Mapping of relevant damage and loss databases and data reporting initiatives

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1. Introduction

The issue of reliability of post-disaster damage and loss data has been on the floor for long time. In his doctoral thesis in 1943 Gilbert White, a US geographer among the founders of disaster studies, was discussing the severe limitations of data on flood impacts in the US. In a similar vein ten years after the same concern was raised by two scholars, Hoyt and Langbein (1955). They also highlighted some of the reasons behind the limited reliability of damage data that unfortunately are still relevant today such as:

- fragmentation of collection among a large number of agencies that do not communicate between each other;
- different criteria for damage inclusion for different sectors,
- lack of quality control.

The issue has not been really central to the debate in the field, the literature on the topic, mainly reports and few scientific papers, is relatively scarce. Overviews were provided by (Cochrane 2004 a. and b.; Gall et al 2009; Delmonaco et al 2011; Migliorini et al 2019). In 1999 the US National Research Council was highlighting how the reality of post disaster damage assessment fell short of the ideal in which the various types of damage and their metrics were collected and managed according to a standardized, coherent framework. In particular they were pointing at the fact that damage and losses were collected by different sectors according to differing definitions and interests they had in how compensation should have taken place and paid by whom (insurance, government, individuals, businesses).

In the more recent years though there has been a growing concern on the lack of reliable damage and loss data for different reasons:

- Accountability needed at the national level as destructive events have become more frequent, growing need of careful programming of increasingly scarce resources;
- Accountability required by international agreements such as Sendai. The latter requires in fact to be able to measure the seven targets. Indicators that are mandatory requires the extensive availability of damage and loss data;
- Accounting required for the implementation of the Paris Agreement, that is on the one hand compensating countries that have no responsibility in global warming for the impacts of climate change and on the other to be able to "attribute" damage and losses trends to climate change related phenomena.

It should be noted that there are different forms that post disaster damage data collection may take. Databases are one example: data from various events are input in a digital archive that can be consulted at any time, and from which data can be retrieved as a result of queries. Another form that is rather frequent in practice is that of a report. The report may well be digital, however data are presented there as part of an overview, an assessment and therefore cannot be queried as such unless manually from the document. The report type of post disaster damage data collection is more frequent than generally considered. Be it in the form of reports or a database, the core issue is to counteract the perishability of damage and loss data. The latter may be lost due to a number of reasons: shifting of authorities responsible of the various phases of post-event management from emergency to reconstruction, technical issues, lack of accuracy in data and database maintenance. Some data if not correctly collected at the time of emergency will be lost forever, as memory tends to fade, and simply it is very hard to reconstruct what happened exactly during the frantic time of an emergency (Adams et al 2024).

In principle those two main forms of managing post disaster damage and loss data are not incompatible and actually could be seen as sequential in a future looking perspective. In case databases are designed cross sectoral and flexible enough to allow multiple queries, multiple reports can be extracted or developed using stored data. Such reports can regard individual events, in this case databases are used as repositories containing information that can feed different sectors of a report (related for example to damage to different sectors). Another form of report may regard an area for which multiple events have been recorded through time or different regions in the same country, etc.

The increased interest in damage and loss data is evidenced by activities carried out by the EC JRC that has established jointly with DG ECHO a working group on the matter since 2013, published a number of reports on the topic (Joint Research Centre 2013; 2014; 2015; Do O Pinto Alho et al 2018). It is also a concern for central banks (national) as well as the European Central Bank that has devoted a number of studies to the assessment of the likely impacts on economy of impacts due (mainly) to climate change and related phenomena (European Central Bank 2022).

This study results from a research activity in the topic funded by the European Commission through DG ECHO grants and currently under the AHEAD project. The study is mainly aimed at understanding the situation in terms of databases that are used to collect/query damage and loss data due to disasters and identify key elements for improving the current conditions and the gaps and fallacies of existing databases. Databases have been analysed and searched as regards damage to assets and infrastructures, whilst data on human losses and affected population has not been considered and is not part of the Ahead research.[1]

2. Damage and loss data in the form of reports

In France for example the IGEDD (Inspection Générale de l'Environnement et du Développement Durable - in English: General Inspection for Environment and Sustainable Development) has been publishing 1708 documents since 2001[1].

A query by keyword in the title returns 94 documents on prevention, 33 on floods, 4 on drought, 9 on accident, etc., and 31 are "Return of experience" (Retour d'expérience), among which 17 are dedicated to exceptional natural or industrial disasters, most of which about floods (also droughts, snow, typhoon, etc.).

Formal return on experience ("REX") from exceptional disaster is a long-run endeavour from the Franch authorities. A first document was edited in 2005; it was, generic (e.g concerning all kinds of natural disasters). Subsequent projects led to a REX guideline dedicated to floods (last version edited in nov. 2024, "REX technique inundation"[2]).

[1] https://igedd.documentation.developpement-durable.gouv.fr/recherche
[2]https://doc.cerema.fr/digitalCollection/DigitalCollectionAttachmentDownloadHandler.ashx?parentDocumentId=601034&documentId=601035&skipWatermark=true&skipCopyright=true

The main purpose of "REX technique inundation", as the guideline states, is to give useful insights to feed the future prevention and preparation as much as possible, possibly in the perspective of long-term recovery, that should entail an adaptation part. Following this document, all the concerned authorities and entities should participate in the elaboration of a "REX technique": ministries, regional and prefectoral levels, civil authorities, authorities in charge of structures with prominent social mission (hospitals, senior residences, schools) that may potentially be disabled by a natural disaster, the departmental council, towns and village communities, etc.

[1] For a resembling approach on the loss of life and human health refer to the works of Freddy Vinet of the LAboratoire de Géographie et d'Aménagement de Montpellier (LAGAM), e.g. Vinet (2017).

REX elaboration timeframe ranges from the "hot report" ("retour à chaud", when security forces may be still active) potentially down to the recovery phase, typically a few years (or even a decade) after the disaster. In the latter perspective, longer-term data curation is envisaged as a key aspect. However, according to the current guidelines, the modalities remain to be formalized maybe in a yet to come document.

Reports from the IGEDD website are stored as documents, not as data.

Similarly the various reports that have been produced following the PDNA standard. The latter results from the joint effort of multiple international organisations, originally the UN ECLAC, then continued by the UNDRR, and the European Commission (GFDRR 2013). Several disasters worldwide have been reported through this methodology. The two ways of reporting damage and loss data are different, serve different purposes, even though in principle they could become part of a unified more advanced practice. Whilst every database is different and return of experience are not all alike, there are some important features that characterizes each type of damage reporting.

- Generally reports such as the PDNA and the French Return of experience from disasters combine the damage data with an analysis of the event. The French REX guidelines also provides insights on the effects of the natural phenomenon, and the sequence of events, in the light of crisis management (still, in the perspective of optimal prevention and preparation, for potential future events to come). As for positive aspects, they do provide information both on the triggering hazardous event(s) and on the consequent impacts. Such reports cover damage and losses to multiple sectors and are often associated with the intent of identifying critical needs and potential lessons learnt for the recovery. They do generally follow a standardized fashion of reporting that is provided in ad hoc guidelines that were developed following initial efforts. The guideline are then adapted to the specifics of the context where the event occurred.
  As for limitations and constraints they do not permit an easy query of data and often the latter are difficult to extract from the narrative context in which they are provided, unless they are reported in the form of tables. Even in the latter case, they do not easily lend themselves to be input in a database.
- As will be seen in the following sections, databases may be very different depending on various factors that we have proposed as criteria to develop a taxonomy. As for the strengths, certainly the availability of inventories that can be more easily searched represents an added value. Furthermore, databases represent more systematized efforts and permit to develop statistical analysis over periods of time or comparing the outcome of extremes in different areas. As for limitations and constraints, most of existing databases are seldom cross-sectoral, limiting the type of assets for which analyses can be carried out. There are often some technical limitations on the type and flexibility of queries that can be actually performed, depending on how the database has been originally designed.

