JRC TECHNICAL REPORTS

Update of the DRMKC Loss database architecture for disaster risk management

2018 – Update of the DRMKC Loss database architecture for disaster risk management

2018

Ríos Díaz, Francisco

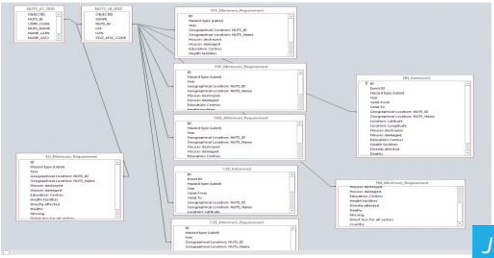
Marín Ferrer, Montserrat

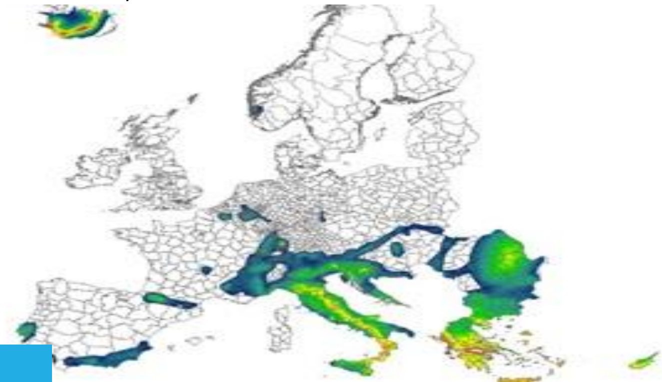
Luoni, Stefano

Antofie, Tiberiu Eugen

Faiella, Anna

European Union disaster loss database





Joint Research Centre

EUR XXXXX EN

Contact information
Name: Ríos Díaz, Francisco
Address: Via E. Fermi 2749, I-21027 Ispra (VA) Italy
Email: Francisco.RIOS-DIAZ@ec.europa.eu
Tel.: +39 033278-5680

JRC Science Hub
https://ec.europa.eu/jrc

JRCXXXXXX

EUR XXXXX EN

PDF	ISBN XXX-XX-XX-XXXXX-X	ISSN XXXX-XXXX	doi: XX.XXXX/XXXXXX

Luxembourg: Publications Office of the European Union, 2018

How to cite this report: Rios Diaz et. al., *Update of the DRMKC Loss Database Architecture for Disaster Risk Management* EUR XXXXX EN, Publication Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-77752-3,
doi 10.2760/647488, JRC110489.

Authors affiliations:

Francisco Ríos Díaz, European Commission, Joint Research Centre (JRC), Ispra, Italy

Montserrat Marín Ferrer, European Commission, Joint Research Centre (JRC), Ispra, Italy

Tiberiu Eugen Antofie, European Commission, Joint Research Centre (JRC), Ispra, Italy

Stefano Luoni, Unisystems Italy external service provider of European Commission, Joint Research Centre (JRC), Ispra, Italy

Anna Faiella, Trainee at the European Commission, Joint Research Centre (JRC), Ispra, Italy

Contents

Abstract

The reformed decision on a Union Civil Protection Mechanism [1], which entered into force on 1 January 2014, paved the way for more resilient communities by including key actions related to disaster prevention, such as developing national risk assessments (NRAs) and refining risk management planning. Under the decision, European Union (EU) Member States agreed to 'develop risk assessments at national or appropriate sub-national level and make available to the Commission a summary of the relevant elements thereof by 22 December 2015 and every three years thereafter'. The decision also requires Member States, together with the Commission, to develop guidelines on the content, methodology and structure of risk management capability assessments. The Commission has published risk assessment and risk mapping guidelines to assist Member States with their NRAs. Risk management capability assessment guidelines were also developed.

The recent communication from the Commission, 'Strengthening EU disaster management: rescEU — Solidarity with responsibility' (COM(2017) 773 final) ([1]), calls 'Member States and Commission to promote more systematic collection and dissemination of loss data, to enhance the collection of loss data and make use of loss data for optimised prevention and climate adaptation planning'.

Systematically collected, comparable and robust disaster damage and loss data are an essential element of the risk assessment and management processes. Thus, the EU Council conclusions on risk management capability of 24th September 2014 call on the Commission to 'Encourage the development of systems, models or methodologies for collecting and exchanging data on ways to assess the economic impact of disasters on an all-hazard basis'.

The current practice in disaster loss data recording across the EU shows that there are hardly any comparable disaster damage and loss data: differences exist in the methods of data recording as well as in the governance approaches to managing the data. The lack of standards for damage and loss data collection and recording represents the main challenge for data sharing and comparing, especially for cross-border cooperation within the EU.

This report is based on an accurate analysis of several databases developed following a diversified number of purposes to collect, record and aggregate information regarding losses having occurred after a shock triggered by different hazards. The report proposes a common structure of a generic database able to accommodate and properly record the required particularities of a vast variety of events triggered by any kind of hazard.

([1]) http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1511770718312&uri=COM:2017:773:FIN

Role of the authors

Francisco Ríos Díaz, as author, was responsible for designing the concept of the database architecture behind the Risk Data Hub, after studying relevant databases in Member States and International Organisations and wrote the report.

Montserrat Marin Ferrer, as the coordinator of the DRMKC projects, overviewed the whole process.

Tiberiu Eugen Antofie, as contributor, provided methodological example and contributed in structuring the historical event catalogue.

Stefano Luoni, as external consultant, contributed adapting the database architecture based on the Risk Data Hub platform.

Anna Faiella, as trainee, contributed to the review of data and the report.

1. Introduction

In the EU, each Member State has different authorities that are responsible for collecting data when a natural or technological hazard occurs. In some cases, authorities in charge are at different levels, i.e. national, regional or municipal, and have to report back to the final body responsible for keeping the data, the national level.

One of the reasons for having a multi-hazard database is so that Member States could have an overview of common data, structured per hazard, to facilitate the identification of weaknesses at national level and the establishment of well-informed priorities in order to reduce the current level of risk.

The database ought to be flexible enough to include different kinds of hazards with its specifics, and help fulfil national, European and international policies and agreements such as the Sendai Framework ([2]), the EU Solidarity Fund ([3]) and the Inspire ([4]) and floods ([5]) directives, or produce the NRA. The loss database will provide a common ground for a number of policies needing data for a more coherent, coordinated and knowledge-based implementation. The loss database will support the complementarity across policies.

Almost every European country has its own database(s). In most cases they are according to hazard, some are in digital format and in other cases the data are scattered across files still in Excel sheets or even in paper format. The challenge of the loss database is to put together all pieces of a puzzle across Member States, different hazards, standards and methodologies in a sensible, understandable and structured way that can be used as a tool to help in sharing cross-institutional data, in reporting to the different frameworks, in being compliant with the directives and in providing sound input for the NRA as required by the EU Civil Protection Mechanism.

For this purpose several national databases that were identified as good practices for loss data collection have been studied and an architecture for loss database was suggested ([6]). All the identified loss databases are in a digital format and they were chosen because they were compliant with a number of policies, either at national or at international level.

This document is linked to other related publications of the European Commission, as "*Risk Data Hub - web platform to facilitate management of disaster risks*" ([7]) and "*Risk Data Hub software and data architecture*" ([8]).

([2]) https://www.wcdrr.org/
([3]) https://ec.europa.eu/regional_policy/index.cfm/en/funding/solidarity-fund/
([4]) https://inspire.ec.europa.eu/
([5]) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32007L0060
([6]) http://publications.jrc.ec.europa.eu/repository/handle/JRC110489
([7]) http://publications.jrc.ec.europa.eu/repository/handle/JRC110489
([8]) http://publications.jrc.ec.europa.eu/repository/handle/JRC110489

2. International legislation and initiatives

In the common goal of reducing the risk of forthcoming disasters, legislation, initiatives and frameworks at both European and international level have been produced during the last decades to find common targets and set milestones for the coming horizon. Some examples of European directives are listed hereunder, but there are many other policies that are contributing to the same goal and that share the same need: reliable data to ensure a knowledge-based implementation, such as the European Radiological Data Exchange Platform [2], the European Community Urgent Radiological Information Exchange/Radioactivity Environmental Monitoring [3], the climate adaptation initiative [4], Articles 35 and 36 of the Treaty establishing the European Atomic Energy Community [5] and the European programme for critical infrastructure protection [6].

2.1. European directives

- Floods directive [7]

The floods directive (Directive 2007/60/EC) focuses on the assessment and management of flood risks and basically prescribes the following three-step procedure.

First step — Preliminary flood risk assessment: the floods directive requires Member States to engage their government departments, agencies and other bodies to draw up a preliminary flood risk assessment, which has to consider impacts on human health and life, the environment, cultural heritage and economic activity, with a legislative completion date of December 2011.

Second step — Identification of areas of potential significant flood risk (APSFRs): the information in this assessment will be used to identify the areas at significant risk which will then be modelled in order to produce flood hazard and risk maps. These maps are to be in place by December 2013 and will include detail on the flood extent, depth and level for three risk scenarios (high, medium and low probability).

Third step — Flood risk management plans: these plans are meant to indicate to policymakers, developers and the public the nature of the risks and the measures proposed to manage them. However, they are not formally binding (e.g. to land use planning). The plans are to be complete by December 2015. The floods directive prescribes an active involvement in the process of all interested stakeholders. The plans are to focus on prevention, protection and preparedness, and shall take into account the relevant environmental objectives of Article 4 of Directive 2000/60/EC, commonly known as the water framework directive [8].

- Inspire initiative [9]

Inspire is 'an EU initiative to establish an infrastructure for spatial information in Europe that is geared to help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development'.

The Inspire directive lays down a general framework for spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may affect the environment. The directive entered into force on 15 May 2007.

Inspire is based on the infrastructures for spatial information established and operated by the Member States. The directive addresses 34 spatial data themes needed for environmental applications.

To ensure that the spatial data infrastructures of the Member States are compatible and usable in a community and transboundary context, the Inspire directive requires that additional legislation or common implementing rules are adopted for a number of specific areas (metadata; interoperability of spatial data sets and services; network services; and data and service sharing, monitoring and reporting). These are published either as Commission regulations or as decisions.

The Commission is assisted in the process of adopting such rules by a regulatory committee, the Inspire Committee, composed of representatives of the Member States and chaired by a representative of the Commission (this is known as the 'comitology procedure').

- Seveso I directive [10]

Council Directive 82/501/EC is an EU law aimed at improving the safety of sites containing large quantities of dangerous substances. It is also known as the Seveso directive, after the Seveso disaster, and was superseded by the Seveso II directive.

- Seveso II directive [11]

Council Directive 96/82/EC (as amended) is an EU law aimed at improving the safety of sites containing large quantities of dangerous substances. It is also known as the Seveso II directive, after the Seveso disaster, and replaced the Seveso directive but was in turn modified by the Seveso III directive.

- Seveso III directive [12]

Council Directive 2012/18/EU an EU directive aimed at controlling major chemical accident hazards. It is also known as the Seveso III directive, is implemented in national legislation and is enforced by national chemical safety authorities.

