Systematic Review

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# Worldwide disaster loss and damage databases: A systematic review

**Sadegh Ahmadi Mazhin[1,2], Mehrdad Farrokhi[1], Mehdi Noroozi[3], Juliet Roudini[1], Seyed Ali Hosseini[4], Mohammad Esmaeil Motlagh[5], Pirhossein Kolivand[6], Hamidreza Khankeh[1,7]**

*[1]Health in Emergency and Disaster Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, [2]Department of Nursing and Emergency, Dezful University of Medical Sciences, Dezful, Iran, [3]Social Determinants of Health Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, [4]Department of Occupational Therapy, Social Determinants of Health Research Centre, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, [5]Department of Pediatrics, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, [6]Shefa Neuroscience Research Center, Khatamol Anbia Hospital. Tehran, Iran, [7]Department of Clinical Science and Education, Karolinska Institute, Stockholm, Sweden*

**Address for correspondence:**
Prof. Hamidreza Khankeh, Health in Emergency and Disaster Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.
E-mail: hamid.khankeh@ki.se

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**Abstract:**

Nowadays, disaster databases have become a valuable tool for disaster risk management and health promotion and serve various purposes. The purpose of this study is to provide a systematic review of disaster databases in the world and to identify the objectives, information sources, criteria, and variables of disaster data registration in the world's reputable databases. To conduct review, all English-language articles published without a time limit until the end of September 2020 were extracted from the databases of Web of Science, PubMed, Scopus, Cochrane Library, Science Direct, Google Scholar, and Embase. Necessary information in the papers including study time, type of disasters, related databases, dimensions and indicators of global and regional databases were extracted by using a researcher-made questionnaire. A total of 22 studies have been reviewed to identify the dimensions and indicators of disaster databases worldwide. The main focus was on global and regional databases, mostly used at the level of scientific societies and disaster experts. After explanation, researchers highlighted each of the disaster databases, along with the main differences available among the existing databases. Some databases have well-defined data collection methods. Their knowledge is high quality and they can be used to create and improve a disaster database at other levels. Disaster database limitations include risk bias, time bias, accounting bias, threshold bias, and geographical bias. To support the right decisions to reduce disaster risk, it is necessary to complement existing global, regional, and national databases. Countries need to take action to set up national databases.

**Keywords:**

Database, disasters, emergencies, natural disasters

## Introduction

The third world conference on disaster risk reduction was held in March 2015 in Sendai. At that time, a new disaster risk reduction framework called the Sendai Framework for Disaster Risk Reduction (SFDRR) was adopted by 187 countries and included seven global targets. This new framework will apply between 2015 and 2030. In addition to the worldwide document, the post-2015 Sustainable Development Goals (SDGs) were adopted in September 2015 with 17 global goals and 169 goals. These goals include reducing mortality, reducing the number of people affected, and reducing the direct economic damage caused by disasters. Providing accurate information on human impacts and disaster-related damage is critical to measuring and monitoring these objectives.[1,2] Member states are required to monitor and report disaster damage. Many developing countries face a lack of capacity and institutional frameworks to record disaster damage and have not enough historical data in this regard.

Disaster damage data are hugely significant to support disaster risk reduction decisions and public health promotion. Ideally, data should be standardized and recorded using



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a standard global method.[3,4] According to international documents, the ideal database in the field of human impact and disaster damage is a database that provides information in a stable, continuous, reliable, and accessible form and can be used for decision-making and policy-making in the field of disaster risk reduction. In general, the purposes of creating and using disaster damage databases are as follows:

1. Conducting disaster relief, recovery, and reconstruction programs (physical damage and its economic equivalent provide a basis for identifying the financial needs of recovery and reconstruction)
2. Assessing the risks of future disasters. Due to climate change and the growing trend of social hazards and changing vulnerability patterns, past damage is not a complete indicator for estimating future damage, but primary data on the past disasters for validation, calibration, and creating vulnerability curves in the future damage assessments and estimations are essential
3. Estimating the economic viability of investments made to reduce losses
4. Following up, monitoring, and evaluating the patterns and trends of human impacts and disasters to achieve the international goals set in disaster risk reduction (international policy frameworks in the field of disaster reduction and climate change such as SFDRR and United Nations Framework Convention on Climate Change [UNFCCC])
5. Performing thematic analysis (e.g., gender differences in mortality rates and damage assessment in specific sectors).[5-7]

The details and dimensions of disaster data must be combined into a set of descriptive terms and figures called metadata; this combination will enable us to record the data in a database and display its various trends and aspects. Disaster databases have become a valuable tool and serve various purposes, from risk assessment in the insurance business and socioeconomic analysis to provide the basis for decision-making to reduce disaster risk and public health promotion. Various scientific institutes use these banks, researchers, national and international governmental and nongovernmental organizations, the media, and of course, the financial and insurance sectors.[8]

According to the global lines drawn on disaster management, each country should have its national database on natural disasters. However, such databases still exist in only a few countries. On the other hand, some sources did mention that one of the reasons for the high vulnerability of developing countries in the face of disasters is the low quality of databases in the field of disasters.[9,10]

To minimize uncertainty and increase the quality of disaster statistics and information, global and national database providers must use common standards and definitions. Fortunately, fundamental steps have already been taken in this direction: The consensus, classification, and terminology defined through natural hazard by global data banks and related organizations such as United Nations Development Programme (UNDP) and Asian Disaster Reduction Center (ADRC). Initiatives are currently underway to develop the guidelines for geocoding and to define human casualty indicators. The next steps in improving the quality of disaster-related damage documentation should focus on accurately determining the categories of losses such as economic losses, indirect losses, and subsequent losses. Although the complexity of economic impact indicators is undoubtedly a challenge, joint efforts should be made to engage database operators and data providers, economists, and organizations involved in disaster loss assessment to enhance disaster loss data.[11]

A disaster database review paves the way for recommendations for the development and coordination of disaster databases by identifying gaps and analyzing the methods used by existing information systems.[12] The purpose of this study is to provide an overview of the disaster damage database in the world and to determine the objectives, criteria, and variables of disaster data registration in the world's reputable and scientific databases.