3. Proposed criteria to develop a taxonomy of damage and loss databases

The majority of articles and reports that have been produced insofar address global databases that report damage and loss damage due to natural extremes (and in some cases to man made incidents) in a given time interval or since a certain date. Global databases such as EM_DAT, DesInventar and some databases provided with differential level of accessibility by re-insurers are typical examples. However, the landscape of databases that report damage and loss data is wider and varied and would deserve to be better explored and analysed. In the following criteria to elaborate a taxonomy is proposed grounding on available literature and on the understanding of the contributors to the Ahead project, therefore building on prior efforts as well (Faiella et al 2022; CONHAZ 2010-2012[2]).

The following criteria are considered:

- **Purpose**, more specifically if databases have been developed to organise historic data or to serve administrations and government in their everyday activity (i.e. whenever a disaster strikes)
- **Type of data** that is stored: empirical, collected through direct surveys or other techniques (remote sensing, satellite, aerial images etc), versus modelled (as is often the case with financial losses) or hybrid. Input data can also be obtained from primary sources (governmental, insurance) or from secondary sources (such as media reporting).
- **Type of damage and losses**, if related only to impact on physical assets or also indirect losses due to business interruption, loss of functionality, damage to supply chains.
- **The adopted units of measure** of damage and losses
- **Sectors** for which the data are collected
- **Type of hazardous events** provoking the damage
- **Severity threshold** that triggers the inclusion in the database
- **Spatial scale** at which the database is developed and managed
- **Timescale** of the data.

a. **Purpose.** Some databases, for example EM_DAT, were originally developed to store data related to past events in order to obtain a valuable datasets from which a number of relevant analyses could be produced, responding to questions related to trends of damage and losses, trends of extreme events by type etc. As the database becomes more structured and technical and curating capacity is in place, new data is input whenever a new event occurs. The main purpose of the database is still the same, providing evidence on the impacts extremes produce overtime. Databases that are curated by governments typically respond to the need of compensating damage and/or to address the needs of the affected community. In principle as times passes and damage provoked by every extreme event are collected and stored, also this type of databases assumes the function of historical witness of the past. To a certain extent, overtime, the difference between the two types could fade away, however at the moment of writing the two still have a rather different perspective, construct and utilization. In addition, historic databases are often fed by secondary sources, whereas data input into governmental databases are directly collected in the field or through other techniques. Which brings to the second criterion.
b. **Type of data that is stored**. As mentioned, governmental or insurance databases are fed with primary data. In the case of the former, different ways of collecting data are used: surveys, claims submitted through forms, satellite and/or aerial images. In insurance databases, claims from affected customers constitute the main type of data. In the case of some historic databases when primary data are not available, secondary sources are often considered, such as media reporting, scientific articles etc. With respect to some type of data, for example financial impact, the latter is modelled rather than measured. Hybrid techniques are also applied. When large gaps exist in the availability of empirical data, from primary sources, modelling is the only option. With the advent of data science and the formidable computational capabilities of ICT, the attempt to develop methods to produce data to fill gaps is relevant, even though a minimal level of empirical, primary source data will always be necessary for calibration and validation.

[2] The EU project CONHAZ compiled and synthesized knowledge on cost assessment methods considering natural hazards. It provided the first comprehensive overview on best practices of cost assessment methods. (Costs of Natural Hazards | CONHAZ | Projekt | Fact Sheet | FP7 | CORDIS | European Commission)

A certain degree of modelling is required also to transform direct physical damage into economic losses. In fact, estimation of costs of the components and assets that must be repaired or substituted requires the application of estimation techniques and models. This is particularly true for the so called indirect damage, such as the cost of business interruption or disruption to supply chains, in which direct reporting and observation as in the case of assets is not really feasible.

c. **Adopted units of measure.** Broadly two types of units of measure are used: monetary and "engineering" descriptions. In the former, a monetary value generally represents either the cost of rehabilitation and repair or the cost of total substitution depending on the level of damage and on what is eligible for refunding. The monetary value generally encapsulates different considerations (in the case of a building for example the required material, labour, design, retrofitting). This means that the cost does not necessarily reflect only what has been damaged or lost, but also a degree of amelioration. In the "engineering£ description of damage, the latter is described in quantitative and qualitative terms. In many databases both measures are provided even though rarely a perfect translation of the engineering description into monetary values is provided.

d. **Type of damage that is collected.** Most data that are collected refer to damage to physical assets, such as buildings and components of infrastructures. Data related to the so called indirect damage, in terms of loss of functionality of services (for example duration of interruption), systemic impact on supply chains (due for example to the service interruption such as transport, power or telecommunication) on production is rarely collected in a systematic fashion and generally nor reported in available databases. Exceptions are business interruption that can be covered by insurance and therefore at least in principle such data is collected by insurance companies.

e. **Sectors.** Few databases collect data for multiple sectors, meaning assets pertaining to economic activities such as industries, commercial and agricultural facilities, dwellings, public services, infrastructures, cultural heritage, ecosystems. Depending on the purpose, the curator of the database only one or few sectors are actually covered by the same database. The situation is still similar to the one described by Hoyt and Langbein for the US in 1955: different agencies, governmental and non governmental organisations collect data relevant for them that is not shared nor coordinated by any authority. In the current data science and IS language, the databases are generally poorly or not at all interoperable. Insurance databases are limited to insured assets that generally represent a subset of damage to some sectors depending on the insurance policies in a given country (such as residential buildings, some economic activities, rarely public facilities and infrastructures).

f. **Type of hazardous event considered in the database**. Some databases are developed to capture damage and losses data due to a single type of hazard, for example floods or storms. Some others record data due to multiple hazardous events, for example in Alpine mountain areas. As mentioned some are including also some types of man-made incidents (for example natech). The fragmentation across hazard types may make the comparison between damage due to different hazards unreliable and inconsistent.

g. **Threshold for inclusion**. Often a threshold for inclusion is envisaged. Such threshold may regard the severity of the hazardous event or, more often, the impact in terms of minimal level of victims versus critical amount of loss. This is evident for example in insurance databases that integrate events that provoked more than a certain amount of total or insured losses. Loss data collection for small- and medium-scale events is challenging because their impacts often go unrecorded or are overlooked in national-level reporting systems. These events may not meet damage thresholds for a formal assessment or to trigger official response mechanisms, which makes them statistically invisible despite their higher frequency. As a result, their cumulative impacts are underestimated, even though, cumulatively, they can be similar or exceed those of large-scale disasters. This invisibility can also affect marginalized and excluded groups, who often suffer repeated losses and prolonged recovery without adequate support.

h. **Spatial scale**. Most damage and loss database have been conceived to cover a specific spatial scale, in order global, national, regional or local. The distinction among spatial scale is evident in data collected by administration, as the collection follow predefine rules by law or regulation. The distinction is less neat in the case of insurance data, that is generally collected at the single item level and then aggregated in some form to serve analytical purposes (for example at the zip code level). In order to be able to map correctly damage and loss data, geolocation is necessary. In principle, there is the possibility to scale up from local level data to upper level, however the method according to which this is done is not always made explicit in national or global level databases.

i. **Time scale**. The timescale of the data is particularly complex for damage and loss data as multiple meaning of time-scale must be considered. First there is the time covered by the database, see point a). Second, the time when the data is collected. In some cases multiple versioning of the damage data may be available: the initial fast estimation to assess immediate needs (for example in terms of needed sheltering solutions), the intermediate estimation, the final pay off. Few databases permit to track the "time" history of the damage data. However, such tracking is useful for a number of applications as discussed in section 4. Third, the time when the data is used. The data may serve the assessment of needs already at the emergency phase, the resources required to permit the initial recovery and longer term recovery and reconstruction. The data will be also used as empirical evidence to support the improvement of risk models for prevention and preparedness. In this regard Mejri et al (2017) proposed a framework depicting the fact that the time of use and reuse of data does not necessarily coincide with the time when the data are produced. In the paper it was shown how data collected during the emergency to support emergency management could then be reused to support recovery and reconstruction.