The Seveso III directive replaces the previous Seveso I (Directive 82/501/EC) and Seveso II (Directive 96/82/EC) directives, updating the laws due to, for example, changes in chemical classification regulations. They all get their name from the Seveso disaster, which occurred in 1976 in Italy. The Seveso III directive establishes minimum quantity thresholds for reporting and safety permits. There are two lists: one that names individual substances, and another that designates hazard categories for those substances that have not been named separately. Documents required based on hazard and quantity are notifications such as the major accident prevention policy and the Seveso safety report.

2.2. Frameworks and international goals

- Sendai Framework for Disaster Risk Reduction (2015-2030) [13]

The Sendai Framework for Disaster Risk Reduction (2015-2030) is an international agreement that was adopted by UN Member States at the World Conference on Disaster Risk Reduction, which took place between 14 and 18 March 2015 in Sendai, Japan, and was endorsed by the UN General Assembly in June 2015. It is the successor agreement to the Hyogo framework for action (2005-2015), which had been the most encompassing international accord to date on disaster risk reduction.

The Sendai document emerged after 3 years of talks, assisted by the United Nations International Strategy for Disaster Reduction, during which UN Member States, non-governmental organisations and other stakeholders made calls for an improved version of the existing Hyogo framework, with a set of common standards, a comprehensive framework with achievable targets and a legally based instrument for disaster risk reduction. Member States also emphasised the need to tackle disaster risk reduction and climate change adaption when setting the sustainable development goals (SDGs), particularly in light of an insufficient focus on risk reduction and resilience in the original millennium development goals.

The Sendai Framework sets four specific priorities for action:

1. understanding disaster risk;
2. strengthening disaster risk governance to manage disaster risk;
3. investing in disaster risk reduction for resilience;
4. enhancing disaster preparedness for effective response and to 'build back better' in recovery, rehabilitation and reconstruction.

To support the assessment of global progress in achieving the outcome and goal of the Sendai Framework, seven global targets have been agreed:

1. substantially reduce global disaster mortality by 2030, aiming to lower the average global mortality per 100 000 between 2020-2030 compared to 2005-2015;
2. substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100 000 between 2020-2030 compared to 2005-2015;
3. substantially reduce direct disaster economic loss in relation to global gross domestic product by 2030;
4. substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;
5. substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
6. substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the framework by 2030;
7. substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

- Sustainable development goals [14]

The SDGs are a collection of 17 interrelated global goals set out by the United Nations. Each of the broad goals has several targets, and the total number of targets is 169. The SDGs cover a broad range of social development issues such as poverty, hunger, health, education, climate change, gender equality, water, sanitation, energy, environment and social justice. The SDGs are also known as 'Transforming our world: the 2030 agenda for sustainable development' [15] or '2030 agenda' for short. The goals were developed to replace the millennium development goals [16], which ended in 2015. Unlike the latter goals, the SDG framework does not distinguish between 'developed' and 'developing' nations. Instead, the goals apply to all countries.

Paragraph 54 of United Nations Resolution A/RES/70/1 of 25 September 2015 [17] contains the goals and targets. The UN-led process involved its 193 Member States and global civil society. The resolution is a broad intergovernmental agreement that acts as the post-2015 development agenda.

The SDGs build on the principles agreed upon in Resolution A/RES/66/288 [18], entitled 'The future we want'. This was a non-binding document released as a result of the Rio+20 Conference [19], held in 2012.

Finally, the Inter-agency and Expert Group on SDG Indicators, in its Report E/CN.3/2017/2 [20], proposes the use of the Sendai Framework indicators recommended by the Open-ended Intergovernmental Expert Working Group [21] to measure specific global targets of SDGs 1 (End poverty in all its forms everywhere), 11 (Make cities and human settlements inclusive, safe, resilient and sustainable) and 13 (Take urgent action to combat climate change and its impacts) within the global indicator framework for the goals and targets of the 2030 agenda. This proposal was considered for approval by the UN Statistical Commission at its 48th session in March 2017. This will provide for simultaneous and coherent monitoring and reporting on the Sendai Framework and on the SDGs.

- National risk assessment [1]

In 2001, the EU Civil Protection Mechanism was established to foster cooperation among national civil protection authorities across Europe. The mechanism currently includes all 28 EU Member States in addition to the former Yugoslav Republic of Macedonia, Iceland, Montenegro, Norway, Serbia and Turkey.

Under the mechanism, the Member States are asked to provide a summary of their NRA every 3 years. For this particular reason, a database that can cope with different hazards is key for this report in order to have the whole picture of the risk at a national level.

Strengthening the EU's Civil Protection Mechanism places disaster prevention and the reduction of risks at the core of our disaster risk management efforts. Prevention actions are required to reduce the impacts of hazards and to make societies stronger for when the next disaster strikes, while also reducing the response needs. Increasing the resilience of EU infrastructure, ecosystems and societies is an essential element of effective disaster prevention.

Thorough investment by Member States in prevention and preparedness monitoring is of crucial importance. For this purpose, the loss database will be a tool to monitor and report on the successful implementation of prevention and preparedness plans by making available reliable data on the effective losses suffered after a shock and by keeping track of the positive and negative trends.

The recent communication from the Commission, 'Strengthening EU disaster management: rescEU — Solidarity with responsibility' (COM(2017) 773 final), calls 'Member States and Commission to promote more systematic collection and dissemination of loss data, to enhance the collection of loss data and make use of loss data for optimised prevention and climate adaptation planning'.

- United nations framework convention on climate change Paris agreement [22]

The Paris Agreement is an agreement within the United Nations Framework Convention on Climate Change dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020. The Agreement aims to respond to the global climate change threat by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

3. National databases

There are diverse hazard-based databases in every Member State. Some are on digital format, while others are just in plain text or Excel sheets.

For this technical document some of them have been studied because they are considered to be a reference point for a particular hazard. The databases that have been taken into account are the following.

— **FloodCat**: an Italian catalogue for past floods designed by the Italian civil protection department with the support of the Italian national institute for environmental protection and research, and developed by the CIMA Foundation.

— **CDTE and CNIH databases**: Spain has a historical databases on earthquakes and floods, dating back several decades.

— **AJDA**: a Slovenian database developed by the Ministry of Interior of Slovenia; it is multi-hazard and based on the asset.

— **eMARS**: a database of technological hazards, compliant with the Seveso I, II and III directives.

— **EM-DAT**: an emergency events database developed by the Centre for Research on the Epidemiology of Disasters in Belgium.

— **Database from Consorcio de compensación de seguros**: a Spanish database for insured losses from flood (riverine, pluvial and coastal), strong winds, earthquake, tsunami, volcanic eruption and meteorite impact in Spain by the 'Consorcio de compensación de seguros', which is by law the public Spanish insurance company responsible for paying-out these losses. Its database has a big amount of data since several decades back. 'Consorcio de compensación de seguros' covers losses in properties (residential, commercial, industrial, infrastructures, motor vehicles...), personal damages and business interruption.

— **Desinventar**: a database developed by the United Nations Office for Disaster Risk Reduction and implemented in many countries.

3.1. FloodCat (Italy) [23]

Directive 2007/60/CE (floods directive) of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks asks the Member States to collect and provide information on past events and their consequences. In particular, Article 4 of the directive requires Member States to carry out a preliminary assessment (preliminary flood risk assessment) to identify the areas for which potential significant flood risks exist or might be envisaged.

The Italian government has by law (a directive of the President of the Council of Ministries, Dir.P.C.M. 24th of February 2015) established that the Civil Protection Department must make a web-GIS platform named FloodCat available to regions and river basin district authorities (floods directive competent authorities). The platform fulfils the function of catalogue of flood events and, therefore, should be used to address the mentioned requirements of the directive. FloodCat is thus the official technological platform for collecting information on past floods according to the EU floods directive.

FloodCat has afterwards been updated thanks to the Disaster Risk Management Knowledge Centre support service funded by Directorate-General for European Civil Protection and Humanitarian Aid Operations and then implemented by the Joint Research Centre (JRC). The updated version has taken into consideration JRC's *Guidance for recording and sharing disaster damage and loss data* as well as the indicators proposed in the Sendai Framework.

For these reasons FloodCat has been identified as a reference for data collection in the case of flood events and is compliant with the floods directive (2007/60/CE). It is also already a good candidate to take on board when considering a multi-hazard database schema.

According to the floods reporting schema, for each significant flood the following information should be reported.

- Location (name of place, river basin, sub-basin and/or coastal area).
- Category of flood (past or potential future flood).
- Type of flood.
- Extent (area of land inundated or length of river stretches or coasts).
- Probability of flood event (frequency, recurrence).
- Date of commencement and duration of flood.
- Type and degree of adverse consequences for:
    - human health,
    - environment,
    - cultural heritage,
    - economic activity.
- Other relevant information.

Considering all this, FloodCat is being designed based on three elements:

1. events,
2. phenomena,
3. damages.

3.1.1. Events

Events are the main element on FloodCat. An event represents a flood associated to a particular situation in time. An event can have several phenomena associated to it.

An event in FloodCat can be described by the following fields.

- event ID,
- event name,
- source of flooding,
- event category,
- start date,
- time frame (duration),
- unit of management,
- flooded area,
- extent of land inundated or inundated length of river stretches or coasts,
- event recurrence or frequency,
- other relevant information.

3.1.2. Phenomena

Phenomena are associated with events in FloodCat, considering it is normal to have one too many phenomena linked to one event.

Phenomena represent the definition of the event's dynamics in terms of mechanism, characteristics, and localization of the flood to which impacts are associated. Each phenomenon is associated with only one characteristic and one or more mechanisms

A phenomenon in FloodCat can be identified by the following fields:

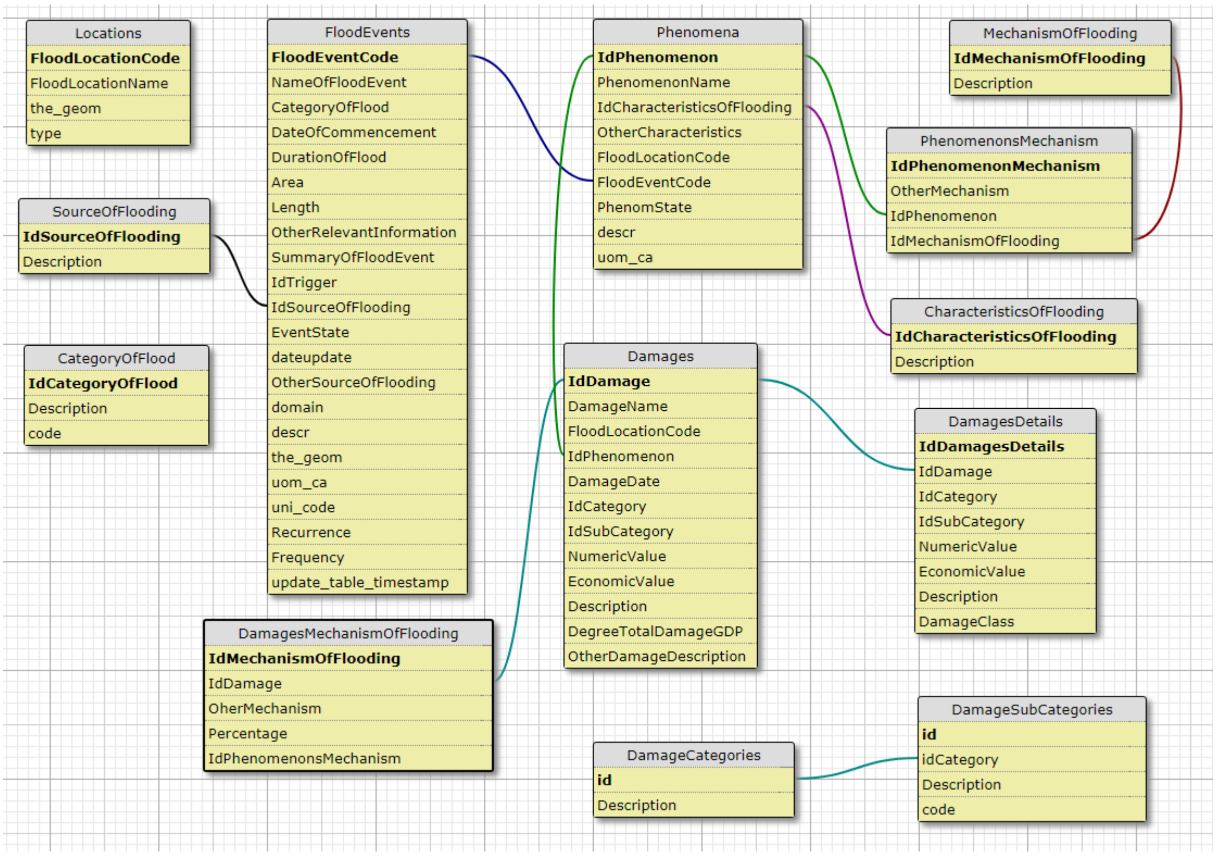
- ID of the event,
- ID of the phenomenon,
- phenomenon name,
- phenomenon description,
- characteristics of the flood,
- mechanism of the flood,
- location (area).

3.1.3. Damages

Damages are linked to phenomena and the fields associated with damage are:

- ID of the phenomenon,
- ID of the damage,
- name,
- summary,
- location code (area/point),
- date,
- ID of damage category,
- ID of damage subcategory,
- numeric value,
- economic value,
- mechanism of flooding,
- damage description,
- degree of damage (damage class),
- ID of the event.

Figure 1. Diagram of the FloodCat model



3.2. CDTE and CNIH databases (Spain) [24]

The Spanish catalogue of earthquake damage was developed by the Spanish department of civil protection and is based on agreements signed between the directorate-general for civil protection, the insurance compensation consortium, the national geographic institute, and the national centre for geographic information. Its main table is based on general event data such as:

- episode number code,
- start date,
- end date,
- denomination of the episode,
- type of event,
- type of cause,
- total amount of the episode,
- author,
- creation date,
- update date,
- modifying author.

The Spanish database also records the characteristics of the event, the sources, and human and material losses associated with the event (services, infrastructure, buildings, industries ...).

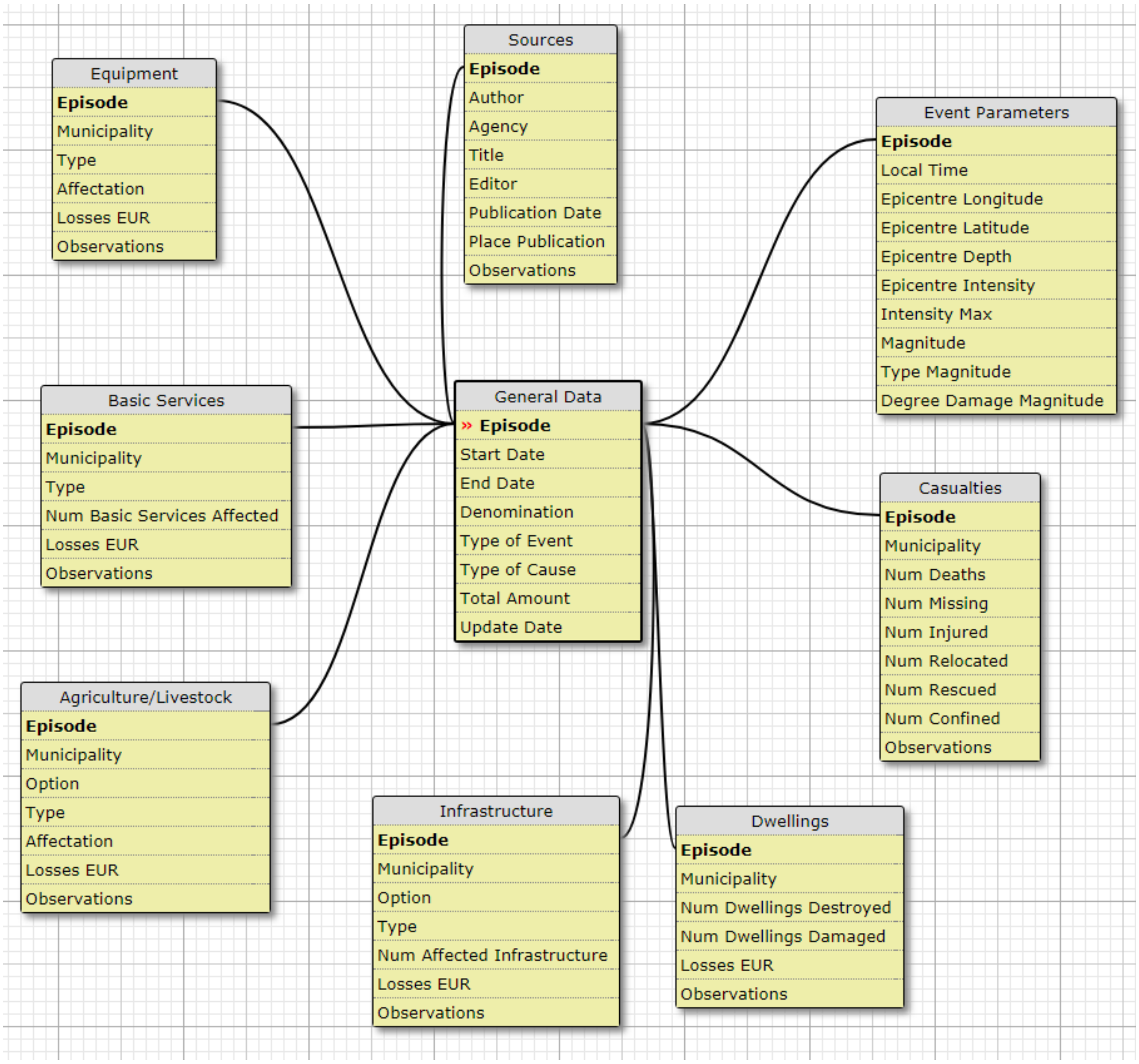
The human losses are not disaggregated by gender, age or income and are only at the aggregated level.

The rest of the losses (infrastructure, buildings, agriculture and services) have basic information, such as:

- municipality,
- minor entity of population,
- option,
- type,
- affectation,
- losses in euros,
- more detailed information.

The graphical structure of the earthquakes database is as follows.

Figure 2. Diagram of the Spanish earthquakes database



3.3. AJDA database (Slovenia) [25] [26] [27]

The Slovenian database is a structure based mainly on the asset. It is different from other databases that we have seen, as in this case there is a catalogue of assets even if there has been no event. In addition, when an event happens the event can be associated with one or more assets, depending on how many assets have been affected by the event.

The damage evaluation methodology in Slovenia includes damage caused by natural and industrial accidents. The damage groups include land, facility, fixed and current assets (movable property and stocks, agricultural production, multiannual plantations), cultural property and loss of revenue in a holding.

The database is fed from external sources of information and regularly updated during the year, as in the case of the cadastral data (knowing how many people live there, the data are disaggregated by range of age, income, etc.), prices for material and repairs.

Considering this structure, when an event happens it is very easy to generate a compensation report. This can be done almost immediately as all the information required is already linked to the event and is up to date (prices and assets).

When an event happens, the people affected have to fill in some forms (different ones depending on the hazard) and they make an estimation of the costs and affected assets. Later on, these forms are digitalised and passed all the information into the AJDA system. From that point, if it is necessary, an expert will do an on-field research to assess the damage more specifically and make a more accurate estimation of compensation.

3.4. eMARS [28]

The Major Accident Reporting System (MARS and later renamed eMARS after going online) was first established by the EU's Directive 82/501/EEC in 1982. It has remained in place with subsequent revision to the Seveso directive in effect today. The purpose of eMARS is to facilitate the exchange of lessons learned from accidents and near misses involving dangerous substances in order to improve chemical accident prevention and mitigation of potential consequences.

eMARS contains reports of chemical accidents and near misses that have been provided to the Major Accident Hazards Bureau of the JRC from the EU, European Economic Area, Organisation for Economic Cooperation and Development and United Nations Economic Commission for Europe countries (under the Convention on the Transboundary Effects of Industrial Accidents). Reporting an event into eMARS is compulsory for EU Member States when a Seveso establishment is involved and the event meets the criteria of a 'major accident', as defined by Annex VI of the Seveso III directive. For non-EU, Organisation for Economic Cooperation and Development and United Nations Economic Commission for Europe countries, reporting accidents to the eMARS database is voluntary. The information of the reported event is entered into eMARS directly by the official reporting authority of the country in which the event occurred.

Chemical accident reports from investigations can be powerful in raising awareness of potential failures that could cause major accidents in establishments using dangerous substances. They also provide the general public with access to accident information to aid local and national efforts to reduce chemical accident risks.

Reports in eMARS are not intended to serve as instruments for passing judgement on individual companies or countries associated with an accident. A blame culture surrounding the database would greatly reduce the sharing of information. For this reason, companies' names and locations are not identified in the database in order to maintain focus on the lessons-learned value of the information and to encourage complete and accurate reporting of what happened so that everyone can learn from it.

Some of the information contained in the eMARS database is as follows.

Profile table:

- title,
- start date,
- end date,
- accident type,
- reported,
- Seveso II status,
- industrial activity,
- reason for reporting.

Accident table:

- description,
- fire details,
- explosion details,
- others.

Site table:

- description,
- installation/unit description,
- process,
- equipment,
- initiating events,
- other.

Substances table:

- substances involved,
- substances classification,
- details.

Causes table:

- description,
- plant/equipment.

Consequences table:

- human (injuries, fatalities, others),
- cause,
- disruption.

Emergency response.

Lessons learned.

3.5. EM-DAT (CRED, Belgium) [29]

EM-DAT is a global database on natural and technological disasters containing essential core data on the occurrence and effects of disasters in the world since the beginning of the 20th century. EM-DAT is maintained by the Centre for Research on the Epidemiology of Disasters at the School of Public Health of the Catholic University of Louvain located in Brussels, Belgium.

Its main objectives are to assist humanitarian action at both national and international levels, to rationalise decision-making for disaster preparedness and to provide an objective basis for vulnerability assessment and priority setting.

