the International Standard Industrial Classification of All Economic Activities (ISIC Rev 4) Sections O, P, or Q.

86. For cases where additional data are available on the nature of the disruptions to basic services, national agencies might also consider development of an additional collection of two other key dimensions for analysis of the disruptions to basic services. This can be done, for example, by counting the number of people impacted and the length of time of the disruptions (see Table D2 in the Annex). Although this information is not relevant for international reporting under the Sendai Framework or SDGs, some official statistical agencies are already collecting such information and are encouraged to continue.

CHAPTER 5: DISASTER RISK REDUCTION ACTIVITY

1. Disaster risk reduction-related (DRR) activities are activities that boost coping capacities of society where a disaster occurs or may occur. Outcomes of these investments e.g. coverage of early warning systems and the basic knowledge and preparedness of households (see Coping Capacity, Chapter 3), affect the overall risk profile for a given community or region within a country. The costs of investment in DRR are expenditures or transfers for activities with a disaster risk reduction (DRR) purpose.

2. A main area of interest about disaster risk reduction activity statistics is national DRR expenditure. The size of this expenditure can be compared with other activities and with total GDP. Risk analyses can benefit from comparisons between investment within the categories of DRR activities, like post-disaster reconstruction expenditures and post-disaster "structural measures" for future disaster prevention, e.g., build back better as discussed in Chapter 4.

3. The Report of the OECD Joint Expert Meeting on Disaster Loss Data "Improving the Evidence Base on the Costs of Disasters: Key Findings from an OECD Survey" (OECD, 2016), made a connection between statistics on impacts and investment in disaster risk reduction as follows:

> *"The rationale for the work on improving the evidence base on the cost of disasters is grounded in the evidence that recent shocks from natural and man-made disasters continue to cause significant social and economic losses across OECD countries. The increase in damages is widely considered to outpace national investments in disaster risk reduction, but this claim is more intuitive than supported by evidence. Indeed, there is hardly any comparable data available on national expenditure for disaster risk management."*

4. Investment in disaster risk reduction has been shown, via case studies, to be highly efficient and financially smart investments if compared to risk of potential losses.[33] The case can be strengthened by development of robust statistical evidence for the costs and benefits of DRR activities over time. Moreover, monitoring current risk situations, including existing investments in risk reduction, can be used for identifying new investment opportunities that have the potential to significantly reduce risk or prevent unacceptable risks.

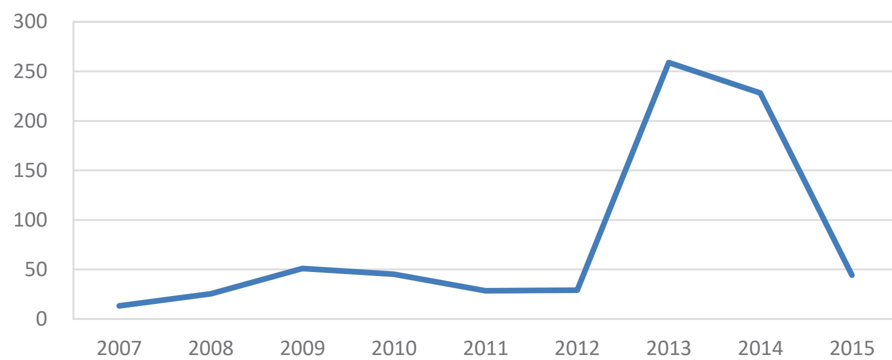
5. Many national governments have previously conducted ad hoc studies of disaster risk expenditures, known as DRM expenditure reviews. The aim for producing DRR economic statistics, is to separate values for expenditure with a DRR purpose, for regular annual accounting of relevant expenditures. This way, governments can track the trends of investments in reducing risks of disasters and to make assessments with respect to the measured risk and with respect to the costs of impacts when a disaster occurs.

6. OECD (2014) provided examples from a selection of OECD and non-OECD member states over time. Relevant expenditures tend to be on the rise for the countries with available time series statistics, but trends vary by types of expenditure. For example, after large disasters there are large spikes in DRR expenditures for response, recovery and reconstruction. These trends and peak values can be compared with the broader and more stable trend of other forms of DRR expenditures for a cross-country and cross-disaster analyses of how costs of DRR are

[33] See, e.g., UNDP, 2004

manifested and how they might be addressed efficiently and with minimum impacts to people. For example, the sample trend analysis below was produced using actual data on expenses related to emergency response or recovery from multiple sources for a country that experienced a very large disaster in 2013.

Sample of trend in expenditures related to disaster response and recovery (millions of US Dollars)



7. Moreover, the relevant expenses by government and other actors after a disaster are also used for estimating **direct economic loss**. (see chapter 4)

8. Expenditure statistics are typically aggregated at national scale, but equally important is to identify statistics on transfers, including transfers from the national budget (or from international sources) to local projects and local government. Producing statistics on transfers is crucial for identifying beneficiaries and potential gaps or opportunities for targeted interventions to reduce risks.