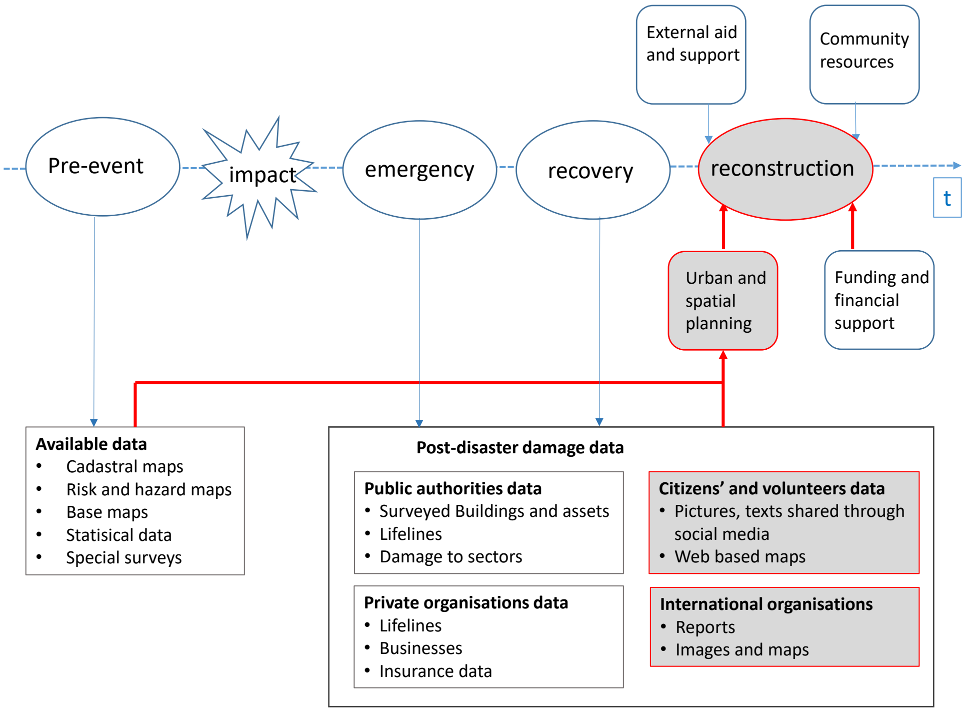

Figure 1. Data needed for forensic investigation of disasters (source: Mejri, Menoni et al 2017)

4. The multiple uses and use cases of damage and loss data: a key question to be better explored in research and practice

Damage and loss data have a significant potential in terms of use cases as discussed in literature. The most recent report displaying a high maturity on the topic has been recently developed by the UNDRR (2025) in a report providing an explicit inventory of relevant use cases with examples of application. However, discourses and exemplification of potential uses are available in literature (De Groeve et al 2013).

It is difficult though to speak about such use cases in general, without anchoring the discussion to the characteristics of the damage and loss reporting, as each form, each initiative provides different possibilities depending on how it responds to the various criteria discussed in section 3.

Uses are somehow constrained or enabled by the type of database or the reporting system that is available. This makes it also difficult to list the elements of added value of reporting to attract more administrations and more officers to take part in this endeavour. In the following first such uses will be discussed in general terms, then a couple of examples will show how databases differently organised and responding to the various criteria listed in section 3 provide differential opportunities in terms of use cases they can actually serve.

4.1. A general overview of use cases.

UNDRR (2025) has proposed a rather comprehensive and exemplified discussion on use cases of damage and loss data. The first attempt to our knowledge to enlist the latter has been provided in JRC (2013).

A useful way to structure the discussion is considering the time scale, that is what is the main use of data at different phases of the disaster event.

4.1.1. Use cases for emergency management

Damage and loss data are collected right after the impact for different purposes. At first such data are key to address urgent needs of the affected population and to perform emergency interventions. Data therefore are collected especially as far as damage to residential buildings, economic activities and infrastructures are concerned. This type of data can be obtained through initial direct surveys performed by trained personnel, in the form of usability assessment or a mix between surveys and claims by affected people. There is a well established tradition in different countries especially for seismic events (Faiella et al 2022). Other data are obtained through satellite images. In this regard, the Copernicus Service for damage assessment is an eminent example of fast reconnaissance maps and reports that are produced with different time delays to support the emergency with increasingly reliable data. In some cases, data collected for the immediate assessment of damage extent and magnitude and the more evident needs remain the only available ones.

4.1.2. Use cases for recovery

More often than not though other types of collection take place to support the programming of recovery, compensation, resources allocation. Such collection is often carried out in the second phase of the emergency or the initial recovery and is designed to get more precise estimation of costs and intervention needs. Such collection can be carried out by different stakeholders. Depending on the extent of damage, insurance companies decide whether to systematically survey damage or use parametric assessment to speed the process. Often mixed methods are used, as systematic surveys are needed for more complex assets. In this regard a continuity can be found with initial rough assessments that often insurance and reinsurance companies mandate to specialized firms that are able to provide an initial scenario of damage based on the extensive mapping capacity they have of exposed assets and the magnitude, severity and location of the triggering event. When compensation is provided by the state, public administrations at different levels are responsible for collecting damage and loss data and for providing reliable and systematic overview of required resources.

During recovery either further damage and loss data collection is performed to produce final and more accurate estimates or the data that have been already collected during the emergency and the early recovery are structured, organised to be managed by the different agencies and organisations that are in charge of refunding (in the case of insurance) or overseeing reconstruction (in the case of public administrations). In this phase the data are used to assess what can or should be repaired even in case of extensive damage, due to the value of the affected asset, to program priorities and set deadlines.

Ideally recovery is the time when the so called forensic investigation of damage is carried out in order to better understand the causes of the observed damage especially to evaluate the effectiveness of disaster risk mitigation and climate change adaptation measures in place at the time of the event occurrence. The focus is on use cases aimed at supporting policies and improvement of prevention capabilities, so the term “forensic” is not intended in its literal sense. Even though from a methodological perspective the type of analyses may hold some similitudes to the expert counselling in courts (Slosson and Shuirman, 2014), the forensic analysis as intended here serves to decide how and where to rehabilitate and rebuild in a more resilient way that will constitute better prevention to future hazard occurrences. Forensic investigation is often based on a rigorous methodology that permits to elicit lessons learnt from the event, broadening the understanding of the causes and drivers of damage capturing elements of exposure and vulnerabilities that should be be better addressed and/or reduced while reconstructing. Several methodological frameworks are available for the forensic investigation as considered here.

The Forin initiative has been proposed by the IRDR in 2010 (Burton 2010) and then the methodology has been revised and systematized in 2016 after a number of events have been analyzed (Oliver Smith et al 2016). The main objective is to find out the social, political root causes and drivers, intended as those factors such as poverty, corruption, poor practices and poor enforcement capability that are at the origin of the damage suffered during and after severe disasters. Linked to the IRDR initiative, the Centre for Disaster Managment and Risk Reduction Technology (CEDIM) based at the Karlsruhe Institute of Technology in Germany, conducts Forensic Disaster Analyses by rapidly investigating disasters in near real-time through an interdisciplinary approach. Their goal is to support reconstruction after disasters comprehensively but also derive insights for future risk reduction (CEDIM, 2025).

The Perc methodology consists in a thorough analysis of some damaging events as part of the social corporate responsibility mission of the insurance company Zurich (Keating et al 2016). However it clearly aims with the own words of the report guidelines (Zurich Insurance Company 2015) to “develop perspectives on appropriate risk transfer and risk management solutions in flood vulnerable areas, including the pre-requisites for their effective functioning”.

The French REX methodology (here REX means “Return of experience”) that has been discussed above as one form of damage and loss reporting, has as its main objective to shed light on the causes and the mechanisms that produced the disaster outcome.

The German Committee for Disaster Reduction (DKKV) developed in 2012 guidelines for practitioners to analyse events ex post. The event consequences are analysed through the lenses of pre-existing vulnerabilities and risk management capacities (DKKV, 2012). In all cases to be effective the forensic investigation requires more than just the availability of damage and loss data, they require to establish causal relationships therefore relying on some data that are antecedent the disaster and regard the territory as it was at the hazard occurrence.

Therefore, in ideal terms, forensic investigation requires to combine damage and loss data with exposure, vulnerability and risk assessment data that characterize the affected context at the time of the event occurrence. The availability of such data is key also for recovery and reconstruction, as at the very least there must be an understanding of how the extreme event has transformed the landscape and the territories that were affected (see figure 1).