The EM-DAT database records events which follow at least one of the following criteria:

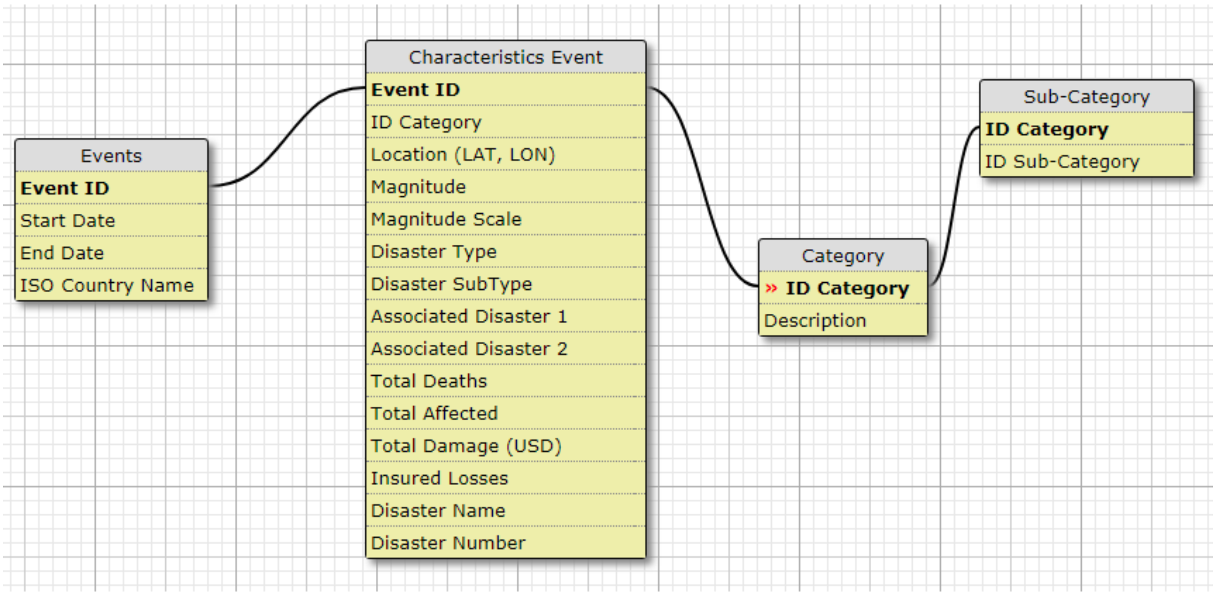
- 10 or more people dead;
- 100 or more people affected;
- the declaration of a state of emergency;
- a call for international assistance.

EM-DAT provides geographical, temporal, human and economic information on disasters at the country level.

The structure of the EM-DAT database is based on events, linked with a table of characteristics of events.

The following schema is an example of how the EM-DAT database architecture is designed.

Figure 3. Diagram of the EM-DAT database structure



4. Proposed loss database for disaster risk management architecture

4.1. Common aspects

Every database that has been studied has its own characteristics and tracks enough information to serve the purpose for which it was designed. In most cases this happens only to serve one hazard, and only in the case of Slovenia (AJDA) is the database designed to be multi-hazard.

That being said, AJDA is the most advanced database from among those that we studied in detail. It could even be used as a case study or as an entry point to export into other countries with similar characteristics, both in terms of the size of the country, which is relatively small, and from the point of view of hazards to be recorded and to what extent.

However, the Slovenian case cannot be the final solution to the proposal of the loss database architecture at EU level, since every country has its own requirements. Further developments should be made to be able to adapt it to a bigger loss database picture.

Extracting the common set of information for every hazard is a hard task and must be done carefully in order not to leave out any relevant information. The main challenge relies on building a complex but flexible database structure where all the hazards can fit, without losing the valuable pieces of information inherent in every hazard-oriented database.

The loss database for disaster risk management should be based on the following pillars:

- be compliant with the diverse directives and initiatives;
- be able to collect and aggregate data to report to the Sendai Framework;
- contribute to the preparation of the NRA;
- contribute to monitor the SDG;
- be Inspire compliant.

4.2. Elements

The databases that we studied mainly focused on the event. In some cases the events are taken as single and independent facts, but in others, as has been seen in some cases, they can be related and one event can be the result of another.

On the other hand, there are assets, which are pieces of the puzzle that alone have a place in the loss database. The assets can be of many kinds and can have associated information. An asset can lead to economic loss and environmental, cultural heritage and even human costs of those living (houses), working (employment places), studying (schools, universities) or just passing by (shopping centres, cinemas, theatres ...).

Even from the point of view of the economic losses, these can either be direct or indirect. For this reason, an important piece of the database is the assets.

For the loss database for disaster risk management there are three pieces of a triage:

- events,
- assets,
- damages.

4.3. Events

Some of the databases that have been taken into account consider the event as the main piece of information. Everything revolves around this element and the whole database is based on it.

Let us consider the element event as one element — but not the only one — without which the loss database would not make any sense. It is one piece of information, but it is meaningless without the other two elements (assets and damages).

In our database, one event can happen on its own, as a cascading effect resulting from another, or as the result of several others (e.g. the tsunami that occurred in Japan after the earthquake and nuclear leak at the Fukushima power plant).

Disregarding this kind of information is not critical from the point of view of the damage or loss in human lives, but can help in identifying possible cascading effects, potential risks and future cascading events likely to happen in certain areas.

For this reason, in the proposed loss database schema, the main element (event) table would have the following information, common to all hazards:

- (Identification Data) event ID,
- start_date,
- duration/end_date,
- denomination,
- type_of_event,
- update_date,
- (International Organisation for Standardisation) ISO_country_name,
- methodology,
- pedigree.

Associated to this events table would be another table with metadata information with the following fields:

- generated number (like a GLIDE number),
- URL,
- title,
- status.

The events table would be linked to supporting tables as well. There would be one for every hazard with its hazard-only information and another would contain the coping capacity information of the country(ies) affected by the hazard.

The following tables would be supporting tables.

- Coping capacity:
  - ISO country code,
  - country name,
  - coping capacity index.
- Earthquake:
  - magnitude,
  - intensity,
  - scale,
  - depth,
  - localisation (latitude/longitude),
  - affected population,
  - affected area,
  - radius.

- Tropical cyclone/hurricane:
  - category (Saffir–Simpson),
  - max wind speed,
  - affected population,
  - affected area,
  - radius.
- Storm surge:
  - max sustained wind speed,
  - max storm surge height,
  - affected area,
  - affected population.
- Landslide/avalanche:
  - type of soil,
  - speed of landslide/avalanche,
  - depth of snow/landslide,
  - affected area,
  - affected population.
- Flood:
  - source of flooding,
  - unit of management,
  - flooded area/affected area,
  - inundated length,
  - frequency,
  - recurrence,
  - rainfall height,
  - rainfall duration,
  - characteristics of flooding,
  - mechanism of flooding,
  - water depth.
- Chemical/biological/technological hazard:
  - type of substance/allergens,
  - infestation,
  - danger level,
  - wind direction,
  - affected area,
  - affected population,
  - radius,
  - exclusion area.
- Cyberattack/terrorist attack:
  - type of infrastructure affected,
  - loss/damage of data,
  - target of attack,
  - destruction/loss of hardware,
  - affected area,
  - affected population.
- Volcano:
  - source,
  - location (latitude/longitude),
  - wind direction,
  - lava slide speed,
  - affected area,
  - affected population,
  - radius.

- Cosmic:
  - magnetic disruption level,
  - impact meteorite location (latitude/longitude),
  - solar and cosmic radiation level,
  - affected area,
  - affected population,
  - radius.
- Forest/wild/underground fire:
  - wind direction,
  - affected area,
  - affected population,
  - radius.
- Drought:
  - air humidity,
  - number of days since last rainfall,
  - soil composition.
- Nuclear:
  - disaster scale,
  - radiation leak,
  - affected area,
  - affected population,
  - radius,
  - exclusion area,
  - type of radioactive material leaked.
- Tsunami:
  - wave height,
  - wave speed,
  - affected area,
  - affected population.
- Climatological (cold and heat wave):
  - extreme temperature,
  - number of days,
  - recurrence,
  - frequency,
  - affected area,
  - affected population.

4.4. Assets

The assets table contains all the information about different assets, but its main source of information is fed with the date from the cadastre in order to have an up-to-date version of the buildings, land and infrastructure. The cadastral data should be updated twice a year. The assets table contains the following fields:

- asset ID,
- asset name,
- asset description,
- asset value,
- asset location ID,
- asset owner ID,
- asset economic ID,
- asset environmental ID,
- asset heritage ID,
- event ID.

Linked to the assets table there should be several supporting tables.

Economic table

This table would provide further information on economic details, if any, associated to the asset and linked to the 'asset economic ID' code.

Cultural heritage table

This table would provide further information on cultural heritage details, if any, associated to the asset, such as ID codes identifying the cultural heritage, value, year, type of heritage or restoration costs, and linked to the 'cultural heritage ID' code.

Environmental table

This table would provide further information on environmental details, if any, associated to the asset, such as the kind of environmental damage, affection or costs associated impact, and linked to the 'environmental ID' code.

People table

The cadastral data should provide data about the owner and people living in the apartments, houses or flats, and do so in a disaggregated way:

- gender (male/female),
- age (under 18/adults/seniors),
- income (low/medium/high),
- disability.

This table should be linked with the assets table by the asset_ID, which identifies every single asset. It would be linked with the events table by the event_ID to be able to link events to human losses that are not associated with assets (e.g. deaths that occurred in the open air). The fields of this table are:

- asset ID,
- event ID,
- number of males,
- number of females,
- number of males aged under 18,
- number of females aged under 18,
- number of male adults (aged 18-65),
- number of female adults (aged 18-65),
- number of male seniors (+ 65),
- number of female seniors (+ 65),
- number of males on low income,
- number of females on low income,
- number of males on medium income,
- number of females on medium income,
- number of males on high income,
- number of females on high income,
- number of males with disability
- number of females with disability.

Prices table

The **prices** table is updated twice a year. It contains the prices for the squared metres of the buildings depending on the area *(*area code*)* in order to rapidly asses the direct loss when an event affects a property. Besides this, this table has information about the costs of repairing single parts of the assets, such as windows, walls, doors and roofs, with its prices updated. This table is directly linked to the value table as well, which shows the aggregated value of the asset before any event has happened. This table is linked to the assets table by the asset_ID code. Its fields are:

- asset ID,
- area code,
- item ID,
- item description,
- value,
- total value.

In addition, the assets table is linked with a localisation table, where the precise location of the asset is displayed:

- Localisation ID,
- latitude,
- longitude,
- area code,
- street,
- commune,
- region/province,
- ISO country,
- country name.