## Martial and Methods

The present study is a systematic review of the dimensions and indicators of disaster databases worldwide, which was performed according to the PRISMA guidelines for systematic review and meta-analysis studies.[13] All stages of research, including search, selection of studies, quality assessment of articles, and data extraction, were performed by two researchers independently (The criterion for researchers' agreement is the quality of articles based on the tool used. If the article does not get the required score in separate reviews, it will be reviewed by a third researcher).

### Data sources

To conduct this review study, both bibliographic and citation databases were considered as the primary sources of our data. In this regard, in the initial search, all English-language articles published without a time limit until the end of September 2020 were extracted during searches in the databases of Web of Science, PubMed, Scopus, Cochrane Library, Science Direct, Google Scholar, and Embase. Moreover, books, academic websites, documents, and credible reports of international organizations involved in disaster management were reviewed and searched based on the purpose of the study.

### Search strategy

Researchers searched all articles with Medical Subject Headings (Mesh); the following keywords and terms were searched accordingly.

In a database that had operators (AND, OR, NOT), they were selected from the relevant location on the site. Moreover, operators were not embedded with keywords.

TS = ((disaster* OR hazard* OR catastrophe* OR earthquake* OR volcano OR mass movement* OR storm* OR flood* OR extreme temperature* OR drought* OR wildfire* OR wildfire* OR rockfall* OR landslide* OR avalanche* OR subsidence OR storm surge* OR heatwave* OR heatwave* OR cold wave* OR cold wave* OR extreme winter condition* OR inundation* OR windstorm* OR man-made* OR Mass casualty incident* OR bioterrorism* OR outbreak* OR Accidents OR Event* OR Emergency*) AND (catalog* OR collection OR database* OR inventor* OR compilation*) AND (impact* OR loss* OR dead* OR death* OR killed OR affected OR injured* OR homeless OR displaced OR relocated OR victim* OR fatality* OR casualty* OR mental health OR morbidity OR mortality).

Timespan = All Years.

Search language = English.

### Inclusion criteria

All English-language articles in the field of disaster databases, which were published in the world's academic journals within the specified time frame, mentioned the dimensions and indicators of the databases and were of good quality (according to the Strengthening the Reporting of Observational Studies in Epidemiology [STROBE] checklist, articles with a higher score have a higher quality), were included in the study. Narrative studies that spoke about the dimensions and indicators of these databases following the research question were also included in the study.

### Exclusion criteria

Exclusion criteria included articles that did not meet the desired quality. Beyond, review studies, narratives, meta-analyses, case reports, or series of cases that did not examine the dimensions and indicators of databases were also excluded from the study. Articles published in non-English languages were excluded from our research, too.

### Quality assessment of articles

The quality of the articles was assessed using the STROBE checklist.[14] This checklist has 22 parts, which are scored based on each section; the lowest score of this checklist is 15, and the maximum is 33. In this study, an acceptable score of 20 was considered.[15,16] Checklist items include title and abstract, introduction/background/rationale, objectives, methods/study design, setting, participants, variables, data sources/measurement, bias, study size, quantitative variables, statistical methods, results/participants, descriptive data, outcome data, main results, other analyses, discussion/key results, limitations, interpretation, generalizability, and other information/funding.[14]

### Extracting the data

First, by considering the inclusion and exclusion criteria, the title and abstract of the articles were reviewed by two researchers independently. Then, full text of the articles was reviewed, and if both researchers opted to reject the articles, the reason was mentioned. In case of disagreement between them, the article was judged by another reviewer. Data extraction was performed using a preprepared checklist that includes study time, type of disasters and related databases, dimensions, and indicators of the database at global and regional levels.

### Selection of studies

A search of databases yielded 325 studies. Initially, the articles were entered into Mendeley software( Mendeley is a free online reference manager at https://www.mendeley.com. Mendeley is a subsidiary of Elsevier), and after the initial review, 27 articles were removed from the study due to duplication. Then, by reviewing the titles and abstracts of articles, 77 articles were deleted due to irrelevance. After reviewing the full text of articles, 199 articles were deleted due to lack of components or indicators of disaster databases and 22 articles had inclusion criteria that entered the process of a systematic review [Figure 1].

## Results

Researchers extracted articles from this study and categorized in [Table 1] based on the author's name, title, year of publication, and a brief description of the article.

The number of global, regional, and national publicly available databases has increased significantly over the past decade, reflecting the need and importance of tracking and monitoring disaster impacts at the local level. In this study, 25 global and regional disaster loss databases were identified [Table 2].