4.1.3. *Use cases for prevention*

Damage and loss data is often reused to support risk modelling, to develop risk models and/or to improve and better calibrate them. Earthquake and flood risk models rely heavily on evaluations and damage estimates carried out in the aftermath of severe events. More recently the whole process from damage assessment and explanation to improvement of vulnerability and damage curves was described in Menoni eta al (2017). Damage and loss data are not used only to improve risk modelling for structures but also to better forecast the response of complex systems to stress, such as critical infrastructures and supply chains. Improved risk models are useful to support recovery and reconstruction but are more widely used by the entire community of researchers and practitioners as part of preventative effort before an extreme event strikes. In this sense damage and loss data are also useful in peace time before the occurrence of any event, as regions may learn from each other not only in terms of improved risk modelling but also regarding what works better under which circumstances as mitigation and adaptation measures. In this regard, in UNDRR (2025) an entire chapter is devoted to evidence based early warning. With the latter the intent is to better tailor early warning on the expected damage being therefore better able to prioritize and reduce damage by early intervention on those assets that can be more easily secured in case of certain types of hazardous events.

4.2. Use cases that are enabled by large datasets.

Both risk models and improved early warning systems must rely on a relatively large number of occurrences. The type of learning from single individual events, as in the case of Return of experience, has significant merits, but it is clear that damage and vulnerability functions or enhanced early warning systems require a statistical analysis of data. Here is where databases with a large number of instances provide the most advantage. This is also why historic databases are used and continuously developed despite some limitations in the quality and comprehensiveness of data related to past events.

Large datasets are also necessary for accounting purposes. Those refer for example to the need to detect trends along time responding to questions such as: has the damage due to certain types of events has actually increased in a given period of time? Or what is the average financial need required by certain regions/countries given the damage claimed and reported in a given period of time? Those questions are important for programming resources at the governmental level or identifying financial gaps with respect to availabilities (for example in the insurance sector).

Another very important use case relates to the reliability of attribution laws of damage to certain risk factors, such as climate change (Pielke 2011). In fact, in the absence of reliable and comprehensive enough data it is very difficult to demonstrate that climate change is responsible for example for the increased level of damage on the built environment. The latter can be explained in fact also on the basis or poor urban planning and the creation of increased exposure and vulnerability overtime to stresses that may be exacerbated by climate change but have always been there (such as floods, landslides or wildfires).

4.2.1. Use cases enabled by cross sectoral damage and loss databases

An important use case that requires both data collected overtime and cross sectoral relates to Sendai reporting or to any other type of accounting at national or regional level aimed at assessing to what extent DRR and CCA have been effective in reducing impact of extremes. In fact, indicators to measure Sendai targets require that data on how much damage to critical infrastructures, economic activities, cultural heritage must be available apart from data on affected population and dwellings. In addition, data overtime are necessary to be able to identify increasing or decreasing trends.

Another example is the emerging discipline of disaster waste management which encompasses innovative and integrated strategies for effectively handling the vast amounts of waste generated by natural or man-made disasters. These approaches are designed to improve capacities to manage sudden waste surges, upgrading waste facilities and build emergency mobile waste units. International data bases could help the collaboration across environmental, engineering, economic and public health sciences (Disaster Waste Management Guidelines | UN-OCHA). [3]

4.3. Use cases in a nutshell

Damage and loss data serve multiple use cases. They provide key empirical evidence on the outcome of extreme events given certain levels and characteristics of exposure, vulnerability, severity of hazards. To unleash their full potential, they require to be combined with other type of data, for example statistical data, maps representing various characteristics of the built environment and hazard distribution. A variety of stakeholders may take advantage of available and accessible damage and loss data: researchers, risk modellers, practitioners. But the collectors themselves may reuse data for their own programming purposes, for improving scenarios on which urban and emergency plans are (or should be) developed, for deciding post-event intervention for more resilient recovery and reconstruction.

The various uses should not be considered in isolation either. As discussed by Walia and Menoni et al (2020), the different uses are connected to each other. In order to better model risk and produce more reliable scenarios and forecasts, the forensic investigation of data is needed to extract lessons learned from multiple events. In their turn forensic investigation requires that data on vulnerability and risks have been prepared before the disaster to assess the quality of mitigation and adaptation.

Accounting is linked to the possibility of improved risk models at large scales or to evidence the role of individual risk components on the damage overtime.

5. Methodology of the mapping

5.1. Search of relevant sources and references

Providing an overview of the current landscape of post disaster damage and loss reporting initiatives is less straightforward than one may consider at first sight, especially when the criteria for a taxonomy provided in section 3 are considered. In fact, different types of reporting and tools must be considered. Hereafter only database initiatives as such will be considered for the mapping. Two types of databases will be considered: those designed with the intent to take stock of past events and those mainly aimed at supporting data collection on the ground for administrative and compensation purposes.

In order to produce the mapping two main sources have been considered: published articles in scientific journals and reports produced by different organisations. Reviews that we could find relate mainly to global databases (Mazhin et al 2021; Moryama et al 2018; Wirtz et al 2014). To our knowledge there are no reviews that attempt to depict the overall current landscape from global to local with the exception of that provided by Grasso et al (2013) in a UNDP report.

As for the former it must be said that literature is not particularly wide. The review has been built on the basis of prior knowledge developed by the consortium and already quoted in previous articles and reports developed in previous related projects. Additional references have been found through ad hoc searches in

[3] UN Office for the Coordination of Humanitarian Affairs (OCHA): https://www.unocha.org/publications/report/world/disaster-waste-management-guidelines (t.b. added to the references).

Google_Scholar using different combinations of key words as shown in Figure 2. The latter in fact summarizes the criteria and the strategies used to identify both published literature and reports written by international and national organisations. Such reports can be distinguished in two groups: reports that reflect on damage and loss data reporting in general providing overviews from different countries and reports that illustrate the functioning of one specific database that has been developed by the organisation that authors the report.

Through this strategy it is believed that most initiatives have been captured, at least those that have been reported in a document that is publicly available. It has been decided to omit initiatives the consortium is aware of but for which no form of publicity is available. Reports have been searched in the following languages: English, Italian, Portuguese, Spanish, French, German.

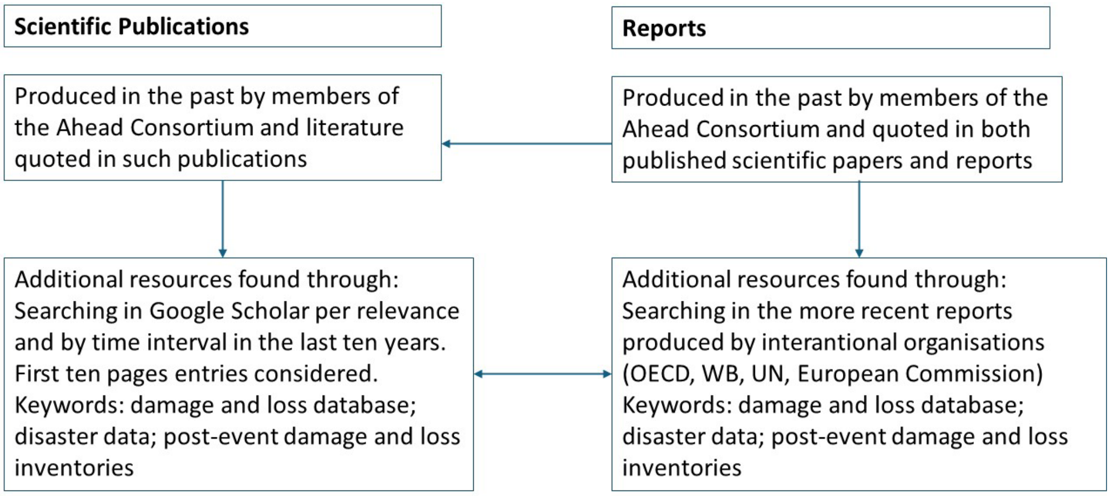

Figure 2. Strategies for identifying relevant databases through scientific publications and grey literature

5.2. Proposed framework for the mapping

Given the criteria considered in section 3 for the taxonomy, a framework has been developed to map the various initiatives as shown in Table 1.

First the Data Curator is defined, distinguishing between governmental, insurance, research institutions and international organisations (such as the OECD, UN, etc.). The second column relates to the hazards that are covered by the database followed by the source of information or the way in which it has been produced; the type of damage and losses that are considered. Finally, data accessibility is considered, distinguishing between fully public, restricted, public but only in some forms, etc.

