Search & Rescue

Emerging technologies for the Early location of Entrapped victims under Collapsed Structures & Advanced Wearables for risk assessment and First Responders Safety in SAR operations

D4.1 Data aggregation

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Executive Summary

This deliverable provides information about the retrieval of data from resources relevant to past large-scale disasters and the aggregation of data coming from heterogeneous sources, such as smart glasses, smart helmets, drones, and sensors.

As far as the past disasters are concerned, 23 relevant resources have been identified, thoroughly analysed, and evaluated according to specific criteria. Those resources concern almost all types of disasters and provide information mainly about the details of each disaster and the caused casualties. However, a few resources also include data about the needs, the used equipment, and the number of responders that were required for the search & rescue activities during the respective disaster. The examination of the identified resources revealed that 10 of the 23 resources have the potential to provide invaluable information that can be proved to be handy during crisis preparedness and Search & Rescue activities.

Regarding the aggregation of data coming from heterogeneous sources, the Data Fusion and Mediation System will be responsible for gathering all the data and storing them to a Cloud Server. All the sources, e.g., drones, will send their data to the Data Fusion and Mediation System through various ways, such as Wi-Fi, Bluetooth, and Restful APIs.

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1   Introduction

In the following sections, an overview of the purpose and scope of this document is presented. The structure and the relationship to other documents are described, as well as the list of abbreviations used in the current deliverable.

1.1   Purpose and Scope

The purpose of the present deliverable entitled "Data Aggregation" is to identify the kind of data that will be aggregated from both external resources/databases relevant to past disasters and internal heterogeneous sources that will be utilised during the Search & Rescue operations. More specifically the present deliverable aims to fulfil the following main objectives:

- Provide information about the identification and evaluation of existing resources that contain data about past incidents and large-scale disasters for not only natural, technological, and natech hazards, but terrorism events as well.

- Describe the high-level architecture of the Data Fusion and Mediation System that will be responsible for the aggregation and the filtering of the data which will be provided by various sources, such as drones and wearable devices. In addition, this document provides information about the integration of the used sensors into the Mediation System.

1.2   Structure of the Document

The structure of this document is the following:

- **Section 1** presents the purpose and scope of this document and explains the structure and the relationship of this deliverable with other documents of this project.

- **Section 2** gives an overview of resources related to past European/international incidents and large-scale disasters for not only natural, technological, and natech hazards, but terrorism events as well. In addition, it provides information about the aggregation of data coming from heterogeneous sources and devices, such as sensors and drones.

- **Section 3** concludes this deliverable.

1.3   Relationship with Other Documents

This deliverable is the first in a series of two reports (D4.1, D4.8) that documents the retrieval of data from external resources relevant to past large-scale disasters and the aggregation of data coming from internal heterogeneous sources, e.g., smart glasses, drones, and sensors. The results of these two documents will be utilized by tasks 4.4 – "Design of DSS components" and 4.5 – "Development of DSS components". The external and internal data that will be gathered will be used by the DSS component for the support of crisis preparedness and search & rescue activities. In particular, by utilising both past and real-time data, authorities will be able to leverage the DSS component to make the best possible decisions regarding search & rescue operations. The results of these two documents are also connected with tasks T2.5 – "Involvement of volunteer organisations / citizens", T4.3 – "Situational Analysis & Impact Assessment", T6.2 – "S&R Data Communication Interoperability framework", T6.3 – "S&R services interoperability framework", T6.4 – "S&R Design of interoperability framework", T6.5 – "Design of an aftermath knowledge capitalisation mechanism", T7.2 – "Architecture and Design Specifications

of S&R", T7.3 – "Specification of interfaces based on the S&R interoperability framework", T7.4 – "Adaptation of systems and services", and T7.5 – "S&R platform component and service integration". In general, all these tasks will utilize either the data stored in external resources that are relevant to past large-scale disasters or the data fusion and mediation system that is responsible for the aggregation of data from internal sources like drones and sensors.

As such, the present document is related to the following deliverables:

- D4.8 - Data aggregation, V2
- D4.2 - Situational Analysis & Impact Assessment
- D4.3 - Design of SOT DSS components
- D4.4 - Design of PHYSIO DSS component
- D4.9 - Design of SOT DSS components, V2
- D4.10 - Design of PHYSIO DSS component, V2
- D4.5 - Development of SOT DSS components
- D4.6 - Development of PHYSIO DSS component
- D4.11 - Development of SOT DSS components, V2
- D4.12 - Development of PHYSIO DSS component, V2
- D2.5 - Citizens and volunteer organisations involvement in Crisis Management
- D2.8 - Citizens and volunteer organisations involvement in Crisis Management, final version
- D6.2 - Voice, data and services interoperability frameworks
- D6.3 - Presentation and analysis of the designed S&R interoperability framework
- D6.4 - S&R lessons learnt mechanism
- D6.8 - S&R lessons learnt mechanism, V2
- D6.5 - Establishment of technical components and legacy systems taxonomy
- D7.2 - Architecture and Design Specifications of S&R platform
- D7.12 - Architecture and Design Specifications of S&R platform, V2
- D7.3 - Component interface specifications for interoperability within S&R
- D7.4 - Adapted S&R components and services
- D7.5 - Integrated S&R platform 1st version
- D7.6 - Integrated S&R platform 2nd version

1.4   List of Abbreviations

The following table includes all the abbreviations used in the document.

Table 1: List of Abbreviations

Abbreviation	Explanation
S&R	Search & Rescue
eMARS	Major Accident Reporting System
CDD	Canadian Disaster Database
FEMA	Federal Emergency Management Agency
GLC	Global Landslide Catalog
HURDAT	Hurricane Database
NOAA	National Oceanic & Atmospheric Administration
USGS	United States Geological Survey
NATDIS	Natural Disaster

GIDD	Global Internal Displacement Database
RMS	Risk Management Solutions
PCS	Property Claim Services
EM-DAT	Emergency Events Database
ICMS	Insarag Coordination Management System
CP	Command Point
RDV	Reception Departure Centre
GTD	Global Terrorism Database
API	Application Programming Interface
PSAP	Public Safety Answering Point
IoT	Internet of Things
IP	Internet Protocol
WAN	Wide Area Network
EMS	Emergency Management System
GPS	Global Positioning System
UAV	Unmanned Aerial Vehicle
UAS	Unmanned Aircraft System
MOS	Metal Oxide Semiconductors
IC	Integrated Circuit
3D MR CC	3D Mixed Reality Command Centre

2 Aggregation of data coming from heterogeneous sources

The main objective of Section 2 is to elaborate on the aggregation of data coming from both external and internal heterogeneous sources. In particular, Section 2.1 aims to identify, examine, and evaluate external resources that contain information relevant to past European/international large-scale disasters. Those disasters concern not only natural, technological, and natech hazards but also terrorism events. Section 2.2 presents information about the Mediation System that will fuse information coming from internal sources, such as drones and sensors. In addition, it describes the internal sources and explains how those sources will send their data to the Mediation and Fusion System.

2.1 External resources relevant to past large-scale disasters

The main objective of Section 2.1 is to identify, examine, and evaluate external resources related to past European/international incidents and large-scale disasters for natural, technological, and natech hazards but also for terrorism events. The data extracted from those resources will be utilised to support crisis preparedness activities and provide common information to all interested organisations.

2.1.1 Methodology

2.1.1.1 Purpose

Section 2.1 "Methodology" aims to present the methods that have been used to accomplish the following:

- To identify resources relevant to the objectives of the Search & Rescue project.
- To select the criteria that should be used for the evaluation of the identified resources.
- To establish a template for the evaluation of the resources.

2.1.1.2 Methods

This section contains information about the methods that have been used for the identification and evaluation of external to the Search & Rescue project resources relevant to European/international incident and large-scale disasters.
For the identification of resources, the following methods were used:

- Keyword search: Keyword phrases, such as disaster databases, emergency management systems, search & rescue resources, data about casualties caused by disasters, earthquake resources, were used so that search engines would suggest relevant resources.

- Suggestions from partners with expertise in these topics: Partners proposed resources there were aware of and/or have previously used. As a result, we managed to collect a valuable list of resources (candidates) based on the project expertise.

- Identification of databases used in other projects and resources: Conducted research regarding the resources other projects, e.g., IMPRESS, and resources, e.g., Risk Data Hub, have used.

The effective examination and evaluation of the resources required the identification of specific criteria. The following methods were used for the establishment of the evaluation criteria:

- Discussion with partners: All partners and especially the partners that are responsible for the use cases and have relevant experience expressed their opinion about what kind of resources could be useful during crisis preparedness activities.

- Analysis of the extraction process: In order to effectively evaluate a resource and decide whether it would be useful, it is important to understand not only how the included data can be extracted, but also the format of the data. In particular, the data should be available in a format that facilitates their processing instead of complicating it.

After establishing the criteria that should be used for the resources' evaluation, a google form was created for partners to provide their feedback and assessments. Google forms were chosen, because they can facilitate the comparative analysis of the resources and ensure that the evaluations would be easily aggregated and analysed.