Due to the diversity of databases (especially at the national-level or specific risk databases) in line with the purpose of this study, the main focus is on global and regional databases with an all-hazards approach, which

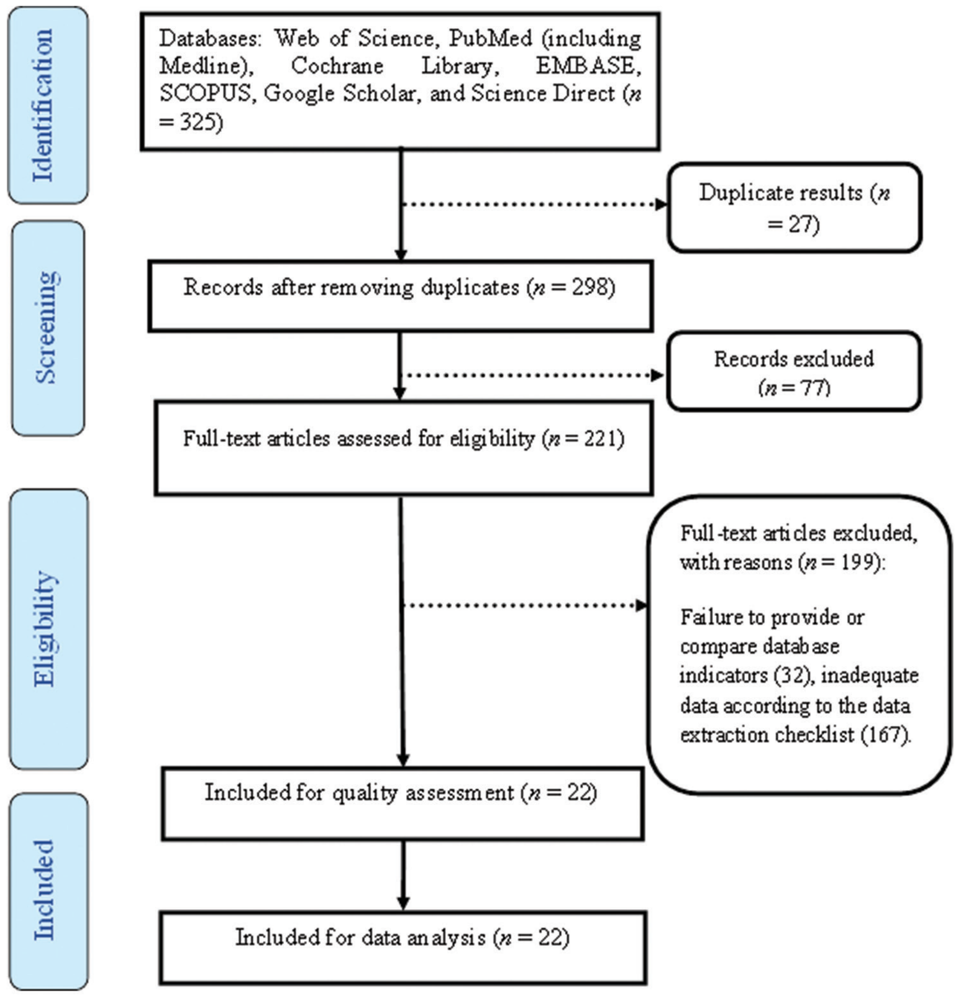


**Figure 1:** Results of PRISMA flow of the systematic literature search

is mostly used in the scientific community and by disaster experts. We examine these databases below.

- Global, regional, and national accident and disaster registration databases
- Worldwide accident and disaster registration databases.
    - Natural catastrophe services (NatCatSERVICE)
    - EM-DAT
    - SIGMA (Swiss Re)
    - GLobal unique disaster IDEntifier (GLIDE).

## Natural catastrophe services

NatCatSERVICE (Munich Re) is a global database of natural disaster data ("natcat"), founded in 1974 in Munich, Germany. The database began with the historic eruption of Mount Vesuvius in 79 AD, and relevant data are available for systematic and analytical evaluation on a global scale from the 1980s onward. Currently, about 1200 events are added to this archive each year.

This unique archive provides comprehensive, reliable, and professional data on insured, economic, and human damages caused by natural hazards. This database forms the basis of a wide range of tools and services used in risk assessment and risk management and is not limited to the insurance and finance industries. It also includes research communities and members of the public interest.

NatCat disaster interpretation tools can be configured to focus only on events in one country or to analyze events that affect multiple countries, so-called regional events. The NatCatSERVICE database contains information about events in each country and, in the event of regional events, combines country information with data about regional events. This concept allows for country-wide or regional (such as continental) analyses.

This database only covers disasters caused by natural hazards. The data are divided into seven categories based on the severity of the economic and human damage caused by the incident. Class 0 disasters include natural events without financial loss or are included in the database due to human casualties but are not used for economic assessments.