4.5. Damage

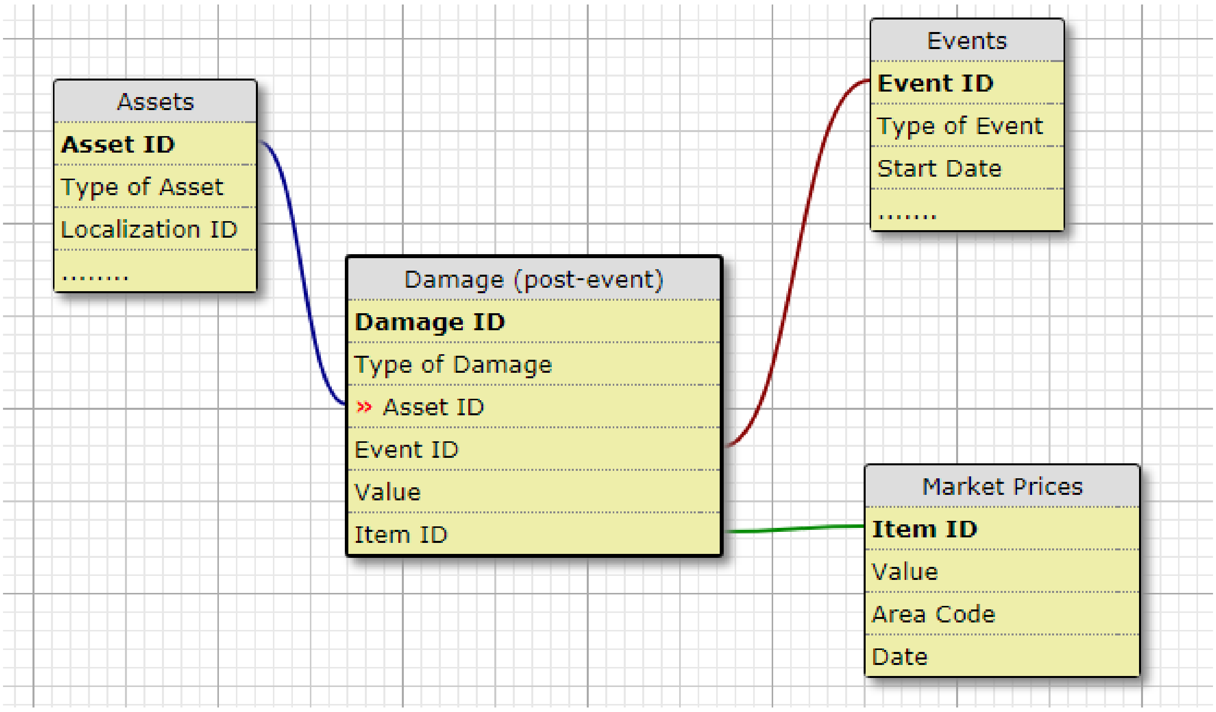
The damages table contains the percentage of damage of an asset. Damage occurs due to an event and an asset suffers damage.

Just as there is a value table associated with the assets, and these data are considered to be the pre-event information of the asset, damage should represent the kind of damage that has been inflicted on the asset, considering this information as the post-event situation of the asset.

This table represents the percentage of damage, to which items, at what extent and at what cost. As there is cost involved, this table is fed by the market price table, which represents the up-to-date prices of the items, or the square metre price depending on the area code of the asset (updated twice a year).

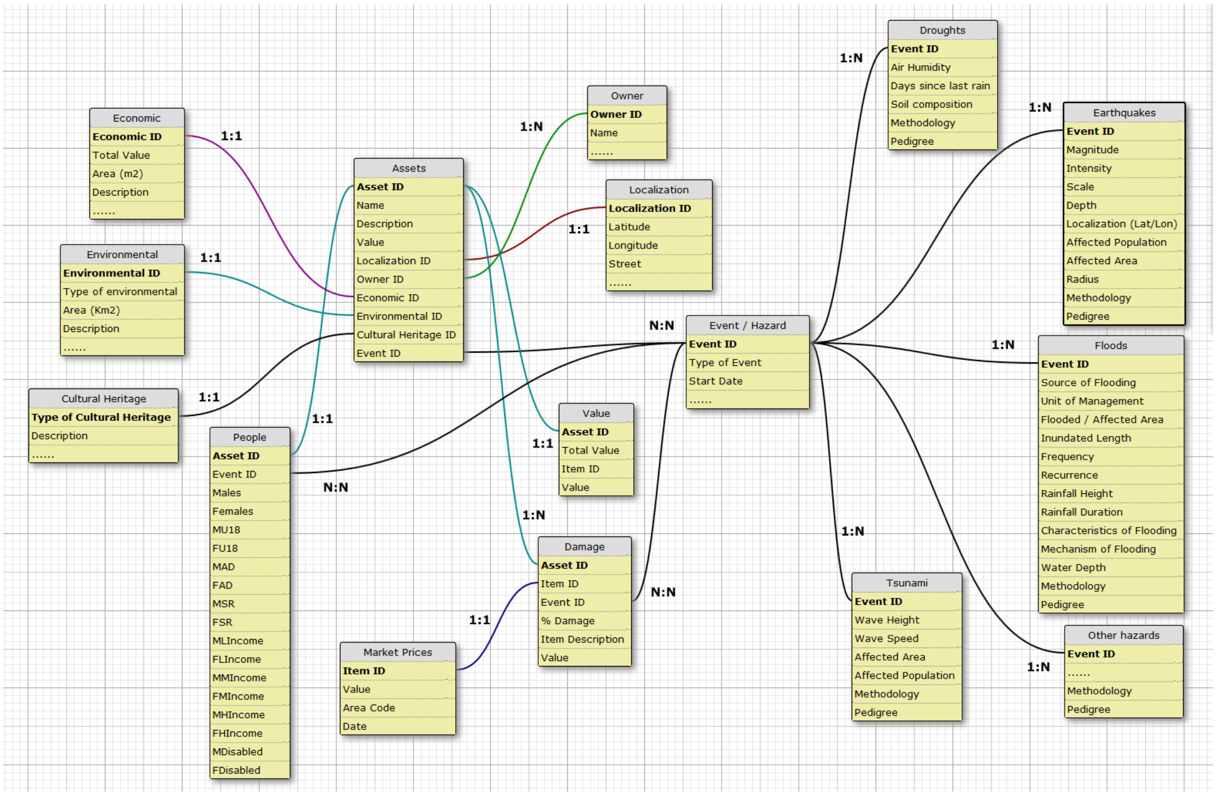
The damage table will be linked to the events table by the event_ID, with the assets table linked by the asset_ID and with the market price table linked by the item_ID.

Figure 4. Structure of how damage is linked to assets, events and market prices



4.6. Loss database architecture

Figure 5. Diagram of the loss database architecture



5. Adaptation of the Database architecture for the Risk Data Hub

5.1. Challenges identified

5.1.1. How to represent together exposure, vulnerability and past events

The Risk Data Hub aims to handle different type of datasets, making them available on a unique portal to help end users in many tasks related to Disaster Risk Management.

The data used come from models, or archives of past events. While models tell us what could happen, past events are something that already happened, in a specific date, under specific circumstances, hence the visualization of these two types of data cannot be the same.

Data is also referred to many natural hazards (technological hazards to be included in a future implementation) and every hazard has its own peculiarities; that’s why data inputs differ from hazard to hazard.

Considering this, the first challenge consists of storing different type of data in a single database and presenting them in a way that preserve their specificity in a single user interface.

Our proposal to this is including a main entity **Damage Assessment** which, along with the overall flexible design, let the system manage and present data about different type of analysis. A more detailed explanation is included in the chapter explaining the Database architecture further on this document.

5.1.2. Harvest data from multiple sources

Having such a wide area of interest, there cannot be only a single source of data. Risk Data Hub works with many scientific partners that provide the application with the outputs of their work. These are typically models used for populating the Risk Analysis datasets of the Risk Data Hub, but sometimes archives of past events are included.

While models have a good coverage and are produced on a regular basis by scientists, the collection of loss data is something that is not homogeneous, nor well defined and structured; that is why data availability is poor, especially on a large scale.

Scientific, economic and political issues that causes this poor availability of data are not a concern of this document. Technically speaking, a way identified to get as many data as possible, is to connect with different sources.

This challenge leads to the development of a dedicated data integration flow for each data source activated. The Risk Data Hub has an ETL layer that is needed to transform data extracted before inserting them into the database.

5.1.3. Identification and classification of events

The identification of events is still a matter of discussion in the scientific community and it’s not homogeneous among different hazards.

The logic used by the Risk Data Hub relies on:

- **An event is identified by Hazard, Country and Date**. This means that, for example, a single meteorological event which covers an area shared by two countries will generate exactly two events in the system, even if distant and not adjacent regions in the same countries are affected.
- **An event is a macro entity that may include multiple phenomena**. This means that while an event can be associated to a whole country and it can last

several days (or weeks), the are single phenomena that map the event to a more specific location and date, such as single burned areas of a vast forest fire.

5.1.4. Unique coding of events

Every data source uses its own way of assigning a code to events; furthermore, events coming from various sources may overlap, hence a new code has to be assigned to keep a consistent archive.

In the Risk Data Hub the code composition is implemented as follows:

[Hazard] (code of 2 characters)

+ [Country] (ISO2 of country)

+ [Begin Date] (in YYYYMMDD format)

+ [Glide Number] (4 digits serial number)

An example would be:

When imported into the system, every event has a status equals to "draft" and it needs moderation to be published. Only when the event is approved, the Risk Data Hub code is generated; this allows to be consistent with the sequence of glide numbers of published events.

5.1.5. Country corner and user privileges

The Risk Data Hub publishes European wide datasets, but the whole system is designed to work also at national or regional level. A single institutional user who is responsible for its country should be able to upload data and choose whether or not to share this data with other users or groups.

The logic is based on 2 main points:

- A user belongs to one or multiple groups and each group has some basic permissions
- Each dataset in the system has a unique owner that can set visibility and permissions for it

Examples:

Ex 1: The group of administrators of the Austrian country corner has privileges for managing all datasets assigned to the Austria Region. A user who belongs to this group uploads two layers and decides for the first one to grant View rights to all groups and for the second one full rights only to the group "Austria_Administrators". After this, the first layer will be visible to every user (but not editable) even if not registered to the site (because it belongs to Anonymous group); the second layer will be visible and editable only by the users in the group "Austria_Administrators".

Ex 2: A country corner administrator uploads data for a new Damage Assessment and choose to grant Edit right to the administrators group and only View rights to the group of non admin users of the country corner of reference. After this, a non-logged user or a user of another country corner will not see anything of that Damage Assessment.

5.1.6. Scalability and performance

Since the Risk Data Hub is expected to store and manage large amounts of data, scalability is a matter to be addressed to keep the application healthy and responsive.

This document is not a technical guide, nor a list of design patterns in Python or any other language. Here we want just state that performance is something taken into consideration and there some practices or tools already in use, as well as others to be applied in the near future.

The following measures are the proposals to achieve the goal:

- Use of Database indexes
- Optimizations of queries
- Use of GeoWebCache: this is a tool that comes with GeoServer and caches tiles generated by WMS calls. Tiles can be both cached after a call to WMS service, or by a bulk seeding process
- Caching of Django Views: Django integrates a configurable caching system for its views, allowing multiple page requests to consume resources only once after the cache expiration
- "Reselect" tool for React: the client application keeps the data retrieved from the backend API in its own internal "store" and would make a new call to the API only if data is not already into it; this saves both bandwidth and system resources

Further improvements:

- Deployment of Geoserver on a dedicated machine
- Use of NoSQL database: when data stored starts to exceed a certain amount, old fashioned relational databases start to suffer a degradation of their performance. The use of a NoSQL database should solve this problem, but at this point the technology selection process is not completed, as there are several constraints to be considered about Geonode and Geoserver.

5.2. Technologies

After collecting and analyzing the main requirements of the platform to be developed, it was time to choose the technologies and tools to be used. Some of these choices were anticipated by the previous chapter and they were the result of checking previous works in this fields, as they pointed out that significant projects were based on **Geonode** and **Geoserver**.