2.1.1.3   Selection Criteria and Resource Analysis Template

The following criteria should be taken into consideration in order to effectively examine and evaluate the identified databases and resources and decide which ones should be leveraged to support crisis preparedness activities.

- It is of outmost importance to gather information not only about the specific characteristics of past disasters, but also about the required resources and effects of those disasters. Such information can facilitate the prediction of casualties and needs during future disasters, and hence help support crisis preparedness activities. In particular, it would be helpful to gather information about the following:
    - Details of the disaster (e.g., type of disaster (earthquake, fire, etc.), location, time, magnitude, duration, cause, scale)
    - Casualties (e.g., total number of injured people, total number of deaths, triage levels, time frame of injuries and deaths)
    - Needs (e.g., required equipment, number of needed intensive care units, health personnel)
    - Used equipment (e.g., drones, robots, wearables, protective equipment, medical equipment plus the respective number)
    - Responders (e.g., type of qualifications of human resources deployed on site (paramedics, doctors, firefighters, etc.), number of responders, cross-border help)
    - On-site procedures (e.g., medical procedures performed, health exams, biomonitoring of responders, environmental monitoring, detection and measurement of hazardous material)
    - Communication between teams (do teams communicate with each other or do the involved teams communicate in a more centralized way (e.g., each team communicates only with the General Secretariat of Civil Protection)?)
- Potential use: What kind of decisions and analyses could be made based on the extracted information?
- Scope: It is important to aggregate information about disasters that have happened all over the world.
- Language: It would be difficult to process information written in a language other than English.
- Public/Private data: Public resources are preferred over private ones and IPRs have to be respected and protected.
- Type/format of the stored data and extraction process: Is in important to take into consideration the format of the stored data when deciding whether a particular resource should be used.

Upon the selection of the abovementioned criteria, the following google form was created so that there is an organised and uniform way to evaluate all the identified resources that are relevant to past large-scale incidents and disasters.

Resource/Database *

Your answer

URL *

Your answer

Description *

Your answer

Types of disasters included in this resource *

☐ Earthquakes

☐ Fires

☐ Floods

☐ Plane crashes

☐ Hurricanes

☐ Chemical accidents

☐ Terrorist events

☐ Landslides

☐ Volcanos

☐ Other:

Categories of relevant data *
What relevant data can we extract from this resource? See Document's Section 1 to understand each of the following categories.

☐ Details of the disaster

☐ Casualties

☐ Needs

☐ Used equipment

☐ Responders

☐ On-site procedures

☐ Communication between teams

☐ Other:

Relevant data in detail *
Please explain what kind of data we can extract for each of the data categories you have checked. You can use the examples of relevant information provided in Document's Section 1 as reference.

Your answer

Type/format of the stored data *

E.g. text, images, csv files, database schema

Your answer

Language *

What language are the data written in?

☐ English

☐ Other:

Scope *

Is the database relevant to a specific region, country or continent, or does it include information about international incidents and disasters?

☐ Global

☐ European

☐ Regional

☐ Other:

Scope details

If the database is relevant to specific countries/regions please provide additional information (e.g. mention some countries).

Your answer

How often are the data updated? *

E.g. immediately after a disaster or once a year.

Your answer

Are the stored data public or private? *

Can we just export the desired data or do we need to communicate with the respective organisation or perhaps even pay for the acquisition of their data?

☐ Public

☐ Private

☐ Other:

Are the stored data public or private? *

Please explain your answer to the previous question.

Your answer

How can we extract the data? *

Are there APIs that we can leverage? Can we connect to the database and use queries? Are the data downloadable (e.g. csv files)? Please be specific!

Your answer

Potential uses *

What kind of decisions can we make based on the extracted information? How can we analyse the data?
What visualisations could be created based on those data?

Your answer

Relevance *

Based on the thorough examination of the database, do we need to prioritise its usage?

◯ High

◯ Medium

◯ Low

Explain why you consider the relevance to be high/medium/low respectively *

Your answer

Figure 1: Google form used to evaluate resources relevant to past large-scale disasters

2.1.2   Findings / Relevant Databases

2.1.2.1   Overview of Findings

The methods described in Section 2.1.1.2 "Methods" resulted in the identification and evaluation of 23 resources relevant to past international incidents and large-scale disasters that could potentially provide information that could support crisis-preparedness and search & rescue activities. The complete list of the resources that have been identified and examined along with their thorough evaluation are presented in section 2.1.2.2 "Relevant Resources" of this deliverable. This section provides an overview of the findings and the type of information that those resources contain.

As shown in Figure 2 the identified resources include information about almost all types of disasters. In particular, the majority of the resources concern more than one type of disasters, with the most common types being earthquakes, fires, floods, hurricanes, chemical accidents, landslides, and volcanos.
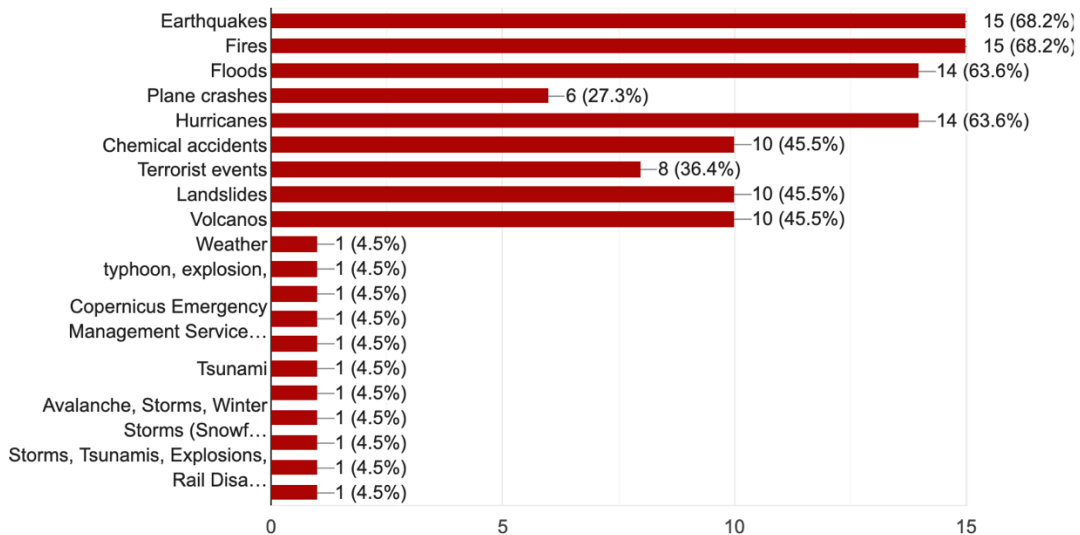
Figure 2: Types of disasters included in the resources

Almost all the resources provide information about the details of each disaster (e.g., date, time, area, magnitude in case of earthquakes). However, only 16 out of the 23 resources contain information about the casualties caused by each disaster. At the same time, information about the on-site procedures and the needs, the used equipment, and the number of responders that were required for the search & rescue activities during the respective disaster are quite scarce. Some databases also contain information about the financial losses caused by the disasters.
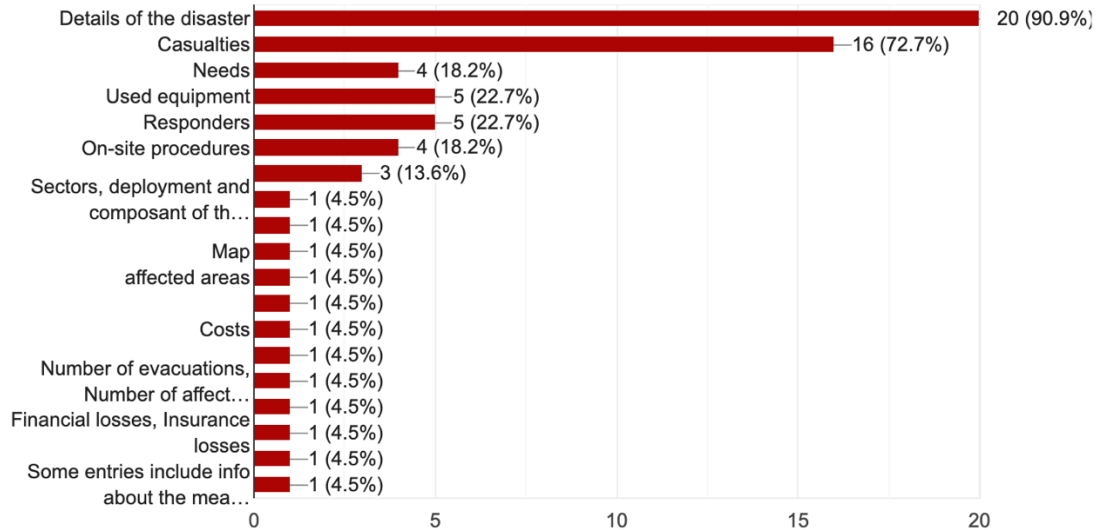
Figure 3: Categories of data included in the resources