**Table 1: General characteristics of the studied articles that were eligible for a systematic review**

| Author | Title | Year | Summary |
|---|---|---|---|
| El Hadri *et al*.[17] | Natural disasters and countries' exports: new insights from a new (and an old) database | 2019 | This paper examines the effects of disasters on exports from 1979-2000. Two different datasets have been used to increase the power and accuracy of data collection: The EM-DAT and GeoMet, which are a new set of data based on geophysical and meteorological data |
| Ries *et al*.[18] | Disasters in Germany and France: An analysis of the emergency events database from a pediatric perspective | 2019 | This study aimed to conduct a comprehensive analysis of the disaster pattern for Germany and France from the children's perspective. EM-DAT analysis shows that children's data are not explicitly recorded in EM-DAT |
| Napolitano E *et al*.[19] | LAND-deFeND-An innovative database structure for landslides and floods and their consequences | 2018 | In this study, the national LAND slides and Floods database (LAND-deFeND) is presented, a new database structure that can organize and manage spatial information collected from different sources with varying accuracy |
| Koç *et al*.[20] | The relevance of flood hazards and impacts in Turkey: What can be learned from different disaster loss databases? | 2018 | In line with the primary purpose of the study in terms of data quality and accuracy, the TABB database was discussed. The TABB database was analyzed by comparing the emergency database (EM-DAT), the global active archive of major flood disasters - the Dartmouth flood observatory database, the news archive, and the scientific literature focusing on disaster lists |
| Moriyama *et al*.[21] | Comparison of global databases for disaster loss and damage data | 2018 | This article aims to investigate the traits and differentiate existing databases in three aspects of the threshold, spatial separation, and data quality control. Restrictions on existing databases are also considered |
| Brown *et al*.[22] | Volcanic fatalities database: Analysis of volcanic threat with distance and victim classification | 2017 | In this study, a volcanic mortality database has been updated to include all data from 1500 AD to 2017. The database contains 635 records of 278,368 killed individuals. Each record includes information on the number of dead people, the cause of death, the date of the accident, and the place of death in terms of distance from the volcano |
| Stahl *et al*.[23] | Impacts of European drought events: Insights from an international database of text-based reports | 2016 | This study examines the diversity of drought impact across Europe based on the drought impact report in Europe (EDII). It presents a unique research database that has collected nearly 5000 drought impact reports from 33 European countries |
| Soto[24] | Deriving information on disasters caused by natural hazards from limited data: A Guatemalan case study | 2015 | This work proposes a way to overcome the data constraints needed when analyzing disasters on a local scale in disaster-prone areas. In this proposed method, data are collected using two databases: the SISMICEDE and the DesInventar databases. SISMICEDE has a short period and high spatial resolution, while DesInventar has a longer duration but low spatial resolution |
| Gall[25] | The suitability of disaster loss databases to measure loss and damage from climate change | 2015 | This article examines the appropriateness of disaster databases for recording the effects of climate change, especially those related to severe weather conditions and slow-moving events |
| Huggel *et al*.[26] | How useful and reliable are disaster databases in the context of climate and global change? A comparative case study analysis in Peru | 2015 | The study analyzed three different disaster databases in developing countries such as Peru: The global database (EM-DAT), the Latin American multinational database (DesInventar), and the Peru national database (Peru SINPAD national information system). The analysis is performed in three dimensions (1) spatial scale, (2) periods, and (3) the classification and criteria of disasters |
| Zêzere *et al*.[27] | DISASTER: A GIS Database on hydro-geomorphologic disasters in Portugal | 2014 | The DISASTER project provides a compatible hydrogeomorphological database for Portugal by creating and operating a GIS-based database on floods and landslides for 1865-2010. Data collection is based on the concept of disasters used in the DISASTER project. Therefore, each hydrogeomorphological case is stored in the database |
| Santos *et al*.[28] | Risk analysis for local management from hydro-geomorphologic disaster databases | 2014 | This paper describes the applications of a hydrogeomorphological disaster database that allows for proper local risk management. Two disaster damage databases have been created with different criteria for events in Central Portugal using national and regional newspapers: one containing all disaster events regardless of the amount of damage reported, and the other one having reported major disasters with casualties |
| Wirtz *et al*.[11] | The need for data: Natural disasters and the challenges of database management | 2014 | This article describes the criteria and definitions for how global multi-risk databases work and the efforts to ensure consistent and international data management standards. Besides, the basic concept and methodology of the NatCatSERVICE database are presented, and many of the challenges associated with data acquisition and data management are described |

*Contd...*

**Table 1: Contd...**

| Author | Title | Year | Summary |
|---|---|---|---|
| Grasso and Dilley[7] | A comparative review of country-level and regional disaster loss and damage databases | 2013 | This study focuses on the implementation of damage and injury databases at the national and regional levels. The UNDP conducted the review |
| Vos[12] | Working paper work package 3 review of disaster databases collecting human impact data in Europe | 2012 | This paper focuses on disaster data in Europe as part of the data needed to measure resilience, focusing on national databases. The primary data collection strategies included internet search and literature review to identify disaster databases across Europe, national levels, and global databases |
| Kron *et al*.[8] | How to deal appropriately with a natural catastrophe database - Analysis of flood losses | 2012 | In addition to the EM-DAT and Sigma databases, Munich Re's NatCat service is now one of three global databases of its kind with over 30,000 datasets. In this study, using the example of floods and flood losses, the problems that exist when analyzing trends are discussed |
| Mohleji[29] | Gaining from losses: Using disaster loss data as a tool for appraising natural disaster policy | 2011 | This study evaluates natural disaster policies through data on disaster damage. This work is a collection of three separate studies. Through the data of economic damages caused by natural disasters, it focuses on analyzing the trend of disaster intensity and answering essential questions about disaster policy |
| López-Peláez and Pigeon[30] | Co-evolution between structural mitigation measures and urbanization in France and Colombia: A comparative analysis of disaster risk management policies based on disaster databases | 2011 | This paper examines the significant differences between the EM-DAT and DesInventar international disaster databases, which are often used as a basis for designing risk mitigation programs |
| Marulanda *et al*.[31] | Revealing the socioeconomic impact of small disasters in Colombia using the DesInventar database | 2010 | This paper presents the results of the evaluation of the DesInventar database, created in 1994 by the disaster prevention social studies network in Latin American. Besides, a new version of the local disaster list was developed in 2005 as part of the US disaster risk index and management program, with support from the Inter-American development bank |
| United Nations Development Programme[32] | Risk knowledge fundamentals: Guidelines and lessons for establishing and institutionalizing disaster loss database | 2009 | This study documents the experiences of the UNDP regional program on capacity building for sustainable recovery and risk reduction in the implementation of disaster loss databases using the DesInventar method |
| Witham[33] | Volcanic disasters and incidents: A new database | 2005 | A new database on volcanic eruption, mortality, and urban evacuation has been proposed. This study aims to quantify the social effects of volcanic phenomena during the 20th century. The data include the number of dead, injured, evacuated, and homeless individuals and the nature of the related volcanic phenomena |
| Sapir[34] | The development of a database on disasters | 1992 | In this study, CRED examines the possible designs and feasibility of database systems for disaster management and response globally. An EMIS has been proposed to provide fast and accurate end-user information by the WHO and other agencies involved in disaster preparedness and response. This article also presents the technical aspects of the first EM-DAT disaster database |

NatCatSERVICE=Natural catastrophe SERVICE, EM-DAT=Emergency events database, EMIS=Emergency Management Information System, UNDP=United Nations Development Programme, EDII=European Drought Impact Report Inventory, CRED=Centre for Research on the Epidemiology of Disasters

Classes 5 and 6 include major and devastating natural disasters and play a unique role in the system. These data provide the most critical and consistent statistics when identifying damage trends around the world. Category 6 includes all disasters that cause economic losses equal to 5% of GDP/per capita of the country where the disaster occurred.