Data Curator	Sectors	Hazards	Source	Uses	Type of damage	Accessibility
Gov National	All / specific	All /one, which one	Surveys/claims made by affected/secondary sources	Compensation & needs/risk assessment/monitoring recovery/learning recovery/improving	Only direct physical damage to assets; indirect damage in what form (business, service interruption); cascading impacts	Accessible only to the curator/limited accessibility for

				DRR and CCA/accounting/….	and systemic damage	aggreagated data/ accessible by demand…
Gov Regional						
Insurance						
Research Organisation						
International organisation						

Table 1. Framing the mapping of relevant databases initiatives

6. An overview of databases and tools for collecting post-disaster damage and loss data

Following the methodology described in section 4 and considering the relevant criteria for a possible taxonomy, Table 2 has been compiled reporting the most relevant databases that could be found. A choice was made to include also databases that are no longer curated and updated but still accessible. The reason is that they can be useful for analysis of historic data that can be of relevance for different types of uses (risk assessment, accounting).

The table is organised as follows:

- As for the columns starting from the first to the left up to the last the information that is provided relates respectively to the scale at which the database is compiled, the name of the database, the curator, the hazards that are addressed and the granularity (the scale at which data are collected), the accessibility, the covered period, sources of the provided information, use cases of the data and eventual comments.
- As for the rows, the database is organised by spatial level, distinguishing between global databases, examples of European country level, examples of European regional level, and international cases.

6.1. Global databases

One of the most prominent international databases is EM-DAT, the Emergency Events Database, maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at UCLouvain. Since 1988, EM-DAT has compiled data on over 26,000 mass disasters worldwide, dating back to 1900. The database aggregates information from a wide range of sources, including UN agencies, non-governmental organizations, insurance companies, and media outlets. EM-DAT classifies disasters into natural and technological categories and provides standardized data on human and economic losses. Its primary purpose is to support humanitarian action, inform disaster risk reduction strategies, and enable vulnerability assessments at national and international levels.

At the national and regional levels, the DesInventar system, originally developed by the Latin American Network of Social Studies on Disaster Prevention (LA RED), has been widely adopted. It is now supported by the United Nations Development Programme (UNDP) and the United Nations Office for Disaster Risk Reduction (UNDRR). DesInventar databases are curated by national institutions and often integrated into government disaster risk management frameworks. These databases typically include detailed, event-level data on disaster impacts, disaggregated by geographic area, hazard type, and affected sectors. For example, Sri Lanka has used its DesInventar-based system in combination with national survey data to analyze multidimensional vulnerability, providing insights into the social drivers of disaster risk.

Building on the legacy of DesInventar, the United Nations Office for Disaster Risk Reduction (UNDRR), in collaboration with UNDP and the World Meteorological Organization (WMO), is developing the Disaster Tracking System (DTS). This next-generation platform is designed to meet evolving user needs and leverage modern technologies for more robust and interoperable disaster data management. The DTS will replace DesInventar and introduce a more comprehensive approach to tracking hazardous events and their associated losses and damages. It will align with the WMO-approved Cataloguing Hazardous Events (CHE) methodology, enabling the integration of meteorological observations with impact data and cascading effects. By strengthening collaboration between National Disaster Management Offices (NDMOs) and National Hydro-Meteorological Services (NHMS), the DTS aims to enhance the entire value chain of disaster data, from event detection to loss quantification. This integration will unlock new analytical capabilities, improve data quality, and support more effective disaster risk governance.

6.2. National databases

As can be seen in the extended Table 2, national databases can be grouped by two types of initiatives: academic or research led and governmental/institutional led. As for the former an eminent example is provided by the German HOWAS 21. HOWAS21 stands for Hochwasser-Schadensdatenbank and is Germany's national flood damage database, developed and maintained by the German Research Centre for Geosciences (GFZ). It systematically collects and analyzes data on direct economic losses from past flood events, primarily focusing on residential, commercial, and public infrastructure sectors. HOWAS21 is unique in its detailed event-level data, which includes spatial and temporal information, damage mechanisms, and socio-economic context. This granularity supports robust risk assessments and model calibration for flood damage estimation (source: http://dx.doi.org/10.1594/GFZ.SDDB.HOWAS21 and https://doi.org/10.1002/9781119217930.ch5)

Unlike broader international databases such as EM-DAT or DesInventar, HOWAS21 is so far tailored to the German context, offering high-resolution data that is particularly valuable for regional planning and scientific research. It complements emerging tools like DTS by providing a long-term empirical foundation for understanding flood impacts and enhancing disaster risk reduction strategies.

All these databases on different scales serve multiple purposes. They are instrumental in identifying trends and hotspots of vulnerability, informing policy and investment decisions, and supporting international reporting obligations such as those under the Sendai Framework for Disaster Risk Reduction. Moreover, they enable the quantification of economic and social losses, which is critical for insurance modeling, climate adaptation planning, and post-disaster needs assessments.

Together, databases like HOWAS21, EM-DAT, DesInventar, and the emerging DTS exemplify the importance of robust, curated disaster data systems at different scales. While EM-DAT offers a global overview suitable for comparative analysis and international coordination, DesInventar and DTS provide granular, context-specific data that support localized risk reduction and resilience-building efforts, whereas HOWAS21 is a national database with event specific information. These systems underscore the need for consistent data collection, institutional commitment, and cross-sectoral collaboration to ensure that disaster loss and damage data effectively inform decision-making and reduce future risk.

Recently the JRC (2025) published a report discussing the result of 18 responses to a survey questionnaire that was distributed to all Member States and to UCPM associated countries. The questionnaire was sent to official authorities in charge of damage data collection who are part of the civil protection system or related to it. Therefore, only data management systems run by administrations or governmental authorities are considered. The questions partly overlap with the indicators considered here in table 1. The situation that is depicted by the report is varied. In general, the replies reveal that only few countries have a structured, well organised, fully functional system for collecting and analysing damage and loss data. This does not mean that damage and loss data are not collected, but that their storage and maintenance is not structured nor following established procedures.

The case of Slovenia still represents an important exception. The Ajda system run by the Administration for Civil Protection and Disaster Relief is in place since 2003 is used to collect data at asset level for natural and industrial disasters. The system connects damage and loss data to other databases in particular to the cadaster and to updated datasets on prices for material and repairs. Such functionalities enable the production reports of disasters including compensation needs in a short time. Initial claims made by owners are checked by civil protection officials especially when more precise and accurate information is needed. The system is not publicly accessible, given also the privacy issues related to the cadastral information. No information has been found though on the use of such rich datasets for modelling and forensic purposes.

Some countries, like Austria, are very active and in the process of developing a functional system coordinating data among different authorities and institutions, however it is still in the making. The website exists and refer to some datasets that are available but there are still some crucial steps to be accomplished to coordinate data from multiple sources. A similar situation is shared by Finland, that can rely on databases on damage to the power system, incidents managed by the civil protection that are increasingly shared but still do not provide access to coordinated data from multiple sources. The main dataset is still the Pronto database run by the Ministry of the Interior and operated by Emergency Services Academy Finland. In Finland there are evidence supported by scientific publications and reports that data are used also for risk modelling, forensic and for damage base early warning.

The Norwegian Knowledge Bank is an interesting joint initiative of Norway Finance managing insurance against natural calamities and weather extremes, the Norwegian Directorate for Civil Protection that manages the web portal, and the public bodies of the Norwegian Water resources and Energy Directorate and the Norwegian Meteorological Institute. The Knowledge Portal has been identified as a best practice in multiple reports and articles. It certainly is a relevant example of the added value of insurance data to complement public data to identify areas that have been repeatedly affected by natural extremes and as a consequence reimbursed by insurance when assets were insurable and insured. The initiative aimed at supporting local governments in their adaptation and risk management policies. It provides a rather unique example in which historic data from past events (recorded by insurers since 1980) are constantly updated and mixed with data from public administrations on post disasters compensation. It certainly constitutes a unique example where resistance by the insurance industry to share data for public interest and for prevention has been overcome. The Knowledge Base is not open to the public, though, it can be consulted only by governmental officials.

6.2.1. Example of a regional database

Ra.S.Da., or Raccolta Schede Danni (Damage Sheet Collection), is an online platform used by the Civil Protection Department of Regione Lombardia, Italy, to manage the collection of data on damage caused by relevant natural events. The interface takes a multi-page form that are filled by local public administrations with damage data related to assets affected in their territory.