As shown in Figure 4, all the resources, with the exception of one, include data that are written in English. Two resources also support local languages, such as French.
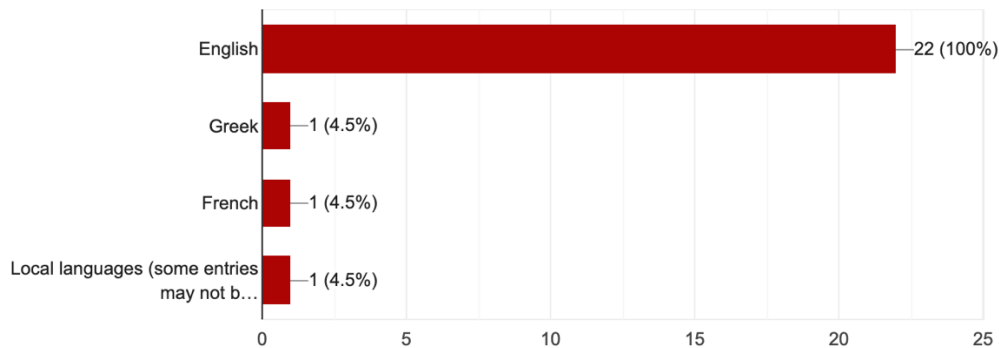
Figure 4: Language in which the information included in the resources is written

While the majority of the identified resources report on disasters that have happened all over the world, some resources focus on specific countries like Canada and the United States of America.
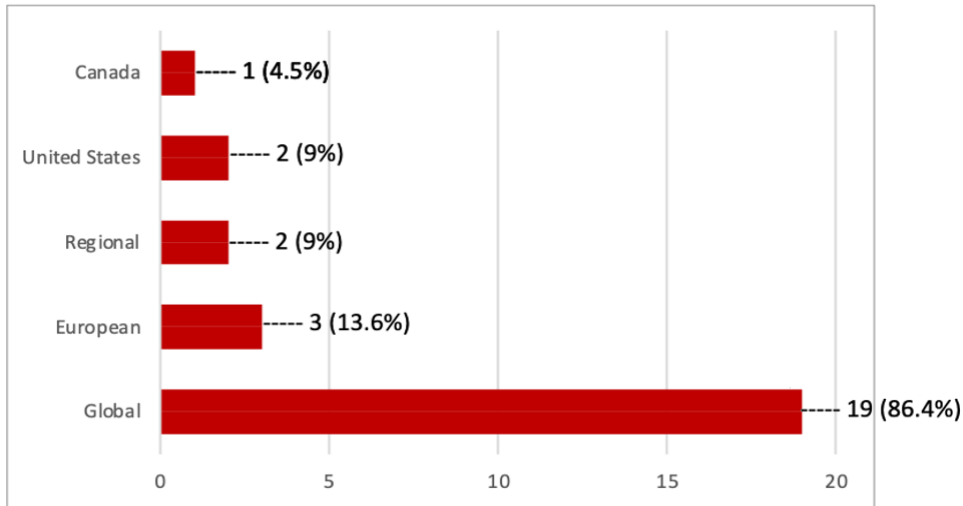
Figure 5: Scope of the resources
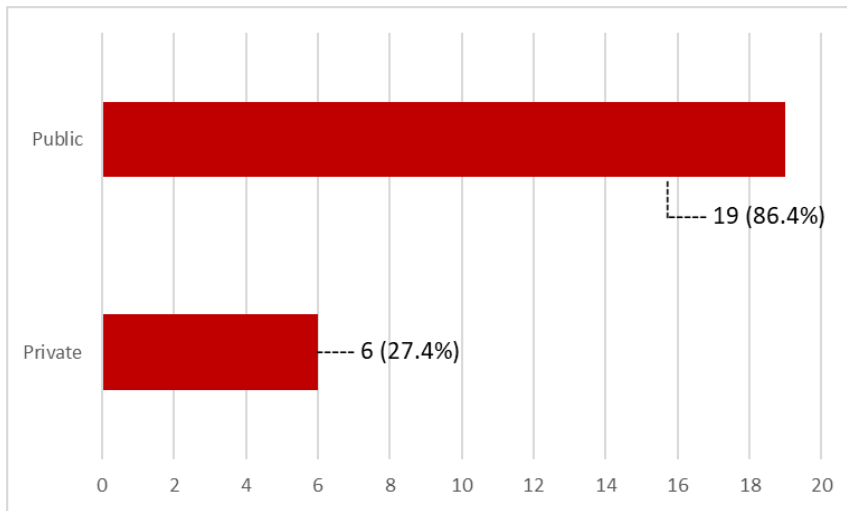
Figure 6: Public/Private resources

In addition, each resource stores data in totally different formats and provides different ways to access and extract its data. For instance, roughly half the resources provide data in csv format among others, while some resources use json, rss, or kml formats. The majority of the resources allow users to directly download the data, while some resources provide APIs that users can utilise to access the stored data and create queries.

2.1.2.2 Relevant Resources

The following tables concern the evaluation of the identified resources. The google form presented in Section "2.1.1.3 Selection Criteria and Resource Analysis Template" was used for the examination and evaluation of the resources.

Table 2: eMARS

Resource/Database	eMARS (The Major Accident Reporting System) [1]
Description	eMARS contains reports of chemical accidents and near misses provided to the Major Accident Hazards Bureau (MAHB) of the European Commission's Joint Research Centre (JRC) from EU, EEA, OECD, and UNECE countries (under the TEIA Convention). The

	purpose of the eMARS is to facilitate exchange of lessons learned from accidents and near misses involving dangerous substances in order to improve chemical accident prevention and mitigation of potential consequences.
Types of disasters included in this resource	Chemical accidents
Categories of relevant data	Statistics about the number of chemical accidents, the reasons for which they have been reported, and the type of industry in which those accidents happened.
Relevant data in detail	- Number of accidents per year - Number of accidents in each country per year - Number of accidents that have happened in each industry type - Percentage breakdown with respect to the "Special Reasons" (e.g. Interesting lessons learned, Injury to people: >=1 fatalities, >= 6 hospitalising injuries) for which the events have been reported
Scope	Global - eMARS contains reports of chemical accidents and near misses provided from EU, EEA, OECD, and UNECE countries.
Language	English
Data Update Frequency	The database is updated when an event that meets the criteria of a "major accident" happens and a Seveso establishment is involved. However, it might take 2-3 years for the reporting process to be completed.
Public/Private data	Public - There is no need to ask for permission in order to download the data.
Type/format of the stored data	Csv, png, and pdf files
Ways to extract the data	It is possible for any public user to query the database using the Search functionalities to filter out specific accident records and download the results in csv files.
Potential uses	eMARS provides information about the countries in which the majority of chemical accidents happen. It also facilitates the understanding of which industry types are the most susceptible to chemical accidents, and hence indicate the types of establishments in which more stringent measures against accidents should be taken.
Relevance	Low - Although chemical accidents are relevant to one of the use cases of the project, this resource does not provide any information that could support search & rescue activities.

Table 3: The Canadian Disaster Database

Resource/Database	The Canadian Disaster Database [2]
Description	The Canadian Disaster Database (CDD) contains detailed disaster information on more than 1,000 natural, technological and conflict events (excluding war) that have happened since 1900 at home or abroad and that have directly affected Canadians. The CDD tracks significant disaster events that meet one or more of the following criteria: - 10 or more people killed - 100 or more people affected/injured/infected/evacuated or homeless - an appeal for national/international assistance - historical significance

	- significant damage/interruption of normal processes such that the community affected cannot recover on its own The CDD describes: - where and when a disaster occurred - the number of injuries, evacuations, and fatalities - an estimate of the costs
Types of disasters included in this resource	Earthquakes, Fires, Floods, Plane crashes, Hurricanes, Chemical accidents, Terrorist events, Landslides, Volcanos, Avalanche, Storms, Winter Storms (Snowfalls/Blizzards), Tsunami, Explosions (air, marine, rail, vehicle)
Categories of relevant data	Details of the disaster, Casualties, Number of evacuations, Number of affected people, Estimate of costs and insurance payments
Relevant data in detail	- Details of the disaster: Event Category (Disaster / Incident), Event Group (Natural / Conflict / Technology), Event Subgroup (e.g., Geological, Meteorological – Hydrological, Terrorist, Fire, Explosion), Event Type (e.g. Earthquake, Wildfire, Landslide, Volcano, Chemical, Air explosion, Derailment), Place, Coordinates, Event Start Date (Date and Time), Event End Date (Date and Time), Magnitude: in case of earthquake - Casualties: Number of fatalities, Number of injured/infected people, Number of people that were evacuated form the area, Number of people that were affected by the disaster - Costs and Payments: Estimated Total Cost, Federal DFAA Payments, Provincial DFAA Payments, Provincial Department Payments, Municipal Costs, OGD Costs, Insurance Payments, NGO Payments
Scope	Mainly Canada - This database contains information on disasters that have happened in Canada or abroad and that have directly affected Canadians. So, the scope is not 100% geographical and limited to Canada, as some International events are included as well.
Language	English
Data Update Frequency	The CDD is reviewed and updated periodically to add disasters that have occurred since the last update and to reflect new information that has become available about past disasters. The exact update frequency is not mentioned.
Public/Private data	Public - The data can be exported without the need to contact the Canadian Disaster Database Secretariat. However, the CDD may contain material that is subject to licensing requirements or copyright restrictions and may not be reproduced, published, distributed or transferred in whole or in part without the consent of the author.
Type/format of the stored data	Tab-Delimited Text files, GeoRSS feed links, KML files, KML feed links
Ways to extract the data	The data can be downloaded as Tab-Delimited Text files, GeoRSS feed links, KML files, and KML feed links.
Potential uses	These data can provide information about the number of casualties caused by each disaster, and thus they can help authorities make predictions concerning future casualties and needs. These data can also be consumed by geographic software, such as map generators, in order to display the areas in which most disasters have occurred.