Accurate and regular resources and data mining are the main principles of this database. The Munich Reinsurance Company relies on several reputable sources, including news agencies (Factiva/Dow Jones, Associated Press), which rank them based on the agency's track record over time. A rating of 25 equals the most valid, and a rating of 6 equals the lowest source credit rating.[7,29] To ensure the quality of the information obtained, conflicting information from various sources is provided to internal experts for re-evaluation and classified into six classes. In this category, each datum is assigned to a quality level on a scale from 1 (very good) to 6 (insufficient). Data records for quality levels 4, 5, or 6 do not comply with database quality standards and are not used for analysis.[11]

Finally, the consolidated information is stored in the NatCatSERVICE database. Nine other sources of information include national insurance associations,

**Table 2: List of global and regional databases identified in this study**

| Database | Type | Ownership |
|---|---|---|
| EM-DAT | Global | CRED |
| NatCatSERVICE | Global | MunichRe |
| SIGMA | Global | SwissRe |
| GLIDE | Global | ADRC |
| GFDRR | Global | World Bank |
| BD CATNAT Global | Global | Ubyrisk Consultants |
| Significant earthquake database | Global disaster-specific | USGS |
| Global Active Archive of Large Flood Events | Global disaster-specific | DFO |
| CAT-DAT Damaging Earthquakes Database | Global disaster-specific | SOS Earthquakes |
| Landslide fatality database | Global disaster-specific | Durham University International Landslide Centre |
| Significant earthquake database | Global disaster-specific | NOAA National Geophysical Data Centre |
| Significant Volcanic Eruption Database | Global disaster-specific | NOAA National Geophysical Data Centre |
| Global historical tsunami database | Global disaster-specific | NOAA (NGDC/WDC) |
| Cambridge earthquake impact database | Global disaster-specific | Cambridge architectural research Ltd |
| Landslides-recent events worldwide | Global disaster-specific | Geological Survey Canada |
| GAPHAZ | Global disaster-specific | University of Oslo (IACS/IPA) |
| EFFIS | Regional/Europe-wide disaster-specific | EC JRC |
| GeoMet | Geophysicists or meteorologists | GeoMet-Data |
| DesInventar | Regional | LA RED |
| Andean Information System for Disaster Prevention and Relief | Regional | Andean information system for disaster prevention and relief |
| Dartmouth Flood Observatory Database | Global disaster-specific | University of Colorado |
| GVP | Global disaster-specific | Smithsonian institution's |
| EDII | Regional disaster-specific | European Drought Center |
| USGS database | Global disaster-specific | The USGS earthquake hazards program |
| Tropical Cyclones | Global disaster-specific | The Earth Observation Research Center of the Japan Aerospace Exploration agency |

GVP=Global volcanism program, NatCatSERVICE=Natural catastrophe services, GLIDE=GLobal unique disaster identifier, EM-DAT=Emergency events database, EDII=European drought impact report inventory, GeoMet=Geophysical and meteorological database, EFFIS=European forest fire information system, GAPHAZ=Glacier and permafrost hazards in mountains, JRC=Joint research centre, NGDC/WDC=National geophysical data center/world data center, ADRC=Asia disaster reduction center, IACS/IPA=International Association of Cryospheric Sciences and the International Permafrost Association , SOS=Science on a Sphere, DFO=Dartmouth flood observatory, BD CATNAT=Base de données catastroph natural, GFDRR=The Global Facility for Disaster Reduction and Recovery, USGS=The United States Geological Survey, LA RED=The Network of Social Studies on Disaster Prevention in Latin America, CAT-DAT=Catastrophe data, The CAT-DAT damaging earthquakes database, NOAA=National Oceanic and Atmospheric Administration's

commercial press, and insurance industry information services (Lloyd's List, World Insurance Report, Property Claims Service); press and media report, international government institutions (United Nations [UN], European Union, and WHO), humanitarian institutions (Red Cross); scientific institutions (National Storm Center, Tsunami Warning Center, Meteo France, Deutscher Wetterdienst, Japan Meteorological Agency, World Meteorological Organization); and academic resources.[7,11,29]

The Munich Reinsurance Company collects the amount of economic damage at the time of the disaster and then, at the end of each month, adjusts the monthly amount of damage caused by the disaster to the current market rate. It also collects the principal amount of damages in the currency of the country where the disaster occurred, because the company is located in Germany, converts the losses into Euros for commercial purposes, and finally converts the number of damages from Euros to US Dollars. The NatCatSERVICE database is reviewed every 3–6 months. The review process includes checking the quality of the data by mentioning the data source ranking and evaluating the amounts of damages by comparing them with insurance claims payments. The Munich Reinsurance Company reviews all amounts of damages and checks suspicious amounts with local sources if needed.[29]

## EM-DAT

The EM-DAT is a global disaster database launched by the CRED Natural Disaster Epidemiology Research Center at the Université Catholique de Louvain in 1988 in Belgium. EM-DAT was created with the initial support of the WHO and the Belgian government.