The system architecture as a whole is composed of several layers, from the ETL that extract data from external sources, to frontend of the website.

Basically, the project is built with Django (Python web framework), using Geonode as dependency, PostGIS as database backend and a client application developed with ReactJS.

Geonode is mainly used for uploading and managing vector and raster layers. Inventory, Analysis and Loss data are loaded into a dedicated database that will be described later in this document.

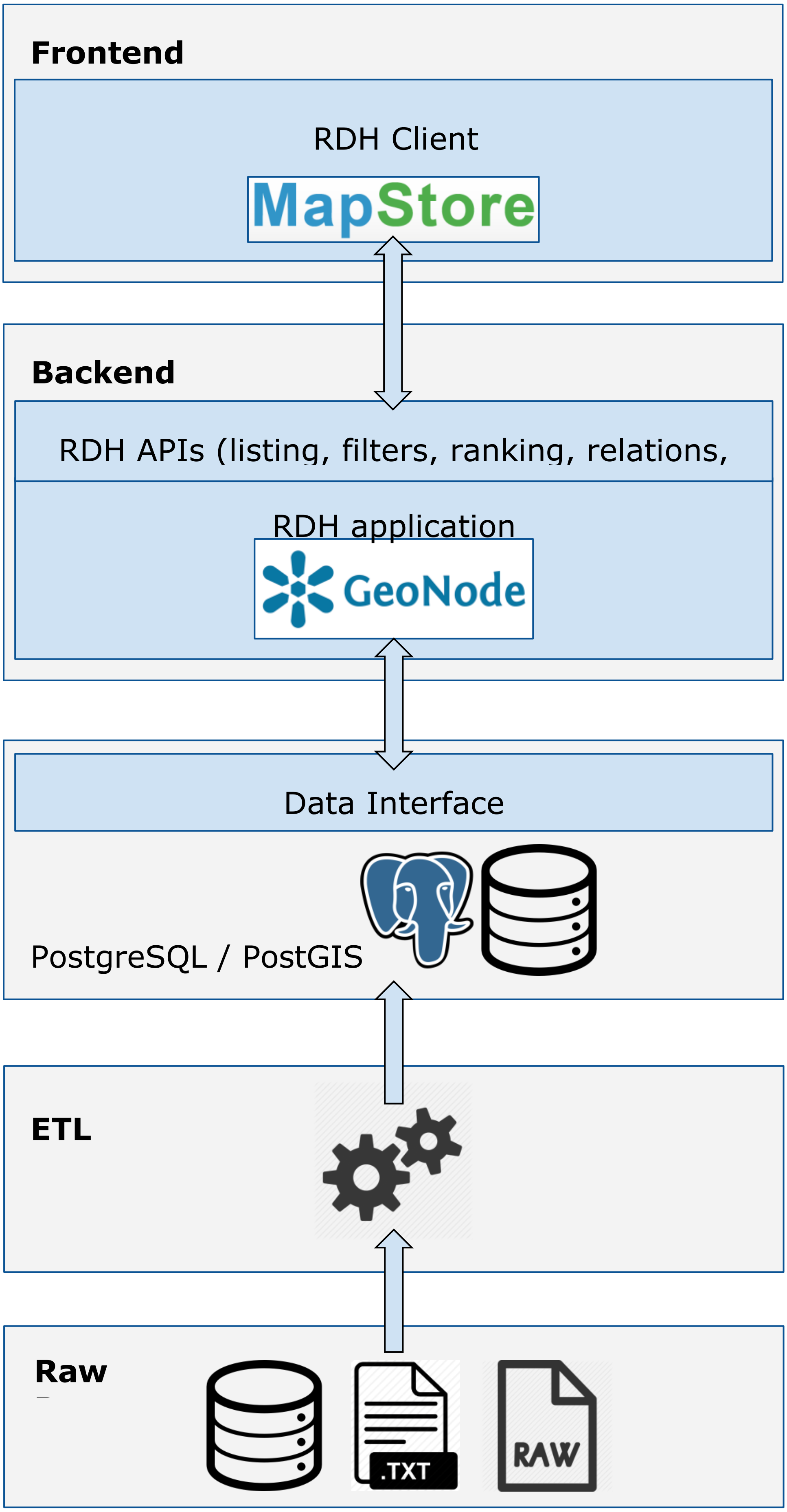
Specific layers are created in GeoServer by SQL Views and are used to extract and filter data to show on map.

The basic operations performed by RDH application against PostGIS database are:

- Data extraction and pre-processing (pg/plsql + Python code)
- Spatial queries to extract spatial relations between datasets
- Extract administrative division boundaries

The basic operations performed by RDH application against GeoServer are:

- OGC/WMS service calls to view layers on map
- (E)CQL to filter layers and contents on map
- SLD for styling multiple geometries and geometry types
- SLD filters for styling contents
- Geofence rules to restrict access to layers and services
- GeoWebCache for tile chaching


Frontend
RDH Client
MapStore
Backend
RDH APIs (listing, filters, ranking, relations,
RDH application
GeoNode
Data Interface
PostgreSQL / PostGIS
ETL
Raw
.TXT
RAW

5.3. Database upgrade

5.3.1. Evolution of Loss Database architecture

The implementation of the base concept of Risk Data Hub required storing data for different purposes, such as **Risk Analysis**, **Inventory of Assets** and **Damage Assessments**.

The database was designed after the **Loss Database for Disaster Risk Management** proposed in latest EU publications (http://dx.doi.org/10.2760/647488). The result was at the same time an abstraction and an extension of that model.

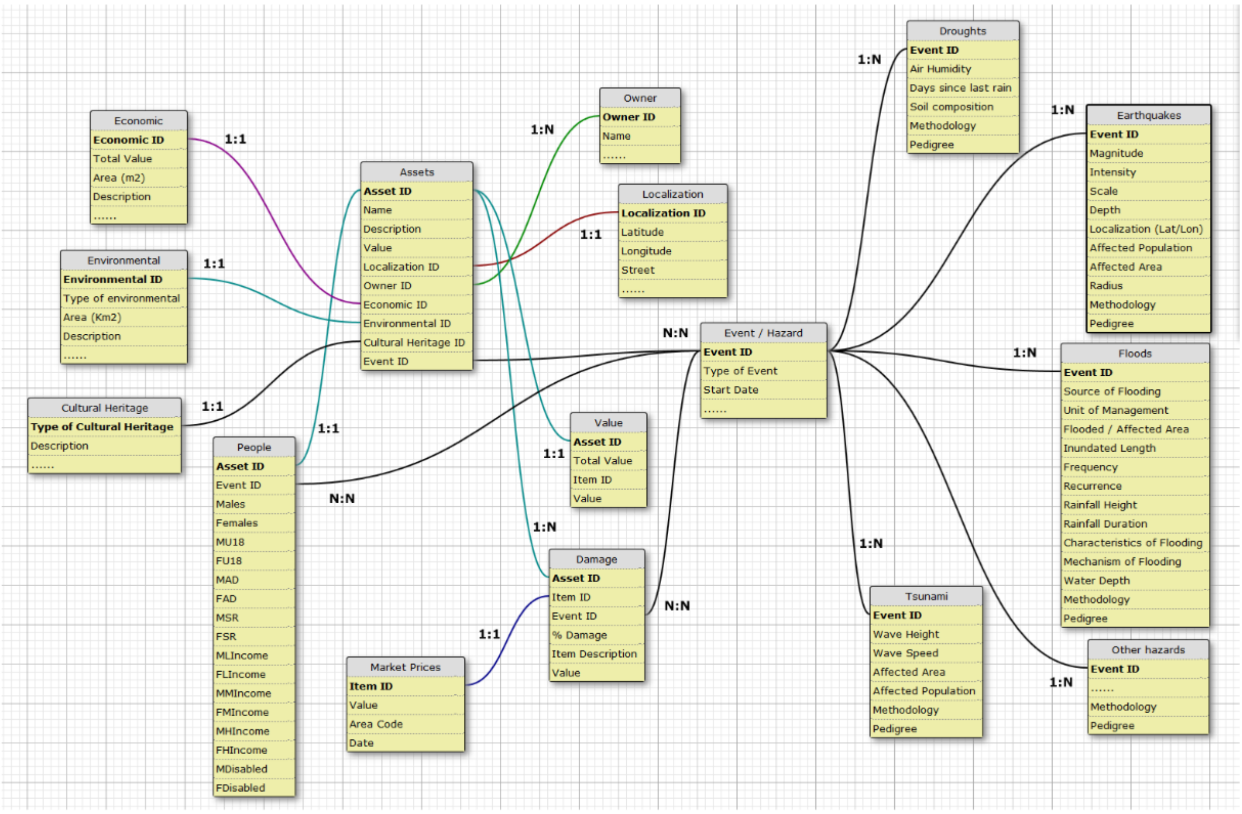


Fig. 5.3.1 – Loss Database diagram as of 2018

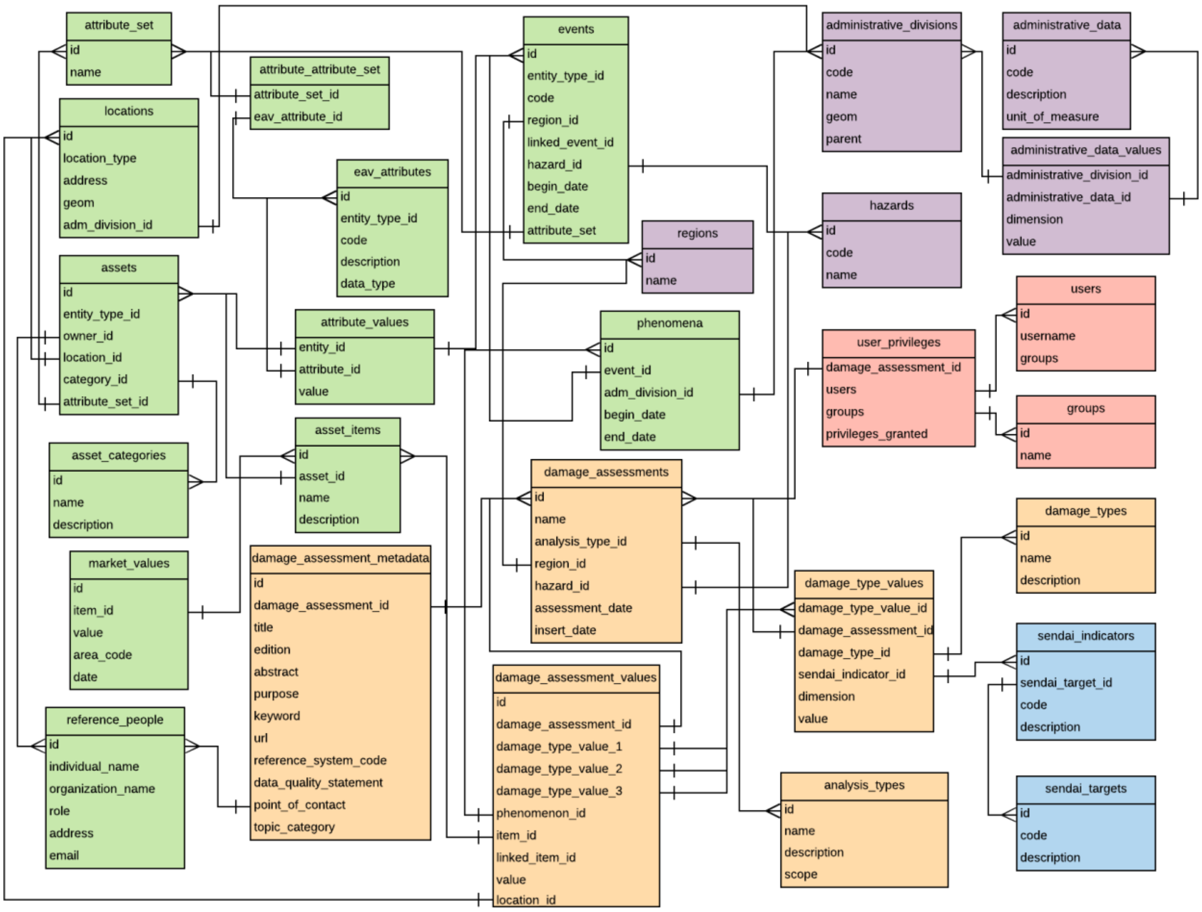


Fig 3.2 – The Risk Data Hub Database diagram. Tables are highlighted in different colors, corresponding to specific functionalities within the application

5.3.2. Changes to the Database architecture

5.3.2.1 Events

The Event entity has been split into a "macro event" and a phenomenon, as explained earlier. An Event table linked to a number of external tables (Hazards) no longer exists: all event attributes are stored in a centralized table, implementing the **EAV** (Entity Attribute Value) data model. Since attributes may differ from hazard to hazard, each Event instance is bound to a specific **Attribute Set** that ideally equals a hazard.