	An analysis could possibly be made about the amounts required for the affected communities to heal, and the duration of the healing depending on the amount of financial aid and its source.
Relevance	Medium - While this database provides invaluable information about the casualties caused by past disasters, almost all those disasters have happened in Canada.

Table 4: FEMA

Resource/Database	FEMA (Federal Emergency Management Agency) [3]
Description	The mission of FEMA (Federal Emergency Management Agency) is to support the citizens and first responders to promote that US citizens can work together in order to build, sustain, and improve their capability to prepare for, protect against, respond to, recover from, and mitigate all hazards. The Federal Emergency Management Agency contains several open-data relevant to various disasters that have happened in the USA.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Hurricanes, Chemical accidents, Terrorist events, Landslides, Volcanos, Droughts, Storms, Tornados, Tsunami
Categories of relevant data	Details of the disaster, Grant programs, Disaster assistance, Hazard mitigation grant amounts, information about alert messages, Damage categories, Mitigated properties
Relevant data in detail	- Details of the disaster: type, description, start and end dates, location (state) - Disaster assistance: type of disaster assistance each area affected by a disaster is eligible for - Financial assistance values including the number of approved applications, as well as individual, public assistance, and hazard mitigation grant amounts. - Alert messages: senders, date, message, status, incidents, urgency, severity, audience, area - Properties that were mitigated by projects funded under the Hazard Mitigation Assistance (HMA) grant programs: location (state, county, city, zip), type of structure, amount paid to the property owner, amount of damage)
Scope	USA - This database contains information relevant only to disasters that have happened in USA.
Language	English
Data Update Frequency	Update frequency: irregular (different for each dataset)
Public/Private data	Public - There is no need to ask for permission in order to access and download the data.
Type/format of the stored data	Open, industry standard, machine-readable formats. Data sets are available in multiple formats, including downloadable files (csv, json, jsona) and through an easily digestible Application Programming Interface (API).
Ways to extract the data	The majority of the datasets can be downloaded as csv, json, and jsona files). The data are also available through APIs. The page about each dataset includes information about the specific data set, links to downloadable files, a data dictionary describing each field, and an endpoint link (if applicable for those data sets available via the API). [4][5][6]
Potential uses	This resource provides information about the financial assistance that people have needed after disasters and the grant programs that were in effect during the reported disasters. Hence, statistics about the needed grants (perhaps per disaster type and area) can

	be created. This resource can also help authorities understand which areas and properties have been affected by disasters.
Relevance	Low - This resource focuses on USA and the majority of its data concern assistance and granting programs that are relevant only to USA.

Table 5: Sigma Explorer

Resource/Database	Sigma Explorer [7]
Description	Sigma Explorer contains data extracted from the annual sigma reports on natural catastrophes. It also contains data relevant to the world insurance markets.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Terrorist events, Storms, Tsunamis, Explosions, Rail Disasters, Collapses of buildings/bridges, Weather related
Categories of relevant data	Details of the disaster, Casualties, Financial losses, Insurance losses
Relevant data in detail	- Disasters: number of disasters (Man-made and Natural catastrophes) per year, type of disaster, date of disaster, area - Casualties: number of victims, injured, homeless per year and per disaster - Number of destroyed/damaged houses per disaster - Insured losses: per year and per disaster - Total losses: financial losses attributed to a major event and losses due to business interruption
Scope	Global
Language	English
Data Update Frequency	The data in Sigma-Explorer are updated after the publication of the world insurance sigma at the end of June on insitute.swissre.com/sigma. Figures for past years are adjusted as new information becomes available.
Public/Private data	Public - The charts can be exported without the need to ask for permission.
Type/format of the stored data	Charts and maps in png, jpg, and pdf format.
Ways to extract the data	The data can be downloaded as images.
Potential uses	This resource provides information about the casualties (deaths, injuries, etc.) caused by each disaster, and hence it can facilitate the prediction of future casualties and needs. Sigma Explorer can also provide information about the insurance costs and the total financial losses caused by disasters. An analysis could possibly be made about the amounts required for the affected communities to heal.
Relevance	Low - The stored data can be exported only as images. As a result, it will be difficult to analyse the data in order to support crisis preparedness and search & rescue activities.

Table 6: DesInventar Sendai

Resource/Database	DesInventar Sendai [8]
Description	The Disaster Information Management System is a sustainable arrangement within an institution for the systematic collection, documentation and analysis of data about losses caused by disasters associated with natural hazards. DesInventar Sendai contains detailed disaster loss data for more than 89 countries.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Hurricanes, Landslides, Storms, Avalanche, Explosion
Categories of relevant data	Details of the disaster, Casualties, Economic Impact, Damages

Relevant data in detail	- Details of the disaster: Type, Date, Location, Region, District, Commune, Event Serial Number, GLIDE number - Casualties: Number of deaths, injured people, missing people, relocated people and evacuated people - Economic impact & damages: Destroyed houses, damaged houses, number of directly affected people, number of indirectly affected people, Losses $USD, Losses $Local, Education centers, Hospitals, Damages in crops, Lost Cattle, Damages in roads
Scope	Global - This resource contains detailed disaster loss data for more than 89 countries.
Language	English, Local languages (some entries may not be translated)
Data Update Frequency	The update frequency is not mentioned.
Public/Private data	Public - There is no need to ask for permission in order to download the data. DesInventar is free of charge for commercial and non-commercial use.
Type/format of the stored data	XML files
Ways to extract the data	The data can be downloaded as xml files. [9][10]
Potential uses	These data provide information about the number of casualties caused by each disaster, and thus they can facilitate the prediction of future casualties and needs. These datasets also contain information about the damages (e.g., concerning buildings and roads) and financial losses caused by each disaster. Hence, it is possible to create statistics about the difficulties encountered by first responders.
Relevance	High - The relevance is high because this database provides information about casualties and damages that can prove to be handy during crisis preparedness activities. In addition, it contains information about disasters that have happened all over the world instead of focusing on a single region.

Table 7: Global Landslide Catalog

Resource/Database	Global Landslide Catalog [11][12][13][14]
Description	The Global Landslide Catalog (GLC) was developed with the goal of identifying rainfall-triggered landslide events around the world, regardless of size, impacts or location. The GLC considers all types of mass movements triggered by rainfall, which have been reported in the media, disaster databases, scientific reports, or other sources. The GLC has been compiled since 2007 at NASA Goddard Space Flight Center. This is a unique data set with the ID tag "GLC" in the landslide editor.
Types of disasters included in this resource	Landslide
Categories of relevant data	Details of the disaster, Casualties, Some entries include info about the means used or needed to resolve the issue
Relevant data in detail	- Details of the disaster: date, time, disaster title, description, landslide category, landslide trigger, landslide size, storm name, location description, location accuracy, country, longitude, latitude, administrative division name, administrative division population, gazetteer distance, gazetteer closest point - Casualties: number of fatalities, number of injured people - Some entries include info about the means used or needed to resolve the issue.

Scope	Global
Language	English
Data Update Frequency	Irregular update frequency
Public/Private data	Public - The data can be exported without asking for permission.
Type/format of the stored data	CSV, RDF, RSS, TSV, XML, and JSON
Ways to extract the data	The data can be downloaded as CSV, RDF, RSS, TSV, and XML files. In addition, the Socrata Open Data API (SODA) provides programmatic access to this dataset including the ability to filter, query, and aggregate data.
Potential uses	These data provide information about the number of casualties caused by each disaster, and thus can facilitate the prediction of future casualties and needs. This database also contains information about the causes of each landslide. Hence, it is possible to analyse the data to figure out the causes of the largest or deadliest landslides.
Relevance	High - While this database provides information about casualties caused by past disasters, it concerns only landslides.