The primary purpose of this database is to serve humanitarian goals at the national and international levels. This database is an active and well-known global database for disaster damage assessment. Its threshold for recording data is specified and the data are stored uniformly. These features allow users to compare disaster damage trends internationally. This database contains necessary information about the occurrence and effects of more than 22,000 significant disasters worldwide from 1900 to the present day, and about 300 events are added to this archive every year. In addition to metadata, data archives primarily include humanitarian data, such as those killed and missing, injured, homeless, or evacuated. Damage data (total damages and insured damages) are mainly based on information from UN agencies, government offices, the International Federation of Red Cross and Red Crescent Societies, research organizations, insurance publications (Lloyd's list), and reinsurance publications.

This database distinguishes between two general categories of disasters (natural and technological), followed by several subgroups: geophysical, meteorological, hydrological, climatic, and biological. Each of these subgroups is again subdivided into several types of disasters (e.g., floods, landslides, potholes). For each reported disaster, the damage is estimated at the dollar exchange rate. In the EM-DAT protocol, if at least one of the following criteria exists, a disaster must be reported: (1) the death number of 10 or more; (2) the number of 100 or more affected persons; (3) the declaration of a state of emergency; or (4) the request for international assistance by the government concerned.[11]

### SIGMA (Swiss Re)

SIGMA is a global natural and artificial disaster damage database founded by Swiss insurer Swiss Re and has published a statistical analysis in annual journals since 1970. The Swiss Re database includes both natural and artificial disasters. Data entry dates back to 1970, and almost every year, 300–350 new events are added to the database. In addition to metadata such as risk, date, and place of disaster (which includes general and insured damages), information about victims is also recorded (casualties and missing, injured, or homeless individuals). Government agencies, nongovernmental agencies, insurance groups, scientific research institutes, international agencies such as the UN or the European Commission, insurance introductory journals, internal reports, online databases, and daily newspapers are the data sources used by SIGMA. SIGMA, such as EM-DAT and NatCatSERVICE, provides data by country. The annual list of all events is published in Sigma – natural catastrophes and artificial disasters – and can be downloaded from the Swiss Re website, but there is no other public access to the database.

In some cases, raw data are provided for a few projects. SIGMA is very strict about inclusion criteria. These measures include economic losses based on adjusted inflation for the year (86.5 million USD for 2010 and 99 million USD financial losses or insured losses including 19.9 million USD for maritime disasters, 39.8 million USD for aviation, and 49.5 million USD for other damages for 2016) and/or 20 killed/missing, 50 injured, or 2000 homeless.[11,26]

### GLobal unique disaster IDEntifier

Another publicly available global database is the GLIDE. This database is a coordinating role between CRED, ISDR, UNDP, La Red/DesInventar, and other databases. The mission of this database is not to provide accurate information and documentation related to disaster damage. Still, it serves to establish communication between disaster damage databases by creating a disaster event identifier. The ADRC, which manages the GLIDE database, starts a unique identifier for each disaster event to link disaster damage information. The GLIDE database, such as the EM-DAT database, imposes a threshold for event registration. Therefore, it does not include repetitive events with high frequency and low intensity.[25]

### Accident and disaster registration databases at the regional level

- DesInventar.

#### *DesInventar*

A common conceptual and methodological framework in Latin America was started in 1994 by a group of researchers, academics, and institutional actors associated with social studies network on disaster prevention. The DesInventar project was started by LA RED, the Network of Social Studies on Disaster Prevention in Latin America. LA RED is a nonprofit organization operating mainly in Latin America, the Caribbean, and currently Asia and Africa.

LA RED established a system for collecting, advising, and displaying information on small-, medium-, and large-scale disasters based on the available data, newspaper sources, and institutional reports in nine Latin American countries. This project was developed to complete a conceptual, methodological, and software tool called Disaster Inventory System. Expansion of the DesInventar was in the sense that it facilitates dialog to manage risk between actors, institutions, departments, state, and national governments if local-scale disasters (city or equivalent) are addressed objectively.

DesInventar is a conceptual and methodological tool for building databases based on damage, casualties, or the effects of emergencies or natural disasters with the support of UNISDR, UNDP, and LA RED. It should be pointed that methodology (definitions and data management assistance), a database with a flexible structure, software for entering the database, and software for consulting and data analysis (which also includes options for selection for search criteria) are the components of DesInventar.

The crisis information management system (DesInventar methodology) consists of a software product with two main components. The first component is the executive management and the second component is the data entry module. The latter is a database with a specific structure and relationships completed by filling in predefined fields (spatial and temporal data, types of events and reasons, and sources) and direct and indirect effects (mortality, destroyed homes, infrastructure, and economic sectors). The analysis module allows access to database information that includes variables, relationships between various variables, effects, types of events, causes, sites, dates, and more. This module makes it possible to display at the same time the requested information with tables, graphics, etc.[30,31]

In the following, the registration threshold, data quality control, resolution/spatial accuracy, time coverage, information sources, contacts, owners/administrators, and the advantages of the databases mentioned above are presented [Table 3].[21,25]

Generally, depending on creating a database, cases such as the number of people killed, injured, homeless, missing, and economic damages are registered in the world's reputable databases. These cases are listed in Table 4 as a comparison between databases.[25]

## Discussion

In this study, systematic disaster database search strategies identified 26 global, regional, and international databases and 22 relevant articles. The search was limited to English-language databases that provided searchable disaster statistics. Therefore, items from databases that provided information in other languages were not entered.

Global and regional disaster databases have consistently and comprehensively covered a wide range of natural hazard data for many years. The general classification of databases expressed in various sources is as follows:

- Geological/geophysical event databases
- Meteorological and hydrological accident databases
- Climate event databases
- Other event databases (e.g., weather, biological epidemic disease).