5.3.2.2 Assets

In the same fashion as events, also the Asset has been split into a "macro asset" and an item: each asset may contain one or multiple assets (e.g. a house containing pieces of furniture). Damages are linked to items, not to macro assets. Asset attributes are not described by an additional table for every type, but they use the EAV data model and they are also divided into categories. Fox a maximum abstraction, People are considered a specific asset category.

5.3.2.3 Locations

A location entity still exists, but defines also a type (e.g. fixed location, non-fixed location, people) and it is linked to damages as well; this way every single damage may have a specific location, as damage location may differ from asset location. Damage location could be a point, or a polygon that defines an extent.

As mentioned previously the Risk Data Hub database implements an abstraction of the Loss Database, which can be identified by the Inventory Section (green) of the schema. There are further sections that allow all the functionalities to exist.

5.3.3. Entity Inventory

This entity allows to store all inventory data needed, both assets and events. The number of columns for assets and events is limited, because all possible descriptive fields are managed via the EAV (Entity Attribute Value) data model, which allows to define new attributes at any time, without the need of changing the database structure.

locations

Description: this entity is useful to store location of any type of asset (fixed, non_fixed, people), or the extent of a single damage

Fields:

- Id (int): unique identifier
- Location_type (enum): eg. Fixed asset
- Address (varchar):
- Geom (binary): geometry (could be Point or Polygon)
- Administrative_division_id (int): reference to administrative_divisions

assets

Description: generic entity affected by event (includes also People)

Fields:

- Id (int): unique identifier
- Entity_type (enum): defines entity type for mapping fitting attributes
- Owner_id (int): reference to reference_people
- Asset_location_id (int): reference to locations
- Asset_category_id (int): reference to categories
- Attribute_set_id: reference to attribute_set

asset_items

Description: single item included in the asset (equals to asset in the simplest case)

Fields:

- Id (int): unique identifier
- Asset_id (int): reference to assets
- Name (varchar):

asset_categories

Description: categories for assets; e.g. Buildings, Infrastructures or People

Fields:

- Id (int): unique identifier
- Name (varchar):
- Description (varchar):

market_values

Description: market value of items

Fields:

- Id (int): unique identifier
- Item_id (int): reference to assets
- Value (decimal):
- Area_code (varchar):
- Date (datetime): start validity date

reference_people

Description: could be the owner of an asset, author of publications, etc.

Fields:

- Id (int): unique identifier
- Individual_name (varchar):
- Organization_name (varchar):
- Role (varchar):
- Address (varchar):
- City (varchar):
- Zipcode (varchar):
- Country (varchar):
- Email (varchar):

eav_attributes

Description: attributes relevant to events and assets (and more) are defined in a single place. This feature allows to define new attributes at any time, without the need to change the structure of database.

Fields:

- Id (int): unique identifier
- Entity_type_id (int): defines entity type for mapping fitting attributes
- Data_type (varchar): defines data type (varchar, text, integer, decimal, datetime)
- Name (varchar):
- Description (varchar):

attribute_values

Description: Attributes values are stored in dedicated tables for each type of data (varchar, text, integer, decimal, datetime)

Fields:

- Entity_id (int): identifier of entity (event or asset)
- Attribute_id (int): identifier of eav_attribute
- Value: (see note below)

***** The database diagram provided with this document includes a simplified view of the implemented EAV (entity, attribute, value) data model. Actually, a table for each data_type / entity_type exists in the database, e.g. event_attribute_values_varchar, event_attribute_values_text, and so on.

attribute_set

Description: attribute sets are used to link attributes to specific instances of an entity

Fields:

- Id (int): unique identifier
- Name (varchar):

attribute_attribute_set

Description: this is a relation between attribute_set and eav_attribute, so it's basically the content of an attribute set

Fields:

- Attribute_set_id: reference to attribute_set
- Eav_attribute_id: reference to eav_attribute

events

Description: an event is a generic entity which may be the cause of a damage.

Fields:

- Id (int): unique identifier of the event
- Entity_type_id (int): defines entity type for mapping fitting attributes
- Region_id (int): could be Europe, or any country corner
- Linked_event_id (int): optional link to an event identified as cause of the current one (chained events)
- Hazard_id (int): identifier of the hazard (eg. Flood)
- Begin_date (datetime): starting date of recognized event
- End_date (datetime): starting date of recognized event
- Attribute_set_id: reference to attribute_set

phenomena

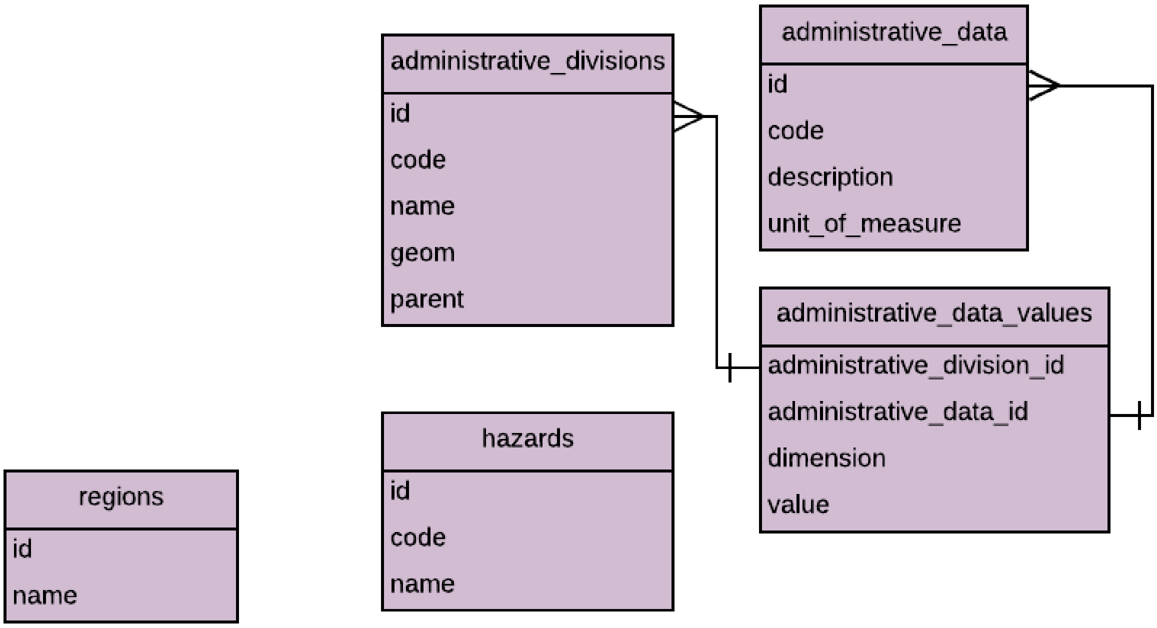
Description: a phenomenon is part of a major event and has specific location and related assessed damage.

Fields:

- Id (int): unique identifier
- Event_id (int): related event
- Administrative_division (int): maps location of phenomenon
- Begin_date (datetime): starting date of recognized event
- End_date (datetime): starting date of recognized event

5.3.4. Entity Administrative Data

This section gathers entities used for basic characterization of data stored for the Damage Assessments



hazards

Description: definition of Hazard (e.g. River Flood)

Fields:

- Id (int): unique identifier
- Code (varchar): e.g. FL for Flood
- Description (varchar):

administrative_divisions

Description: This entity stores basic data of administrative divisions.

Fields:

- Id (int): unique identifier
- Code (varchar): ISO2 for countries, or relevant NUTS code according to Eurostat
- Name (varchar): name of administrative division
- Geom (binary): spatial data
- Parent_id (int): parent adm division

regions

Description: this is crucial for ownership management of data and visibility. Each user in the system belongs to a specific Region and so are the data owned by that user.

Fields:

- Id (int): unique identifier
- Name (varchar): name of Region (e.g. Europe, or country corner, like Austria)

administrative_data

Description: definition of data related to Administrative Divisions, like GDP, Population, Area, and so on.

Fields:

- Id (int): unique identifier
- Code (varchar): e.g. GDP
- Description (varchar): description of data
- Unit_of_measure (varchar): e.g. Mln EUR

administrative_data_value

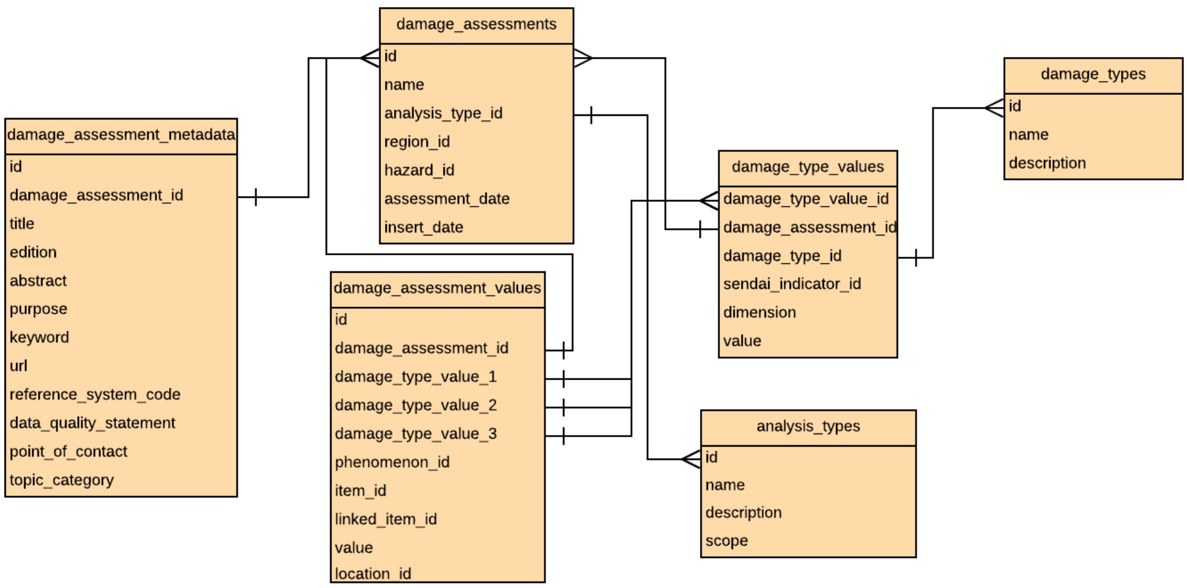
Description: relation between Administrative Data and Administrative Divisions.