Table 8: Hellenic Fire Service

Resource/Database	Hellenic Fire Service [15]
Description	Hellenic Fire Service Resource provides data about past forest fires in Greece, what resources were used to extinguish the fire, and how many acres were burned.
Types of disasters included in this resource	Fires
Categories of relevant data	Details of the disaster, Casualties, Used equipment, Responders
Relevant data in detail	- Details of the disaster: Region (the Region of the fire), Date and time of the start of the fire, Date and time of the end of the fire - Casualties: Acres burned (How many Acres were burned), Types of burned acres (Forests, Forest area, Groves, Grasslands, Reeds - Swamps, Agricultural lands, Crop residues, Broom-places) - Used equipment: Number and types (Fire trucks, tankers, Machines) of needed vehicles, Number and types (Helicopters, A / F CL 415, A / F CL 215, A / F PZL, A / F GRU) of Aerial forces, Number of people needed concerning Hiking forces and types of Hiking forces (Fire-fighters, Volunteers, Army, other forces)
Scope	Greece
Language	Greek
Data Update Frequency	The data are updated once a year
Public/Private data	Public
Type/format of the stored data	csv and xlsx files
Ways to extract the data	The data can be downloaded from Hellenic Fire Service's site as csv and xlsx files.
Potential uses	These data can provide information about the used forces and the acres burned in every event. Plots, like bar plots, about the areas in which most fires occurred can be created. Also, these data can provide plots concerning the number of acres burned in a year. In addition, predictions can be made about the required resources (e.g., number of needed fire fighters and fire trucks).

Relevance	High - While this resource contains invaluable information about fires and the needed forces, it concerns only fires that have happened in Greece.

Table 9: OpenWeatherMap Resource

Resource/Database	OpenWeatherMap Resource [16]
Description	The OpenWeatherMap Resource provides weather data based on Latitude and Longitude through an API.
Types of disasters included in this resource	Weather data not related to a specific disaster
Categories of relevant data	Information about the weather
Relevant data in detail	- Latitude: Latitude is an angle (defined below) which ranges from 0° at the Equator to 90° (North or South) at the poles. - Longitude: Longitude is the measurement east or west of the prime meridian. Longitude is measured by imaginary lines that run around the Earth vertically (up and down) and meet at the North and South Poles. - Temperature: The temperature for the specific Longitude and Latitude - Humidity: The Humidity for the specific Longitude and Latitude - Wind speed: The wind speed for the specific Longitude and Latitude - Rainfall: The rainfall for the specific Longitude and Latitude
Scope	Global
Language	English
Data Update Frequency	The data are updated immediately after weather changes.
Public/Private data	Public - The data are provided by OpenWeatherMap, a public resource which is available only with a key and only a limited number of them is free as JSON files
Type/format of the stored data	JSON files
Ways to extract the data	An API provides free access to a limited amount of data.
Potential uses	These data can be combined with other datasets in order to find the weather conditions of the region in which the disaster occurs.
Relevance	Medium - This resource provides information about the weather, and hence can facilitate search & rescue activities. In addition, it can give input about the weather conditions that might have complicated search & rescue activities during past disasters.

Table 10: HURDAT

Resource/Database	HURDAT [17]
Description	Hurricane Research Division contains information collected during the annual Hurricane Field Program U.S. Data have mainly been collected from NOAA aircraft in flights around hurricanes. The information is also complemented with wind field analyses, land-based radar loops and data archived from U.S. Air Force flights. The data is offered as raw data, not processed. However, there are other options with processed data, but those data are under licensing constrains (no public access).
Types of disasters included in this resource	Hurricanes
Categories of relevant data	Details of the disaster

Relevant data in detail	- Details of the disaster: Date, Name, Record Identifier, Closest approach to a coast, Intensity, Maximum sustained speed, Storm status, etc.
Scope	USA
Language	English
Data Update Frequency	The update frequency is not mentioned.
Public/Private data	Public - The data are public in the sense that they can be downloaded without asking for permission. However, a proper acknowledgement to the "NOAA Hurricane Research Division of AOML" should accompany the use of these data in any publications or presentations.
Type/format of the stored data	Comma delimited format
Ways to extract the data	The data can be downloaded from Hurricane Research Division's site.
Potential uses	Statistics about the intensity and speed of past hurricanes can be created.
Relevance	Low - This resource focuses only on USA. In addition, it contains only information about the details of each hurricane, and hence cannot facilitate crisis preparedness activities.

Table 11: PAGER

Resource/Database	PAGER [18]
Description	Worldwide fatality and economic impact about earthquakes. It provides a score (green, yellow, orange, red) regarding the estimated economic losses and fatalities.
Types of disasters included in this resource	Earthquakes
Categories of relevant data	Details of the disaster, Estimated casualties, Estimated economic loss
Relevant data in detail	- Details of the disaster: time, location, depth, magnitude - Casualties: Number of estimated casualties - Economic loss: estimated economic loss in USD (Millions)
Scope	Global
Language	English
Data Update Frequency	This resource is updated every hour. The user can select whether they need data from the last day, week or month.
Public/Private data	Public - There is no need to register or ask for permission in order to have access and use the data.
Type/format of the stored data	rss, kml, GeoJSON, csv, and QuakeML files
Ways to extract the data	The user can easily connect to different feeding protocols, like RSS. Other formats like KML require to download files. So, it is easy to extract some basic information. However, for more concrete details the user would need to dig into the web (not automatically).
Potential uses	This resource provides information about the details of each earthquake and also predicts the number of casualties and the amount of economic loss caused the respective earthquake. This resource could be combined with other databases in order to understand whether the predictions were close to the actual number of casualties and economic losses.
Relevance	High - This resource contains invaluable information about earthquakes and can be proved to be handy during crisis preparedness and search & rescue activities. In addition, the extraction of the main information seems to be quite easy.

Table 12: USGS Earthquake Program

Resource/Database	USGS Earthquake Program [19]
Description	The USGS monitors and reports on earthquakes, assesses earthquake impacts and hazards, and conducts targeted research on the causes and effects of earthquakes. USGS undertakes these activities as part of the larger National Earthquake Hazards Reduction Program (NEHRP), a four-agency partnership established by the US Congress.
Types of disasters included in this resource	Earthquakes
Categories of relevant data	Details of the disaster, Casualties
Relevant data in detail	- Details of the disaster [20]: time, latitude, longitude, depth, magnitude, id, update time, place, type, locationSource, magSource, horizontalError, depthError, magError, status, etc.
Scope	Global
Language	English
Data Update Frequency	Real time data
Public/Private data	Public – There is no need to ask for permission to export the data
Type/format of the stored data	A simple CVS text format suitable for loading data into spreadsheet applications like Microsoft Excel™.
Ways to extract the data	The data can be downloaded as csv files.
Potential uses	This resource can facilitate the creation of a historical view of earthquakes in the SnR database. This view can be represented on the SnR Platform HMI.
Relevance	Medium - This resource can bring value to SnR in terms of historical data.

Table 13: NATDIS

Resource/Database	NATural DISaster (NATDIS) database [21]
Description	The NATDIS database is the most complete public database about natural disasters in the world. It describes precisely more than 16,500 natural disasters occurred in the world since January 1, 2001 and is updated every year. Opposite to other databases which only reference events that made more than 10 victims or reach a certain economic cost, NATDIS database records every damaging natural event as soon as it has significant human consequences and / or material consequences. Furthermore, all events in this database are fully georeferenced allowing their integration in GIS (Geographical Information System). NATural DISasters News is the English version of the French website http://catnat.net/. As its French equivalent, NATural DISasters News reports international news, statistics and data about natural disaster events. The catalog of events maintained daily since January 2001 by Catnat.net is one of the most complete currently online. In order to statistically use this catalog, all the information on the events has been transcribed in the form of a database: the CATNAT database. It is today the most exhaustive georeferenced database listing natural disasters available on the web. Indeed, each recorded event is described by 27 different fields (location,

	origin of the hazard, hazard, peril, sub-peril, cost, etc.) including a complete article precisely describing the event. Finally, each event is qualified according to a severity scale (material, human and global) specially created to facilitate comparison and research of events. Thus, since its availability, the database CATNAT has been used by around a hundred French and foreign companies and research institutions for their statistical and documentary work. This database is constantly updated. The CATNAT is available in two formats: - Complete CATNAT: downloadable version for subscribers to our site in Access format. This version lists all the events that have occurred from 2001 to year n-1. - CATNAT online: searchable online version, more concise but up to date with the latest events.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Plane crashes, Hurricanes, Chemical accidents, Landslides, Volcanos
Categories of relevant data	Details of the disaster, Casualties, Costs
Relevant data in detail	- Details of the disaster: Country, FIPS code (allows mapping in Geographic Information System), Latitude, Longitude, Continent, Sub-continent, Risk origin code, Risk code, Sub-risk code, Risk origin, Risk, Sub-risk, Year, Start date, End date, Event description (written in French) - Casualties: Number of victims, number of injured, homeless, and affected people, human consequences Index - Costs: Material consequences index, Global risk Index, Cost ($)
Scope	Global, European
Language	English, French
Data Update Frequency	Daily
Public/Private data	Public/Private - Only a part of the database can be accessed without the need to ask for permission. In order to access to the whole dataset, users need to subscribe to one of the subscription plans.
Type/format of the stored data	Excel/csv format files
Ways to extract the data	This database is provided at MS Excel format. The data can be downloaded directly from the website.
Potential uses	This database can provide an updated view of the global natural risks and disasters. The SnR data interoperability layer and the management platform can be sourced by this kind of data. In particular, such data can be visualized on a map with associated parameters (level of risk, costs, severity, etc). In addition, these data provide information about the number of casualties caused by each disaster, and thus can facilitate the prediction of future casualties and needs.
Relevance	High - This database provides information about casualties and cost of first responders operations that can prove to be handy during crisis preparedness activities. In addition, it contains information about disasters that have happened all over the world instead of focusing on a single region. However, users need to purchase their access to the whole database.