The main objective of such a tool is to provide a rapid post-event assessment, allowing users to collect data within a week following the impact. After the one week deadline, local administrators cannot create new reports. In fact, the provision of timely information, albeit rough, is crucial for the assessment of the impact and the efficient allocation of resources on the territory in the immediate aftermath of an event. In addition, the Ra.S.Da. forms collected are also used as a first source of information for the next steps in the management of the crisis, such as the definition of compensation measures for the affected population. Forms are structured in such a way as to report damage that can be refunded by National Civil Protection Department according to legislation in force, i.e. the Civil Protection Act (D.Lgs 1/2018). Ra.S.Da. collects the necessary information for the National Government to declare a state of national emergency. Reported damages is validated through in-situ inspections by the officials of the territorial office of Lombardy Region once the national emergency is declared by the Council of Ministers.

A regional Decree issued in 2008[4] establishes the modalities and the data that must be collected and transmitted from municipalities to the Regional Government and from the latter to the National Department of Civil Protection. Following the prescriptions of the Decree, first, a set of general information is requested to frame the kind of event, a synthetic description of the damages to private assets and infrastructures. The subsequent sections are organized upon different typologies of data or intervention necessary to overcome the emergency conditions, which are distinctively addressed by specific Italian Civil Protection procedures. In Section a. the user declares whether rescue measures and assistance to the population have been carried out, along with an initial estimate of costs an description of the measures. Section b. focuses on urgency interventions, once more to be described and associated to an expense report. Section c. is devoted to damages reported directly by population and economical activities; in this case the level of detail of the estimate is not particularly accurate, because the National contribution would be based on further damage recognition with ad-hoc procedures. The last two sections are oriented to the undertaken measures for reduction of residual risk and possible further necessary interventions that cannot be classified in the preceding sections.

Ra.S.Da. is a constantly evolving tool; it was first implemented in 2003, but has adopted its current interface since 2021, after which multiple updates have been developed. The most recent and relevant is the compulsory request for the user to geolocate (by the means of a wizard) both the event area and the occurred damages, so to provide a more accurate overview of the geographical impact of the event. Furthermore, the so-collected data are also meant to be conveyed into regional geospatial databases and on additional platforms devoted to damage data collection, such as the National Flood Data Catalogue (FloodCat), developed by Italian Civil Protection Department in compliance with EU Floods Directive 2007/60.

6.3. An overall analysis of the current state of the art of damage and loss databases (as depicted in table 2)

The landscape resulting from the mapping in Table 2 is of rather fragmented and very diverse initiatives across spatial levels and geographic areas. At the global level databases pursue an all-hazards approach, whereas at the country level damage data collection more often than not target single hazards only. In general, the granularity is rather coarse with few initiatives that are actually at the municipal or asset level. With respect to similar mappings done in the past however, a tendency towards more consistent approaches and wider coverage in terms of affected sectors can be noticed, especially when it comes to the level of some European Member States that are currently investing in developing such databases. The interaction and interrelationship across levels is difficult to understand, in some cases regional level databases are available but their national counterparts are not or not accessible or structured enough.

The landscape is still in the making, with prior initiatives continuing, other evolving towards different models, and new ones that nevertheless still struggle to be completed and fully available. Three types of main actors undertake damage and loss data collection and use: insurance, public administrations and entities at various levels (including in this group also agencies and operators that may be only partly public but still of public relevance such as infrastructures), and academia. The latter has an important role in some countries and with respect to some experiences that are ongoing since long time and therefore providing a precious resource for analysis and modelling. Those are for example HOWAS in Germany, Sheldus in the USA, Dalih (Romão et al

[4] D.g.r. 22 dicembre 2008 - n. 8/8755 Determinazioni in merito alla gestione della post-emergenza e all’assegnazione dei contributi (art. 2, comma 1, lettera b), l. 225/1992)

2023) that has an international coverage albeit being managed by a national university. EM-DAT is perhaps the most eminent example of international database run by an academic institution. Whilst the objective that is shared by those initiatives is clear: provide access to researchers and analysts relevant data on damage and losses that can be used for multiple types of scientific use cases, they display varying levels of trustworthiness and reliability, as they often have to rely on secondary data. In this regard HOWAS is an interesting exception that has made a huge attempt to collect data through direct surveys.

Whilst it is reasonable to expect that procedures and methods for damage data collection by public authorities and insurance companies be more systematic and structured, the analysis of the different cases and the results of the JRC (2025) Report suggest that the situation is not that straightforward. The first important aspect is the existence or lack of a legal framework that not only mandates post disaster damage data collection but also prescribes a methodology. This is the case for example of Slovenia (with a 2003 decree) and Norway (with the addition on data and information for civil protection purposes in 2021). A legal framework addressing specific methodological aspects and formats of reporting has been introduced in 2008 in Lombardy for the Rasda procedure. In cases where a specified format and methodology exists, the collection of damage and loss data follows a standardized procedure and the same type of data is collected for each event, making intertemporal comparison possible. In cases where such formalization does not exist, even where data are collected according to an ambitious scheme, like in Austria, there are more difficulties in developing a framework and in getting data after each event. The Cesare system in fact, that, according to its website is still under development, has accomplished agreements with a number of bodies collecting damage and loss data as well as are responsible for statistical data, however they probably encounter difficulties in establishing how the data deriving from multiple sources can be structured and managed in a coherent and meaningful way.

Finland is somehow an intermediate case, in which some data are collected by civil protection authorities and in their Pronto Portal data are collected and available, but as for other type of data multiple sources exist and bodies such as the Finnish Meteorological Institute, a public body that provides weather and meteorological forecasts for a variety of use cases, uses data to carry out research in multiple domains related to weather and climate. The need as in the Austrian case to coordinate data from multiple sources does not permit an easy shortcut to the development of a comprehensive, working, and manageable information system.

In many cases, such as Italy for example, data is collected and also in a rather rigorous way by public authorities as the State is the principal compensator in case of natural disasters given the very low penetration of insurance. However, a working framework for not only collecting data but also make them reusable for multiple purposes does not exist yet at the national level. The Da.Do experience is an interesting example of secondary use of damage data that derive from usability assessment (Dolce et al 2019). An instrument that is mainly addressing scientific and research needs but with the aim of improving modelling and evaluation of mitigation measures, therefore supporting at the end an evidence and science base policy.

Overall, the situation is rather mixed, with different initiatives, pursuing differential goals, by different organisms with differing mandate and goals. Some novelties have emerged in the more recent years, in terms of stronger determination by governments and administrations not only to better standardize and organise the damage data collection and use for compensation and resources allocation but also for other purposes. The use cases discussed in section 4 are starting to be perceived as relevant as they are also connected to some legal obligations and/or international agreements such as the Sendai targets.

7. Challenges in developing and maintaining damage and loss databases

As results from the analysis, and as can be seen in Table 2, developing a database is not a problem and in fact the landscape is quite rich in initiatives. However, there are many constraints when it comes to a database that must serve the activities of governments from initial estimates to needs assessment, resources allocation and final compensation updates. Additional constraints and limitations exist in the type of other use cases that are actually implemented by different organisms that collect such data.

The constraints, difficulties and limitations take many levels in fact, from procedural/administrative, to the existence and nature of mandates, to the actual degree of digitalization of administrations that is still very diverse across countries and regions, to the availability of functional information systems able to support the variety of use cases. Such levels will be discussed hereafter.

7.1. Existence and nature of legal frameworks and mandate

The existence of a legal framework and clear mandate for some organisations to collect damage and loss data is an important pillar of the most advanced practices. The reason is also that often such framework provides guidance to collect such data in a standardized fashion responding to certain requirements. One problem that current legal frameworks do not always solve is the cross sectoral nature of the collection that is never carried out by a unique authority but rather by a multiplicity of administrations, bodies, and organisations. The framework does not always require that datasets from different organisations be interoperable and accessible through a unified system. On the other hand, systems that are conceived in such a way, as for example the cases of Finland and Austria, struggle to overcome the constraints of data sharing across different organisations. Each organisation may well have a legal framework to collect the data, but not necessarily to share it with a sort of coordinating body.