As mentioned earlier, disaster registration databases deal with all hazards and, in some cases, with a specific hazard. Among these databases, distinctions can be made, such as differences in categories, the scope of work, and the type of events recorded. Some databases, with years of experience in disaster data collection, have well-established data collection methods. Their knowledge is high quality and very valuable and can be used to create and improve a disaster database at other levels. Many global databases have a national breakdown level and allow for international comparisons between countries. It is not appropriate to use these databases to assess the effects of disasters at lower resolution geographical levels, such as on a national scale. Thus, national disaster databases that collect data at lower resolution levels are valuable for supplementing data on smaller-scale events.

A comparison of different disaster databases shows a lot of inconsistency between global and national databases. Current international and national databases suffer from many limitations in controlling the damage caused by national hazards, leading to misinterpretation of disaster data. Given the focus on national geography, disaster-related databases at the national level can provide comprehensive and detailed information on human, social, cultural, environmental, and economic impacts.[12,20,35]

This study describes the main differences between existing databases in threshold registration, data quality control, spatial resolution, time coverage, data sources, contacts, stakeholders, and database advantages. In its disaster definitions, EM-DAT defines a disaster as a situation or event that affects local response capacity, necessitating a request for external assistance from a national or international level.[11]

EM-DAT criteria for recording disaster data are more evident than DesInventar and other databases. This database is the primary source of epidemiological information about disasters. However, the disaster threshold ignores the effects of high-frequency and low-intensity disasters. However, cumulative losses from recurrent, smaller, and larger hazards are more significant than large, severe, and unlikely hazards. Extensive hazards are defined as recurrent or persistent hazards with low or moderate severity, often of local nature, leading to catastrophic cumulative effects. Criteria used by DesInventar validate the term "small disaster." However, this definition is comparable to the CRED definition of disasters as high intensity but relatively rare events due to differences in the purpose of these databases in recording disaster data. In Europe, most research and risk management focus on CRED-type disasters.[30]

For DesInventar, on the other hand, the criterion for recording disasters is creating one or more units of

**Table 3: Characteristics of global and regional disaster databases**

| Spatial coverage | Global | | | | Regional |
|---|---|---|---|---|---|
| | NatCatSERVICE | EM-DAT | Sigma | GLIDE | DesInventar |
| Threshold to record | The occurrence of human injury (loss of life, injury, homelessness) or property damage | One of the following criteria must be fulfilled: (1) 10 or more human deaths, (2) 100 or more people affected/injured/homeless, (3) declaration by the country of a state of emergency and/or an appeal for international assistance | For the 2016 reporting year - insured losses: 19.9 million USD for maritime disasters, 39.8 million USD for aviation, 49.5 million USD for other losses, or economic losses: 99 million USD or Casualties: 20 dead or missing, 50 injured, 2000 homeless | ≥10 fatalities, ≥100 affected, declaration of the state of emergency, or call for international assistance | All disasters (one or more human losses or one or more dollars of economic losses) |
| Data quality control | Database owner | Database owner | Database owner | Database owner | Varies by country (governments, NGOs, or research institutes) |
| Spatial resolution | Country | Country | Country | Country | The minimum level of geographic resolution |
| Temporal coverage | 79 AD-present | 1900-present | 1970-present | 1930-present | Varies by country |
| Data sources | Property claims service, insurance clients, UN agencies, World Bank, press, academia, etc. | UN agencies, IFRC, World Bank, reinsurers, press, news agencies, etc. | Property claims service, insurance clients, UN agencies, World Bank, press, academia, etc. | UN agencies, IFRC, World Bank, reinsurers, press, news agencies, etc. | UN agencies, weather services, geological services, press, etc. |
| Audience | The general public, the insurance industry | Humanitarian community, academia | The general public, the insurance industry | Loss database operators | Emergency management, hazard mitigation planning, academia |
| Owner | Munich Re, Germany | Centre for Research on the Epidemiology of Disasters, Université Catholique de Louvain, Belgium | Swiss Re, Austria | Asian Disaster Reduction<br>Center, Japan | Varies by country |
| Advantage | Reliable information on insured losses<br>Graphics can be obtained based on the statistical data by clicking | Actively and continuously maintained<br>Human losses are disaggregated into deaths, injured, affected, homeless<br>Data are to be stored in a uniform format<br>The threshold to record is clear<br>Users can download the dataset itself | Reliable information on insured losses<br>Graphics can be obtained based on the statistical data by clicking | This database collaborates between CRED, ISDR, UNDP, La Red/DesInventar, and others<br>The GLIDE database generates a unique identifier for each disaster event to link loss information and to advance event and data comparability between databases | Widely used tool - Human losses are disaggregated into deaths, injured, affected, homeless<br>Data are to be stored by each country in a uniform format developed to record disaggregated data.<br>UNISDR encourages countries to use DesInventar in implementing the SFDRR<br>Users can download the dataset itself |

NatCatSERVICE=Natural catastrophe services, GLIDE=Global unique disaster identifier, EM-DAT=Emergency events database, IFRC=International Federation of Red Cross and Red Crescent, USD=US Dollar, CRED=Center for research on the epidemiology of disasters, ISDR=International Strategy for Disaster Reduction, UNDP=United nations development programme

human or economic damage. In Sigma, the annual threshold is set and adjusted based on annual inflation and the dollar exchange rate.[26] In general, the Sigma database uses strict points as entry criteria. The disaster registration threshold in the NatCatSERVICE database is lower and occurs as soon as human injury (loss of life, injury, and homelessness) or property damage in a data set occurs. These events are classified into six classes of disasters (categories 1–6), depending on the severity of the financial or human impact: from a natural disaster with minimal economic impact (category 1) to "a major natural disaster" (category 6).[11]