Fields:

- Administrative_division_id (int):
- Administrative_data_id (int):
- Dimension (varchar): e.g. Year 2018 of GDP
- Value (decimal):

5.3.5. Entity Damage Assessment

This section represents the core of the Risk Data Hub, as it defines the Damage Assessments and how the datasets are organized. The **Analysis_type** entity basically defines a dataset in terms of data analyzed (Buildings, People) and of scope (Risk Analysis or Historical Events). The **Damage_type** defines the dimensions used to measure data within the Assessment (e.g. Climate Change scenarios, return periods of events).



analysis_types

Description: defines the type of data analyzed (e.g. Polulation, Buildings, Econonic values)

Fields:

- Id (int): unique identifier

- Name (varchar):
- Description (varchar):

damage_assessments

Description: definition of data measured

Fields:

- Id (int): unique identifier
- Name (varchar): name given (unique)
- Analysis_type_id (int): reference to analysis type
- Region_id (int): reference to Region, needed for Risk Analysis that do not use events
- Hazard_id (int): reference to Hazard, needed for Risk Analysis that do not use events
- Assessment_date (datetime): date declared for the assessment
- Insert_date (datetime): date of insertion in the database

damage_types

Description: definition of considered scenario. It is useful for complex analysis with predicted values in different declinations of a given scenario (e.g. climate change)

Fields:

- Id (int): unique identifier
- Name (varchar): name given (unique)
- Description (varchar):

damage_type_values

Description: relation between Damage_Assessment and Damage_Type

Fields:

- Id (int): unique identifier
- Damage_assessment_id (int): reference to damage assessment
- Damage_type_id (int): reference to damage type
- Sendai_indicator_id (int): reference to sendai indicator
- Dimension (varchar): e.g. Axis of a chart
- Value (varchar): value of damage type for given assessment and dimension

damage_assessment_value

Description: value assigned to the loss for given phenomenon, damage assessment, damage type and item

Fields:

- Id (int): unique identifier
- Damage_assessment_id (int): reference to damage assessment
- Damage_type_value_1(2,3)_id (int): damage type specific to DA
- Phenomenon_id (int): reference to phenomena
- Item_id (int): reference to asset_items
- Linked_item_id (int): eg. allows to map people into a building
- Value (decimal):
- Location_id (int): reference to locations, to store location (extent) of the single damage

damage_assessment_metadata

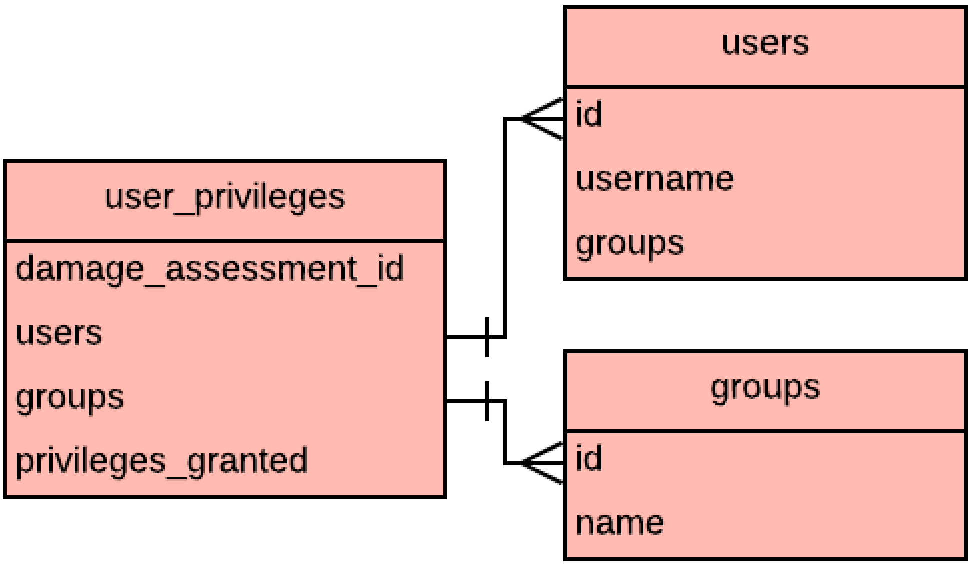
Description: complementary description of a damage assessment publication

Fields:

- Id (int): unique identifier
- Damage_assessment_id (int): reference to damage assessment
- Title (varchar):
- Edition (varchar):
- Abstract (varchar):
- Purpose (varchar):
- Keyword (varchar):
- Url (varchar):
- Reference_system_code (varchar):
- Data_quality_statement (text):
- Point_of_contact (int): point of contact for the publication (reference_people)
- Author (int): author of publication (reference_people)
- Topic_category: e.g. Environmental, Structure, etc.

5.3.6. Entity Authorisation

These entities ensure that the datasets are properly managed by their owners which may allow other users to perform operations (view, create, edit or delete).



users

Description: users registered

Fields:

- Id (int): unique identifier
- Username (varchar):
- Groups (array): list of groups the user belongs to

groups

Description: group of users for permission purposes

Fields:

- Id (int): unique identifier
- Name (varchar): name given (unique)

user_privileges

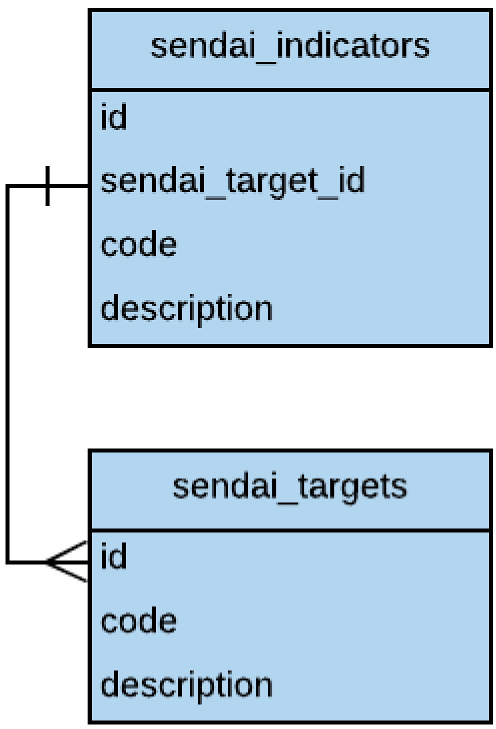
Description: privileges assigned to group or single user to perform actions against a Damage Assessment (view, create, edit, delete)

Fields:

- Damage_assessment_id (int): reference to damage_assessment
- Users (array): list of users for current entry
- Groups (array): list of groups for current entry
- Privileges_granted (array): list of privileges granted for current entry

5.3.7. Additional information

This additional section collects entities that are not strictly relevant to the main functionalities of the application. These tables are used only to store a mapping between the Assessments performed by the Risk Data Hub and the Sendai Indicators, while outputs useful for Sendai reporting are generated, when data available is consistent, using a logic implemented in the source code of the application.



sendai_targets

Description: Sendai Target as defined by UNISDR specifications

Fields:

- Id (int): unique identifier
- Code (varchar): (unique)
- Description (varchar):

sendai_indicators

Description: Sendai Indicator as defined by UNISDR specifications

Fields:

- Id (int): unique identifier
- Sendai_target_id (int): reference to target
- Code (varchar): (unique)
- Description (varchar):

6. Conclusions

This report explains the multi-hazard Database architecture and concludes with an update of what was previously proposed previously in December 2017. The main aim of this proposed architecture was to be able to maintain the multi-hazard approach and it has been modified over the time in order to adjust to the specific needs that were coming up during the development of the Risk Data Hub, while maintaining the initial purpose.

References

[1] "http://ec.europa.eu/echo/what/civil-protection/mechanism_en," [Online].

[2] "https://eurdep.jrc.ec.europa.eu/Entry/Default.aspx," [Online].

[3] "https://rem.jrc.ec.europa.eu/RemWeb/activities/Ecurie.aspx," [Online].

[4] "http://climate-adapt.eea.europa.eu/," [Online].

[5] "http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32000H0473," [Online].

[6] "http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al33260," [Online].

[7] "http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32007L0060," [Online].

[8] "http://ec.europa.eu/environment/water/water-framework/index_en.html," [Online].

[9] "https://inspire.ec.europa.eu/," [Online].

[10] "http://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A31982L0501," [Online].

[11] "http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31996L0082," [Online].

[12] "http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0018," [Online].

[13] "http://www.unisdr.org/we/coordinate/sendai-framework," [Online].

[14] "http://www.un.org/sustainabledevelopment/sustainable-development-goals/," [Online].

[15] "http://ec.europa.eu/environment/sustainable-development/SDGs/index_en.htm," [Online].

[16] "http://www.un.org/millenniumgoals/," [Online].

[17] "https://goo.gl/Cg3dxQ," [Online].

[18] "https://goo.gl/wPDb1E," [Online].

[19] "https://sustainabledevelopment.un.org/rio20.html," [Online].

[20] "http://undocs.org/E/CN.3/2017/2," [Online].

[21] "https://www.preventionweb.net/drr-framework/open-ended-working-group/," [Online].

[22] "http://unfccc.int/paris_agreement/items/9485.php," [Online].

[23] "http://www.isprambiente.gov.it/pre_meteo/idro/Val_prem.html," [Online].

[24] "http://www.consorsegurosdigital.com/en/numero-06/front-page/catalogue-of-earthquake-damage-in-spain-a-tool-to-reduce-disaster-risk," [Online].

[25] "http://dppi.info/sites/default/files/Slovenia1.ppsx," [Online].

[26] "https://goo.gl/BwuFyL," [Online].

[27] "https://ajda.projekti.si," [Online].

[28] "https://minerva.jrc.ec.europa.eu/en/minerva," [Online].

[29] "http://www.emdat.be/," [Online].

List of abbreviations and definitions

NRA	national risk assessment
JRC	Joint Research Centre
APSFRs	Areas of potential significant flood risk
UN	United nations
SDGs	Sustainable development goals
CDTE	Catalogo de daños por terremoto en España
CNIH	Catalogo nacional de inundaciones históricas
eMARS	Major accident reporting system
FloodCat	Catalogue of past floods

List of figures

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at:

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

- at the following standard number: +32 22999696, or

- by electronic mail via:

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at:

EU publications

You can download or order free and priced EU publications from EU Bookshop at: . Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see).

-EN-N

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

Joint Research Centre

EU Science Hub

Publications Office

doi: 10.2760/647488

ISBN 978-92-79-77752-3