Table 14: GLIDE database

Resource/Database	GLIDE database [22]
Description	This database is able to provide information on the date, duration, location, magnitude, source and a description of disastrous events. This data can be collected on the basis of the GLIDE number, date, disaster type, and country and include information on human and economic loss. To improve the access to disaster information, to avoid time consuming and laborious tasks and the scattering of data, Asian Disaster Reduction Center (ADRC) proposed a globally common Unique ID code for disasters. This idea was shared and promoted by the Centre for Research on the Epidemiology of Disasters (CRED) of the University of Louvain in Brussels (Belgium), OCHA/ReliefWeb, OCHA/FSCC, ISDR, UNDP, WMO, IFRC, OFDA-USAID, FAO, La Red and the World Bank and was jointly launched as a new initiative "GLIDE". A GLobal IDEntifier number (GLIDE) was issued every week by EM-DAT at CRED [23] for all new disaster events that meet the EM-DAT criteria from 2002-2003. Of course, Ways to cover disasters that fall out of EM-DAT criteria was being sought and would be provided in due course. And from the beginning of 2004, "Automatic GLIDE Generator" begins to generate new GLIDE for all new disaster events. The components of a GLIDE number consist of two letters to identify the disaster type (e.g. EQ - earthquake); the year of the disaster; a six-digit, sequential disaster number; and the three-letter ISO code for country of occurrence. So, for example, the GLIDE number for West-India Earthquake in India is: EQ-2001-000033-IND. This number is posted by the above organisations, on all their documents relating to that particular disaster and gradually other partners will include it in whatever information they generate. As information suppliers join in this initiative, documents and data pertaining to specific events may be easily retrieved from various sources, or linked together using the unique GLIDE numbers. Today, users all over the world can pick up the GLIDE number from the homepages of CRED, ReliefWeb and ADRC. ReliefWeb, La Red and ADRC have prepared a specific website [24] to promote GLIDE. Being in its experimental phase, the group encourages to visit this website and welcomes comments or suggestions. GLIDE was originally designed for global-scale disaster data base. Multi-country hazards were registered more frequently. But GLIDE number may fail to register small (maybe local) disasters and man-made disasters.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Plane crashes, Hurricanes, Chemical accidents, Terrorist events, Landslides, Volcanos, etc. Actually, all kinds of disasters are classified.
Categories of relevant data	Details of the disaster, Identifiers of the disasters (GLIDE - GLobal disaster IDEntifier)
Relevant data in detail	- Details of the disaster: main event features and parameters (place, year, type of event, etc.) - Global disasters identifiers
Scope	Global
Language	English

Data Update Frequency	Immediately after a disaster the GLIDE number is created/detached and can be referred by other databases (e.g., ReliefWeb). Once a year all the created IDs are checked.
Public/Private data	Public - The site shares a summarized description of all the events characterised by a unique ID.
Type/format of the stored data	Text for the GLIDE numbers. Besides, information in the GLIDE database may be presented in many forms, including tabular and graphic forms.
Ways to extract the data	GLIDE is not a container of disasters detailed information. Instead, it provides a way to create a unique identification number that can be referred by other databases to identify the event in a unique way. The databases using these identifiers are then linked to the GLIDE web site. All ID numbers generated can be accessed and downloaded after registration. [22]
Potential uses	It is an easy way to get information on the date, duration, location, magnitude, source and a description of disastrous events. This data can be collected on the basis of the GLIDE number, date, disaster type, and country and will include information on human and economic loss. Such information can be used for the prediction of future casualties and needs.
Relevance	Medium - The GLIDE number is a unique identification token that can be used for all international disasters. It gives a global way to associate unique IDs to disasters in data management systems. SnR database can be referred by GLIDE by fulfilling some simple rules in using GLIDE numbers.

Table 15: Global Internal Displacement Database

Resource/Database	Global Internal Displacement Database (GIDD) [25]
Description	This platform details the first results generated by our global disaster displacement risk model. It presents data on displacement risk associated with sudden-onset disasters. The main objective is to start presenting evidence on how to address internal displacement from a prospective point of view by assessing the likelihood of such population movements taking place in the future.
Types of disasters included in this resource	Earthquakes, Floods, Hurricanes, Tsunami
Categories of relevant data	Details of the disaster, Casualties
Relevant data in detail	- Details of the disaster: ISO3 country identifier, country, event name, type of disaster, etc. - Casualties: Number of displaced people
Scope	Global
Language	English
Data Update Frequency	Immediately after a disaster
Public/Private data	Public - This interactive platform is designed for policy makers, NGOs, researchers, journalists and the general public. The GIDD enables users to explore, filter and sort the data to produce their own graphs and tables.
Type/format of the stored data	database schema, csv files, pdf files
Ways to extract the data	Some data can be downloaded directly from the website. Users can also connect to the database and use queries to gain access to the desired data.
Potential uses	In an effort to make the data and analyses on internal displacement more user-friendly and transparent, the creators of GIDD have developed this interactive platform designed for policy

	makers, NGOs, researchers, journalists and the general public. The GIDD enables users to explore, filter and sort the data to produce their own graphs and tables which can be exported in several different formats. Users can also access and export the data used to generate these visualizations. This database can facilitate the prediction of future displacements caused by large-scale disasters.
Relevance	Medium - This a useful database that is big and can facilitate the creation of visualization tools with high accuracy of disasters. In addition, the data about displacements can prove to be handy during crisis preparedness activities.

Table 16: U.S. FOREST SERVICE

Resource/Database	U.S. FOREST SERVICE [26]
Description	This dataset contains pre and post-fire unmanned aerial vehicle (UAV) imagery collected as part of a prescribed fire research campaign conducted at the Camp Swift Military Base in Bastrop County, Texas on January 15, 2014. The Camp Swift Fire Experiment 2014 consisted of three fires ignited in burn blocks of dimensions 100 meters (m) by 100 m on January 15, 2014. Fires were ignited on relatively flat areas of grass vegetation in moderate winds. Post-fire aerial imagery was collected from a Canon©T3i mounted on a MLB Company SuperBat III unmanned aerial vehicle (UAV) after completion of the three burns. This data package contains five distinct georeferenced post-fire images and one mosaiced image of these five distinct images covering the three burn blocks.
Types of disasters included in this resource	Fires
Categories of relevant data	Details of the disaster
Relevant data in detail	Raw and georeferenced pre and post-fire aerial imagery
Scope	USA
Language	English
Data Update Frequency	Not mentioned but it seems that the data re not updated regularly.
Public/Private data	Public - These data were collected using funding from the U.S. Government and can be used without additional permissions or fees. "If you use these data in a publication, presentation, or other research product please use the following citation: McNamara, Derek J. 2018. Camp Swift Fire Experiment 2014: Post-fire unmanned aerial vehicle (UAV) imagery. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2018-0048"
Type/format of the stored data	Images, metadata, file index, data files, and any other supplemental files provided by the author
Ways to extract the data	The data can be downloaded directly from the website.
Potential uses	This dataset can facilitate the understanding of fire behavior and has the potential to help firemen to act in relevant Environments. Also, these data images could be helpful for the training of object detection algorithms in order to make a system classify and detect the fire when the UAVs are in action.
Relevance	Medium - This dataset does not concern data relevant to the consequences of past disasters. However, it contains information that can help the authorities to train and organize firefighters and first responders.