The main limitations of disaster databases are over- or under-reporting of certain types of risk (risk bias), a gap in historical records (time bias), reliance on direct or indirect financial losses (accounting bias), focus on high-intensity events (threshold bias), and over-focus on densely populated or more accessible areas (geographic bias).[20]

**Table 4: Comparison of cases registered in global and regional disaster databases**

| cases registered | NatCatSERVICE | EM-DAT | Sigma | GLIDE | DesInventar |
|---|---|---|---|---|---|
| Killed | x | x | x | | x |
| Injured | x | x | x | | x |
| Missing | x | x | x | | x |
| Homeless | | x | | | x |
| Affected | x | x | x | | |
| Evacuated | x | x | x | | x |
| Relocated | | | | | x |
| Displaced | x | | x | | |
| Property loss | | x | | | |
| Environmental loss | | x | | | |
| Insured loss | x | | x | | |
| Aggregate economic loss | x | x | x | | x |
| Infrastructure damage | x | x | x | | x |
| Economic sector damage | x | x | x | | x |
| Geophysical | x | x | x | x | x |
| Hydrological | x | x | x | x | x |
| Meteorological | x | x | x | x | x |
| Climatological | x | x | x | x | x |
| Technological | | x | | x | x |
| Climate change | | | | | |

NatCatSERVICE=Natural catastrophe services, GLIDE=Global unique disaster identifier, EM-DAT=Emergency events database

Various sources can be used for the input data of a disaster database: official reports and announcements, information collected during internet searches, reports of humanitarian actions of non-governmental organizations, data collected by academic institutions, media reports, etc. In the meantime, the arguments are in favor of including newspaper reports as one of the primary sources of information in the disaster database because: (a) newspapers cover events on a local scale more than any other source; (b) a similar event is often reported in different newspapers, so it is permissible to compare and sift through facts; (c) newspapers are usually better at maintaining and accessing their archives; and (d) newspaper information covers a broader time than other media sources such as television and the Internet.[28]

A small number of disaster databases allow free access to disaster information. However, access to the data may be done after registration or through special agreements with the responsible institution. Despite the application of standard definitions of the type of disasters and human impacts in each database, there is a wide heterogeneity between databases in terms of the kind of data collected, the volume of data, and accessibility, depending on the focus and methods of collecting each database. As a result, comparing datasets between databases is very challenging.[12]

The EM-DAT database may not be appropriate if you need to use disaster-related data. The reason given is that the severity of disasters, which is usually measured by EM-DAT based on the amount of damage or the number of victims, is itself related to the level of development. To report a disaster in the EM-DAT database, there must be at least one of the following criteria: ten or more killed, 100 injured or more, a state of emergency declared, or a formal request for international assistance.[21]

It should be pointed out that data on armed conflict and terrorism are not included in the EM-DAT, which may be biased as the effects of wartime disasters may be much more severe. The mortality data reported in EM-DAT and other global disaster databases for adults and children are not available separately and categorized. To create an approach based on vulnerable groups, age-classified data are needed.[18,36]

EM-DAT, Sigma, and NatCatSERVICE have their specialists evaluate data set quality control, while DesInventar data quality is government controlled. In terms of spatial resolution, only DesInventar provides the location data of a disaster event at the level of city divisions. Other limitations in databases include lack of segregated data, limits of spatial coverage and spatial segregation, incompleteness and reliability of data, and specific recording of total damage (including indirect damage).[11,17]

Financial loss is an essential parameter in disaster databases. There are ambiguities in distinguishing between direct and indirect damages. NatCatSERVICE defines direct damage as follows: direct damage is observable and measurable immediately after a disaster (destruction of homes, property, schools, vehicles, machinery, livestock, etc.). In the other class, damages are divided into two categories: insured damages and economic damages. Insured claim figures are very reliable since they reflect claims paid by insurance companies. Some studies have reported that EM-DAT and NatCatSERVICE do not report the damage to infrastructure and the agricultural sector sufficiently and accurately. This could call into question the achievement of these banks' goals in calculating economic losses.[11]

Finally, no systematic review of disaster databases was found in the literature review. in this study, a comprehensive review of the most authoritative disaster databases has been conducted. this work paves the way for a better understanding of the components and criteria of disaster databases in the field of creating and developing disaster databases at all levels.

### Limitations

In this study, disaster databases at the national level and specific risk databases have not been examined. One of the reasons for this is many of these banks and the modeling of these databases from reputable global databases.

In this study, only English-language studies were reviewed.

## Conclusion

In the context of the unequal and discontinuous increase in the risk of disasters and their effects, the need to collect and share disaster impact data is crucial to protect people, improve public health promotion, and reduce economic damage. A systematic set of information and standard data on the occurrence and effects of natural disasters is an essential tool for scientific and policy-making purposes and disaster response and recovery activities.

Many national and regional databases are currently running with international support. United Nations Office for Disaster Risk Reduction (UNISDR) has supported many countries in building and updating disaster databases in partnership with UNDP. UNISDR support has been through financial support or technical assistance (updating, training, advocacy, data dissemination, and institutional support). In particular, UNISDR has provided technical assistance to all countries that use DesInventar software to develop and enhance their software or applications. Other specialized UN agencies, such as the WHO and the Food and Agriculture Organization of the United Nations support countries to record data in their respective sectors.

To support sound disaster risk reduction decisions and public health promotion, it is essential to complement existing global, international, and national databases.

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### Conflicts of interest

There are no conflicts of interest.

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