Sharing disaster loss data between private institutions and government researchers poses several challenges, primarily due to concerns over data confidentiality, commercial sensitivity, and legal liability. Private entities, such as insurance companies, utility providers, or infrastructure operators, can be reluctant to disclose detailed loss data that could reveal vulnerabilities, affect market positions, or lead to regulatory scrutiny. The lack of clear legal frameworks for data sharing, and different institutional priorities on this issue can hinder collaboration and the ability to obtain a comprehensive view of the overall disaster impacts. In this regard the Knowledge Bank in Norway is a relevant exception.

7.2. Clarity on what type of data must be collected and managed

There is a balance to be stricken between the completeness and comprehensiveness of damage and loss data one would like to have to fulfil all possible use cases and the cost, in terms of effort, time, and money needed for this purpose. A modular approach may prove itself, as additional types of data and functionalities can be added overtime as new needs become more pressing. In fact, often such procedures start with collecting data on damaged assets that must be repaired or compensated, but then extends to other type of impacts, such as loss of working hours, disruption of supply chains etc, especially when economic activities are affected. In this regard, the absence of standardized methodologies for collecting, classifying, and reporting disaster loss data is a critical challenge as reported also in the JRC (2025) report by many responding institutions. Terms such as "direct loss," "indirect loss," "economic loss," and "non-economic loss" are often inconsistently defined or applied across agencies and sectors. The lack of common metadata standards undermines the ability to make comparisons across events and sectors.

7.3. Procedural and administrative constraints

Digitalization is still insufficiently developed in public administrations and this creates significant obstacles in the development of stable, maintained and easy to query archives. Skilled personnel is needed to input data and query systems. In addition, data awareness is still not so developed across administrations and in some cases nor in insurance companies. The added value of well maintained and functional databases is not sufficiently perceived by officials who are often reluctant to fulfil the task of collecting damage and loss data in a systematic fashion that is a time consuming activity. Excel files and pdf are still used in many instances, as other practices conducive to errors and inefficient data management. Whilst local governments are often considered the key base level at which such data should be collected, there is lack of training, motivation for officials. In addition, the possibility offered by modern ICT to better involve citizens in the collection is insufficiently explored. Legal constraints and lack of procedural clarity often does not allow such involvement that could be beneficial, if only the management across different levels of government and organisations were designed more flexibly and adaptable to contextual needs.

7.4. Availability of ad hoc working tools

Developing a database is not difficult per se; however not any database nor information system will work for what is after all a rather complex task. In fact, the information system that is needed must be able to integrate data from multiple sources, be queried to serve a variety of use cases, and, perhaps most importantly, be maintained overtime.

The sustainability overtime of information systems is a key weakness of one shot projects that are not embedded in an administrative procedure following a clear mandate that will require personnel to be hired for maintaining and improving the system itself.

The most successful experiences are like that, whilst one time projects, independently from their quality, risk to fail after somewhile if they are not able to become part of a more ordinary procedure.

Another aspect that should not be underestimated, regards to complexity of the design of a functioning database that must be cross sectoral. For each sector in fact, different components, different assets have to be considered. Damage to each component and asset is not necessarily alike from one sector to another, meaning that careful data modelling must be carried out for each sector. In order to be queried for multiple purposes, a relational database is needed, one which makes explicit in its structure the possible relationships among components, assets, sectors. In addition relevant relationships must be modelled also across different types of damages, such as for example between direct and indirect damage, but also physical damage to assets and damage to intangibles (as in the case when cultural heritage is affected). The time and effort needed for the design of the database is often underestimated leading to a situation where data are available but it is not that clear how and where to store them in the system in a meaningful way.

The process that is followed for the design of information systems is also relevant. As discussed by Lien Lievne et al (2023) for the Norwegian Knowledge Bank, it is not enough to better involve stakeholders in the initial phase of requirements elicitation and even not in the later testing phase. As suggested by Faiella et al (2022) stakeholders should act as knowledge domain expert and guide the coding and the development of the system at each stage. Finally it should be also mentioned that needs are also evolving, new ideas arise seeing what a system can do and accordingly new demands have to be met. It is an iterative rather than a one forever process that requires though that an administrative structure be in place.

An important aspect that has been raised by users of the Knowledge Bank is the limited possibility to overlay data from multiple sources, that is the maps on compensated losses with hazard maps of maps on damage to public assets that were not insured. The possibility to complement different types of data as shown in figure 1 is key as it permits to develop more reliable assessments of risk and mitigation needs. To a certain extent, also knowing what has not been damaged, comparing the damaged areas to those that have not been affected is important for forensic investigations. There must be the possibility to explain why certain areas and assets were damaged and other equally exposed were not. For governance purposes, such gaps can lead to misinformed decisions about resource allocation, risk prioritization, and the effectiveness of risk management measures. Being able to manage jointly different datasets on damaged assets and infrastructures, on exposure, vulnerability and risk assessments carried out before the event would be crucial. By now a significant amount of such assessments are already available on flood prone areas, following the obligations of reporting for the Flood Directive. Having the possibility to compare such maps with maps of flood caused damage and losses would provide essential information on eventual pitfalls of available risk

assessments, on the gaps in multi-hazard assessments and would better support future policies and investment in disaster risk reduction and climate change adaptation.
In this regard, the capacity of information system to support the collection and analysis of cascading events is still limited. The data model should foresee the possibility to link one hazard to another in generating compound damage. The EM_DAT database claims to be providing also information on compound events, however from a test that we conducted, such functionality is still very limited. Future projects aimed at designing enhanced information systems should take interconnected impacts into greater consideration. Compound hazards can in fact blur the boundary between losses of different events, making attribution difficult and increasing the possibility of double counting or underreporting. Temporal and spatial overlaps between events complicate loss data timelines and geographic delineations, in particular when different sectors collect losses independently, without integrating their interdependencies.

7.5. Reliability, quality and ethical concerns

The systematic and consistent collection of disaster loss data for different uses also requires processes to characterize their reliability and quality. Therefore, the collected data should be characterized by a measure of its uncertainty to express its quality for a given purpose. Most loss databases do not provide such uncertainty/quality measures due to the lack of a simple and consistent approach to express uncertainty. The concern over the quality of insurance data provided by the Norwegian Knowledge Bank is an example. Interviewed officials (Lien Lievne et al 2023) expressed their concern based on checks they had made on the quality of data provided by insurance companies.

On the other hand, there must be a certain understanding that absolute quality and objectivity is a chimera as stated by Handmer (2003). Different figures are often taken as interchangeable to measure damage but in fact they are not. For example, even considering official data, money that has been granted may be just reflect substitution or repair costs to the pre-event condition or instead embed a quota for amelioration, which actually would be more consistent with resilient recovery objectives. However, this latter figure does not represent perfectly what has been lost, as it also embeds a quota for improvement, that is so to say "independent" from the impact of the event.

Several loss components are quantified in monetary terms, but certain components (e.g. social, environmental, and cultural losses) are often qualitative, subjective, or expressed through non-monetary metrics. Integrating qualitative data with economic data requires novel approaches to obtain a holistic view of disaster impacts.

Loss data should be able to inform risk modeling, urban planning, and resilience strategies. However, if data is overly aggregated or lacks disaggregation, its utility for planning targeted interventions is limited. However, collecting disaggregated or sensitive data can raise ethical concerns, and data sharing requires adequate data anonymization and informed consent procedures to be in place to prevent data misuse. Inadequate handling of these situations can erode trust in data managing entities and lead to underreporting or data manipulation in future events.

8. Conclusions

The request of mapping of relevant initiatives that has been mandated by DG ECHO for funded projects has been interpreted by the Ahead Consortium as related to the current landscape of damage and losses databases at the European and international level. In order to accomplish such mapping, the Consortium has grounded on past results of projects, on the experience gained in the field at the various scales by individual members, on more recent reports and literature. The result can be seen in table 2 that covers different aspects that have been considered relevant in the methodological section 5. It has been shown how existing databases differ for their main objectives, for the mandated and curating organisation, distinguishing between academic, governmental and insurance initiatives. The use cases that such data can serve independently from the original initial mandate have been also discussed in section 4 and in the brief illustration of various initiatives. Some discussion and conclusions from the comparison among different databases have been drawn in the last part of section 6 and in section 7. They lead to the conclusion that there is still the need to develop an information system that will serve different purposes and use cases at the same time, taking advantage of recent achievements of data science. In particular, relational databases are able to support multiple queries and to make explicit the interlinkages between assets, hazards, types of damage that may be related to each other. The design of relational databases to embed the knowledge on such relationships requires the full implication of experts of different sectors able to model what damage to each sector and sub-sector mean and what are the vulnerabilities and the exposure conditions that lead to such damage. There is the need of an information system that is interoperable with others to take advantage of the multiple layers of information on hazards, exposure, vulnerabilities that usually exist on assets and geographic areas at least for some hazards that could be overlayed with data on damage and losses. This is the objective of the Ahead project and is also an important driver of the development of the damage and losses module of the Risk Data Hub under construction by the JRC.