9. The publicly-financed disaster risk reduction activities, particularly disaster recovery, are often transfers from central government budgets to local authorities, and/or international transfers, or Overseas Development Assistance (ODA). If the activities with a DRR purpose can be specifically identified and isolated from the broader national aggregates, than these transfers can be tracked through balance of payments and national accounts statistics like other types of transfers and activities (production, investment, employment) in the economy.

10. The Sendai Framework describes **disaster risk reduction** (DRR) as a scope of work "aimed at preventing new disaster risks as well as reducing existing disaster risks and managing residual risk, all of which contributes to strengthening resilience. DRR encompasses all aspects of work including the management of residual risk, i.e. managing risks that cannot be prevented or reduced, and are known to give rise to, or already, materialize into a disaster event." (UNISDR, 2017).

11. Expenditures on disaster risk reduction may be difficult to identify and isolate from current transactions because they are implicitly recorded as part of a broader classification of transactions. There are two complementary approaches that can be applied for isolating the relevant values and producing statistics for a DRR activities, particularly the quantifications, in monetary terms, of DRR transfers and expenditures.

12. The first approach is to produce a focused analysis of transfers from relevant institutions and to analyse transfers and expenditures for a particular geographic region and

time period where there is a large-scale disaster recovery underway. Existing government finance and statistics are derived from administrative records or outcomes of surveys or censuses businesses and household activities, including trends. Analysis of trends, in the case of recovery from large scale disasters will indicate specific and temporary diversions in the trends, which can be used for estimation of expenditures for DRR activities for the recovery in those areas. Furthermore, a post-disaster recovery period is an opportune moment to establish coordination mechanism between government agencies for sharing data or producing proxy measurement for tracking **disaster risk reduction characteristic activities (DRRCA)**.

13. The second approach is to develop a series of functional accounts and indicators that track all types of transfers and expenditures in the economy with a specific DRR purpose. Statisticians develop specific functional classifications in order to define the domain of interest, e.g., the SEEA classification of environmental activities, and DRR-characteristic activities (DRRCA) are defined to objectively identify shares of expenditures or transfers with a DRR purpose. The same approach is also utilized for several other important cross-cutting domains of the economy, e.g., health, tourism, education, environment), often designed as "satellite accounts". These satellite accounts are specially designed extracts (or "satellites") of the system of national accounts (SNA). Satellite accounts have the same structure and accounting rules as the core SNA, but with a specifically designed scope for a functional purpose, such as monitoring DRR-related activities.

14. The provisional classification of DRRCA has been developed (see chapter 8), starting from the Sendai Framework and the terminologies adopted for the Framework in UNGA (2015). The scope of DRRCA activities is:

a. Disaster Risk Prevention;
b. Disaster Risk Mitigation;
c. Disaster Management;
d. Disaster Recovery; and
e. General Government, Research & Development, Education Expenditure

15. Disaster risk reduction characteristic transfers include:

a. Internal transfers between public government services;
b. Risk transfers, insurance premiums and indemnities;
c. Disaster related international transfers; and
d. Other transfers

16. Typical outputs from accounts of expenditures or transfers of DRR activity, following the basic framework of the SNA, will include:

a. Total national expenditure with a DRR purpose;
b. DRR expenditure by source of financing, e.g., central government, local government, private sector;
c. DRR expenditures and transfer by beneficiaries;
d. DRR expenditure by type of DRR activity, e.g., disaster preparedness, recovery and reconstruction, early warning systems;

e. Values of transfers from central government to local authorities; and

f. Values of transfers from international donors, i.e., DRR-related overseas development assistance (ODA).

International assistance

17. **Overseas development assistance (ODA)** is defined by OECD[34] as flows to countries and territories on and to multilateral development institutions which are a) provided by official agencies, including state and local governments, or by their executing agencies; and ii. each transaction of which: a) is administered with the promotion of the economic development and welfare of developing countries as its main objective; and b) is concessional in character and conveys a grant element of at least 25 per cent (calculated at a discount rate of 10 per cent). ODA's are international compilations of statistics.

18. Humanitarian assistance is the portion of ODA in the OECD database related to three sectors: and Disaster Prevention and Preparedness, Emergency Response, and Reconstruction Relief and Rehabilitation. OECD has created publicly accessible time series compilations of ODA by categories and by donors and recipients. It is worth noting that an estimate of around 80 per cent of the international flows of humanitarian assistance are for conflict-related settings, or other types of complex disaster situations involving refugee crises or violent conflicts.

19. While hazards and disasters are events happening randomly in terms of timing and location, DRR is a continuous activity needed to strengthen society's resistance and resilience and thus DRR statistics should be compiled on a continuous and periodic basis (e.g. as annual accounts). In this way, DRR statistics could become an integrated and relatively conventional domain of statistics, as an extension to the existing national accounts.

20. However, there are also special demands for analysis of DRR activities at certain periods, such as immediately after a large-scale disaster, and emergencies sometimes spur a boost in DRR expenditures and international transfers, which can be tracked via regular compilations of the statistics and then linked with specific disasters for analysis (see sample trend above).

[34] Stats.oecd.org