Table 17: Risk Management Solutions

Resource/Database	Risk Management Solutions [27]
Description	This resource contains up-to-date information about recent natural catastrophes around the world. Building on a 20-year track record, the dedicated RMS Event Response team monitors real-time catastrophes daily to provide clients with information and products to assess the potential impact on their own portfolios.
Types of disasters included in this resource	Fires, Floods, Hurricanes, Storms
Categories of relevant data	Details of the disaster, Casualties
Relevant data in detail	The information, data, and materials contained on this website page may be based on or derived from a variety of proprietary and third-party sources. Examples of event summaries: Typhoon Vamco, known as Typhoon Ulysses in the Philippines, made a series of landfalls across the Philippines on November 11-12. Vamco has brought damaging winds, storm surge, and intense rainfall to parts of Southern Luzon, Central Luzon, and the National Capital Region. Widespread flooding was reported. Cumulative rainfall of 242.4 mm (9.5 in) in a 24 hr period impacted the city of Napier, New Zealand between Monday November 9 and Tuesday November 10. Much of the city center has been flooded with the suburbs of Maraenui, Marewa and Pirima also affected. 200 property and 140 motor vehicles claims have been filed as of the morning of Wednesday November 11. A combination of warm and dry weather and unusually high lightning activity has led to the ignition of multiple wildfires in Northern California. The fires have burned nearly 4.2 million acres in total across the state of California. The White House has approved a Major Disaster Declaration for the State of California. Approximately 10,400 structures have been damaged or destroyed. Tropical Storm Eta made landfall near Cedar Key, Florida, at 09:20 UTC on Thursday November 12. Eta is forecast to bring dangerous storm-surge, heavy rainfall, and gusty winds to portions of the Florida Gulf Coast and the northern Florida peninsula in the coming 24 hours. Eta previously made landfalls as a Category 4 major hurricane in northeastern Nicaragua and as a tropical storm in Cuba and the Florida Keys.
Scope	Global
Language	English
Data Update Frequency	Immediately after a disaster
Public/Private data	Private - Only the event summary is public. In order to access the full report, the user needs to login to RMS Owl. The information, data, and materials contained on this website page may be based on or derived from a variety of proprietary and third-party sources. This Information, data, and materials are provided for educational purposes only, do not constitute

	professional advice, and are presented on an as is basis, without any warranty of any kind. Any use or reliance on this information, data, and materials for commercial purposes are strictly prohibited.
Type/format of the stored data	text, charts, heat-maps
Ways to extract the data	In order to extract the data, a user needs to connect to the database and use queries.
Potential uses	This resource provides invaluable information about past disasters, and hence can facilitate the prediction of future casualties and needs. Through this resource, authorities and first responders can get insightful data for each disaster in order to prepare the rescue team. In addition, RMS can help build a risk strategy, extend organizational capabilities, and deploy technology and resources to transform strategy into reality.
Relevance	Medium - This resource provides information about past disasters that can prove to be handy during crisis preparedness activities. However, the data can be exported only as free text, charts, and heat-maps.

Table 18: Property Claim Services

Resource/Database	Property Claim Services [28]
Description	ISO's Property Claim Services (PCS) unit is the internationally recognized authority on insured property losses from catastrophes in the United States, Puerto Rico, and the U.S. Virgin Islands.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Plane crashes, Hurricanes, Chemical accidents, Terrorist events, Landslides, Volcanos
Categories of relevant data	Details of the disaster In some cases, information about the casualties, needs, used equipment, responders, on-site procedures, and communication between teams is provided.
Relevant data in detail	Historical, centralized data can be extracted, depending on the types of disasters, by years and by continents or countries. Property claim services: - PCS Canada - PCS National Flood Insurance Program Data - PCS Turkey - PCS Global Marine and Energy - PCS Global Cyber - PCS Global Terror - PCS Mexico PCS APAC - PCS Global Large Loss
Scope	Global
Language	English
Data Update Frequency	Immediately after a disaster
Public/Private data	Private – An organization needs to subscribe to the platform in order to have access to the bulletin of each disaster.
Type/format of the stored data	Bulletins are available in PDF format
Ways to extract the data	The data can be exported in PDF format from the database.
Potential uses	These data can provide invaluable information about property losses caused by catastrophes and the causes of such disasters,

	and hence can help authorities understand the impact of past disasters and try to predict the impact of future similar disasters.
Relevance	Low - While the provided information is invaluable, the data concern mainly only property losses and can be extracted only in PDF format.

Table 19: ReliefWeb

Resource/Database	ReliefWeb [29]
Description	ReliefWeb is a humanitarian information service provided by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). The Digital Services Section of OCHA's Information Management Branch is in charge of managing this service. It provides a disaster center, with a map, and events with more information.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Hurricanes, Chemical accidents, Volcanos, Cold Waves, Complex Emergencies, Droughts, Epidemic, Extratropical Cyclones, Heat Waves, Insect Infestations, Landslides, Mud Slides, Storms, Snow Avalanches, Technological Disasters, Tropical Cyclones, Tsunamis
Categories of relevant data	Details of the disaster, Maps
Relevant data in detail	- Details of the disaster: Country, Date, GLIDE id, name, disaster type, status, plan, etc.
Scope	Global
Language	English
Data Update Frequency	Almost immediately after a disaster happens
Public/Private data	Public – There is no need to ask for permission in order to download the data
Type/format of the stored data	Freetext, Maps, Maps + infographics, PDF, JSON
Ways to extract the data	In general, ReliefWeb allows to download a map, or a map+infographic extra info as pdf. Some data can be downloaded as shapefiles, geodatabase, and excel files. A WebCrawler of manual web navigation is required to download these files. An API is also available that provides access to ReliefWeb's curated and continuously updated data archive. This API is publicly accessible using HTTP requests and returns JSON data. [30]
Potential uses	Statistics about past disasters can be created.
Relevance	Low - Although ReliefWeb contains information about many types of disasters, this resource does not provide information that could support search & rescue activities.

Table 20: Copernicus Emergency Management Service

Resource/Database	Copernicus Emergency Management Service [31][32]
Description	The Copernicus Emergency Management Service (Copernicus EMS) provides all actors involved in the management of natural disasters, man-made emergency situations, and humanitarian crises with timely and accurate geo-spatial information derived from satellite remote sensing and completed by available in situ or open data sources. The objective of Copernicus is to monitor and forecast the state of the environment on land, sea and in the atmosphere, in order to support climate change mitigation and adaptation

	strategies, the efficient management of emergency situations and the improvement of the security of every citizen. Information provided by Copernicus improves people's safety, e.g., by providing information on natural disasters such as forest fires or floods, and thus help to prevent the loss of lives and property, and damages to the environment. Copernicus is a user driven programme and the information services provided are available to its Users, mostly public authorities, on a full, open and free-of-charge basis.
Types of disasters included in this resource	The Copernicus Emergency Management Service (EMS) provides information for emergency response in relation to different types of disasters, including meteorological hazards, geophysical hazards, deliberate and accidental man-made disasters and other humanitarian disasters, as well as prevention, preparedness, response and recovery activities. Copernicus EMS consists of the Mapping Service and of the Early Warning System (floods). Examples of included types of disasters: Earthquakes, Fires, Floods, Plane crashes, Hurricanes, Chemical accidents, Terrorist events, Landslides, Volcanos
Categories of relevant data	Details of the disaster, affected areas In some cases, information about the casualties, needs, used equipment, responders, on-site procedures, and communication between teams is provided.
Relevant data in detail	Copernicus EMS On Demand Mapping provides on-demand detailed information for selected emergency situations that arise from natural or man-made disasters anywhere in the world. Rapid Mapping provides geospatial information within hours or days of a service request in order to support emergency management activities in the immediate aftermath of a disaster. Risk & Recovery Mapping supplies geospatial information in support of Disaster Management activities including prevention, preparedness, risk reduction and recovery phases. Copernicus EMS Early Warning and Monitoring offers critical geospatial information at European and global level through continuous observations and forecasts for floods, droughts and forest fires. The European Flood Awareness Systems (EFAS) and Global Flood Awareness Systems (GloFAS) provide complementary flood forecast information to relevant stakeholders that support flood risk management at the national, regional and global level. The European Forest Fire Information System (EFFIS) monitors forest fire activity in near-real time. EFFIS supports wildfire management at the national and regional level for EU member states and across the Middle East and North Africa. The Drought Observatory (DO) provides drought-relevant information and early-warnings for Europe (EDO) and globally (GDO). The service publishes short analytical reports (Drought News) in anticipation of an imminent drought.

Scope	Global
Language	English
Data Update Frequency	Immediately after a disaster happens
Public/Private data	Public - The disaster maps are public. Private - The service is provided free of charge to all users either in rush mode, for emergency management activities which require immediate response and or non-rush mode, to support emergency disaster management activities not related to immediate response analysing pre-disaster risk assessment and population and asset vulnerability or post-disaster recovery and reconstruction. However, it can be activated only by designated authorised users.
Type/format of the stored data	Delivery formats are Layered Geospatial PDF, GeoJPEG and vector (ESRI shapefiles, Google Earth KML, GeoJSON
Ways to extract the data	An API is available to access satellite images – Sentinel 1, Sentinel 2, Sentinel 3, Sentinel 5P. [33][34] The API Hub Access is currently available for all users registered on SciHub [35]. Users can also access the EMS Rapid Mapping Activations – database [36][37].
Potential uses	This system can provide information both about past disasters and real-time disasters. Hence, statistics can be created about past disasters. At the same time, this system can be utilised to support crisis preparedness and search & rescue activities. The data can be analysed to provide information about the location in which the disaster happened, the affected areas, the vulnerable areas, the nearest water resources in case of fire, etc.
Relevance	High - This resource provides invaluable information about the areas that have been affected by past disasters.