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Table 2. Analysed databases

Spatial scale	Name, country (&region)	Data Curator	Covered hazards and granularity	Covered sectors	Covered period	Accessibility	Source of the information on the database/tool	Database use	Comments
Global	Desinventar	UNDRR	All hazards Country level (with reference to the area where the even occurred)	Fatalities, Injured, Estimated economic losses	Depends on the country	Public	Data from official government sources of the different countries	Insurance and reinsurance companies, Privat Sector, Public Institutions, Scientific Institutions	Currently under revision to produce a different type of damage reporting
	EM_DAT	University of Louvain	All hazards Country level (with reference to the area where the event occurred)	Aggregated estimation of losses/event	1900-now	Public	A large literature covers the features of this database including Curator's publications	scientific	It is the most widely referred to in scientific literature despite some shortcomings related to data gaps and reliability of figures related to certain events.
	Nat_CatSERVICE	Munich Re	All hazards Country level	Fatalities, estimated economic losses	1980-now	restricted to reinsured operators	The sources of the database are mainly insurance and reinsurance periodicals, internal reports, Lloyd's list, online database and news	Insurance and reinsurance companies, Privat Sector, Public Institutions, Scientific Institutions	
	Sigma	Swiss Re	All hazards Country level	Fatalities, insured, estimated economic losses, missing persons	1970 – now	Public	Records are completed from information gathered through internal reports primarily and through external organizations. The database has closed accessibility. Reviews with essential information are published yearly.	Insurance and reinsurance companies, Privat Sector, Public Institutions, Scientific Institutions	
	DALIH	University of Porto (Portugal)	All Hazards Country level	Cultural Heritage	2000-now	Public	Online data that includes post-disaster surveys, damage and loss accounting reports, social media and news sources. In addition, data collected by experts on site is also included.	Mainly for research and accounting purpose with respect to the cultural heritage sector	It is an initiative that has been started and is maintained by a research group sponsored by a number of international organizations.
Europe	Italy: Da.D.O.	Civil Protection Department (developed by EUCENTRE)	Earthquakes, single buildings	Ordinary buildings and churches (damage levels)	1976-2019 (data related to the single events in Italy)	Restricted to authorized researchers	Data from the official forms filled after each seismic event to assess the usability of buildings and churches (e.g.: for buildings the AEDES) https://egeos.eucentre.it/danno_osservato/web/danno_osservato?lang=EN (Ref.: Dolce et al. 2019)	For scientific purposes only	The web-gis platform includes all the data collected in the forms, elaborated and standardized. Vulnerability measures and data about the events (PGA and Macroseismic data) are collected too. All the data can be observed and queried in the web-gis maps or downloaded (.csv files).
	Italy: AVI	CNR (National Research Council)	Floods and landslides	Fatalities and rough description of damage to different sectors	Past (mainly since late 1700) to the	Public	It is a collection of different datasets, covering historic data	Media, research papers, research activities	The result of a large research effort that has not been finalized

Europe					Nineties (last entries 2002				
	France	CCR (French Public Reinsurer)	All hazards Municipal level	Housing, cars, professional assets and economic losses	1982 - now	Public	CCR https://www.ccr.fr/	Public Reinsurer of the CATNAT mechanism	
	Spain	CCS (Spanish Public Insurer)	All hazards, Municipal level	Houses, economic assets, vehicles	The CCS was established in 1954	Restricted (can be obtained upon specific requests)	The Database is not public. In the last years there has been wider access for specific purposes (research)	Public Insurer	Consorcio de Compensacion de Seguros is the oficial name. Classification by damage type (personal, property, loss of profit) and type of property (housing, shops and stores, business offices, industry, public infrastructure, vehicles)
	Slovenia	AJDA (run by the Administration for Civil Protection and Disaster Relief)	All natural hazards, Municipal level	Agriculture, buildings, infrastructures	2003-2025	Open	Some scholars have used it for risk modelling, forensic purposes (see Vidmar et al 2019)	Government	It is considered as a best practice in Europe
	Germany: Howas21	GFZ (German Research Centre for Geosciences)	Floods	Private households, Commercial and industrial, Public thoroughfare, road and transport infrastructure, Watercourses and hydraulic structure, Agricultural and forested land, Urban open spaces	2005 - now	user-community concept: organisations that provide an flood damage data in appropriate quantity and quality for HOWAS21 will get full access to all data via the web site	The following institutions have provided data for HOWAS 21: • Deutsches GeoForschungsZentrum GFZ (https://www.gfz-potsdam.de) • Universität Potsdam (https://www.uni-potsdam.de) • Deutsche Rückversicherung AG (https://www.deutscherueck.de) • LAWA Bund/Länder-Arbeitsgemeinschaft Wasser (https://www.lawa.de) • alpS - Zentrum für Naturgefahren und Risikomanagement GmbH (http://www.alp-s.at) • Deutsches Institut für Wirtschaftsforschung e.V. (https://www.diw.de) • Hydrotec Ingenieurgesellschaft für Wasser und Umwelt mbH (https://www.hydrotec.de) • JBA Risk Management (https://www.jbarisk.com) • Landeshauptstadt Dresden (https://www.dresden.de) • Leuphana Universität Lüneburg, INFU - Institut für Umweltkommunikation (https://www.leuphana.de/institute/infu.html) • Riocom Ingenieurbüro für Kulturtechnik und Wasserwirtschaft (https://riocom.at)	support forensic flood analysis and the derivation of flood damage estimation models	HOWAS 21 - das webbasierte Informationssystem zu Hochwasserschäden in Deutschland

Europe							• Risk Management Solutions, Inc. (https://www.metricstream.com) • Swiss Reinsurance Company Ltd (https://www.swissre.com)		
Europe: regions	RASDA, Lombardia (Italy)	Regional Government	Natural Hazards	Public and Private Buildings, Infrastructures	1997-now	Restricted	Regional Government description and a couple of reports that mention it	compensation, risk assessment	
USA	Sheldus	Research. Arizona State University	All hazards County level data	Death toll, damage to different sectors	1960-2023	Public for aggregated data, by payment for event and not aggregated data	Multiple governmental sources (including the NOAA Billion Climate disasters	Multiple uses, mainly addressing research type of uses	
	NOAA Billion $ climate disasters	NOAA	Weather and climate extremes	Death toll and rough description of damage to sectors	1980-2024 (closed by Federal decision in 2025)	Public	https://www.ncei.noaa.gov/access/billions/	As described in the website, "is intended to show the impact of extreme weather and climate events on the economy in inflation adjusted dollars", mainly for accounting purposes	
Australia	Risk Frontiers Database	Australian Institute for Disaster Resilience	All hazards	Number of victims and a text description of events mapped in a Web_GIS platform	1875-2025	Public	https://knowledge.aidr.org.au/disasters/	It collects historic data about emergencies. It does not address specific uses	The curator is partnered by the Australian National Emergency Managemen Agency and by the Australian Red Cross. In the landing page it is said that the list of considered emergencies and disasters is not exhaustive. Calls for the collaboration of anyone who could provide information according to the portal standards.
Canada	Canadian Disasters Database	Public Safety Canada	All hazards including wars and technological disasters	Number of victims and affected people, estimation of costs in a Web_GIS platform	1900-2025	Public	https://www.publicsafety.gc.ca/cnt/rsrcs/cndn-dsstr-dtbs/index-en.aspx	It collects historic data about emergencies and disasters. It does not address specific uses	Public Safety Canada is a governmental Agency. It also collects data about emergencies abroad in which Canadians were involved.