Table 21: EM-DAT

Resource/Database	The International Disaster - Emergency Events Database (EM-DAT) [38][39]
Description	EM-DAT is a global database on natural and technological disasters, containing essential core data on the occurrence and effects of over 22,000 mass disasters in the world. EM-DAT includes all disasters from 1900 until the present, conforming to 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 The database is compiled from various sources, including UN agencies, non-governmental organisations, insurance companies, research institutes and press agencies. The main objective of the database is to serve the purposes of humanitarian action at national and international levels. The initiative aims to rationalise decision making for disaster preparedness, as well as provide an objective base for vulnerability assessment and priority setting.

Types of disasters included in this resource	Earthquakes, Fires, Floods, Plane crashes, Hurricanes, Chemical accidents, Terrorist events, Landslides, Volcanos, Avalanches, Storms, Explosions, Collapses etc.
Categories of relevant data	Details of the disaster, Casualties, Costs, Financial Aid, Used equipment, Responders, On-site procedures, Communication between teams [40]
Relevant data in detail	- Details of the disaster: Disaster Number, Disaster Group, Disaster Sub-Group, Disaster Type, Disaster Sub-Type, Disaster Sub-Sub-Type, Entry criteria, Event name, Glide Number, Country, ISO Code, Region, Continent, Longitude, Latitude, Location, Start date, End date, Local time, Origin, Associated disaster, Magnitude scale and value, Status - Responders / Procedures: Appeal for international assistance, Response from Office of Foreign Disaster Assistance (OFDA) - Financial Aid: Aid contribution - Costs: Total estimated damages (in 000'US$), Reconstruction cost (in 000'US$), Insured losses (in 000'US$) - Casualties: Number of deaths, Number of missing people, Number of injured people, Number of affected people, Number of homeless people - Infrastructural Impact: The infrastructure that was damaged or destroyed by the disaster (Houses, Bridges, Commercial/business, Roads, Rails, Education, Health, Forest, Farmland/crops) - Sectorial Impact: The sectors affected by the disaster (Animals, Industry, Electricity, Water supply/sanitation, Communications, Cultural infrastructure, Transportation, Other)
Scope	Global - The main objective of the database is to serve the purposes of humanitarian action at national and international levels.
Language	English
Data Update Frequency	EM-DAT is internally updated on a daily basis. However, the publicly accessible information is updated every 3 months, once that all the data has been validated and cross-checked using different sources.
Public/Private data	Public - There is no need to ask for permission in order to extract the data. However, the user needs to register in order to gain access to the database. Disclaimer: Users of EM-DAT declare not to create substitute or derivative databases of EM-DAT, so its data cannot be used at an aggregated DB.
Type/format of the stored data	maps, charts: pdf Details about disasters: excel
Ways to extract the data	The data can either be extracted directly from the database or downloaded as pdf and xls files.
Potential uses	These data can provide information about the number of casualties caused by each disaster and the required help, and thus they can help authorities make predictions concerning future casualties and needs. An analysis could also possibly be made about the amounts required for the affected communities to

	heal depending on the amount of financial aid and the economic impact.
Relevance	High - This database provides information about casualties, damages, and responses that can prove to be handy during crisis preparedness activities. In addition, it contains information about disasters that have happened all over the world instead of focusing on a single region.

Table 22: GDACS AND Virtual OSOCC

Resource/Database	GDACS AND Virtual OSOCC [41]
Description	GDACS is a cooperation framework between United Nations and the European Commission (JRC - Joint Research Centre). The information provided includes information about disasters at worldwide level. The information could be helpful in the first phases after a major disaster. The information is provided in real time by a web application, and this can be freely accessed. In addition, there exists also a "restricted area" to share real-time information between all actors in the first phase of a disaster. The information affecting countries and international responders is moderated by a dedicated team.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Hurricanes, Volcanos
Categories of relevant data	Details of the disaster, Casualties
Relevant data in detail	Different kind of data for each type of event. In general: - Summary with details about the event, when, what, etc - Impact, with a common metric provided by the jrc about the GDACS Score. For example, in case of an earhtquake, how many people have been affected in different kms ranges. - Event timeline with different scores - Maps of the area - Media links - Global Telecommunication Service
Scope	Global
Language	English
Data Update Frequency	Immediately after a disaster happens - However, the disaster needs to be reported by some collaborator (UN, JRC)
Public/Private data	Public - Rescue teams can register in GDACS and receive alerts about different disasters with different levels of importance.
Type/format of the stored data	The format depends on the kind of the event in most cases. Geojson, kml, xml, png, rss, shapefile of the area
Ways to extract the data	The data could be extracted through an rss channel. In order to extract information in other formats (e.g., geojson) the user most likely needs to manually find the download that information. It does not seem easy to automatise the extraction.
Potential uses	These data can provide information about the number of casualties caused by each and thus they can help authorities make predictions concerning future casualties and needs. GDACS can also provide real-time information, and hence support real-time search & rescue activities.
Relevance	High - This resource can prove to be handy during search & rescue activities. However, it is difficult to extract all the necessary information.

Table 23: Insarag Coordination Management System

Resource/Database	ICMS (Insarag Coordination Management System) [42]
Description	ICMS is a multi-tiered system, where different groups and functions work together in different areas of the system to produce an information management system that enhances situational awareness and as a result improved coordination and outcomes for affected communities. The team functions for Stage 1&2 are primarily focused around preparation of the team-based systems for deployment, accessing the system, using the INSARAG HUB, infield data collection, Command Point (CP) monitoring and quality assurance methodology (Sector Coordination ref UCC ICMS manual) ICMS has two different login systems and it is important to ensure that the "TEAM LOGINS" are used for all team-based activities. The UCC is the main coordination function of INSARAG based methodology and will coordinate all USAR teams, liaising with OSOCC and LEMA. The need for a USAR Coordination methodology came from the INSARAG Team Leaders, based on lessons learned from previous international deployments and training exercises. The concept is designed to lessen the burden on an UNDAC team to perform the actions, through recognising that INSARAG members could be better suited to perform the function. Using this concept allows the UNDAC team to focus more to the humanitarian needs of the affected country, by streamlining and establishing clearer division of labour regarding the coordination efforts. Implementation of USAR Coordination methodology begins with the arrival of the first INSARAG classified team into the affected country. Its design is based on the assumption— That no Reception Departure Centre (RDC) is in place, meaning that the first arriving INSARAG classified team will need to establish one. If an RDC is in place, the first arriving INSARAG classified team will offer to strengthen it by assigning staff to the function. That each Heavy INSARAG classified team will arrive with four personnel trained in USAR Coordination, and that each Medium INSARAG classified team will arrive with two personnel trained in the same methodology. This staffing level ensures that initial coordination and staffing gaps at the RDC, USAR Coordination Cell (UCC) and Sector Coordination Cell (SCC) can be filled. Other stakeholders such as Emergency Medical Teams (EMT's), UNDAC, International Humanitarian Partnership and its affiliates, can also augment the RDC.
Types of disasters included in this resource	Earthquakes, Fires, Floods, Hurricanes, Chemical accidents, Landslides, Volcanos, typhoon, explosion
Categories of relevant data	Details of the disaster, Casualties, Needs, Used equipment, Responders, On-site procedures, Sectors, deployment of the USAR teams, location of the Base of Operation (BoO), RDC, work site triage, work site report, victim extrication, pictures of the work sites, logistics needs
Relevant data in detail	Map of the disaster, location of the Base of operation, USAR team, sectors, extrication form for all the victims, work site triage for priorities, assessment, work site report for the all the operation on a work site, logistics needs (crane, wood, gasoline, oxygen, etc.)
Scope	Global
Language	English

| Data Update Frequency	Immediately after a disaster happens
Public/Private data	Public - Users can gain access to all the information. However, there are some restrictions regarding victims' personal data.
Type/format of the stored data	Free-text, pictures of victim and work site, schema of work site
Ways to extract the data	To extract the data, users need to connect to the ICMS. To do so they need an official password and to be identified as an official rescue team.
Potential uses	The UCC (Usar Coordination Cell) can utilize this system to create sectors and assign each sector to a USAR team; in each sector, the respective USAR team must do the triage of the sites to define priorities (A, B, C, D) and complete a "work site triage". on the dashboard, the UCC team can see all the operations that are in progress, the location of each team, the BoO of each team, pictures of the work site, maps of the operation, "work site report" for a supervision of the site, the logistic needs of each team (gasoline, wood, crane etc.), the balance sheet of the victims alive, missing, dead, injured, and a file for each victim.
Relevance	High - The ICMS is a tool used by all the international rescue teams; it is a very good software to support the operations and it also has a complete dashboard; the authorities could have a complete vision of the situation, the anticipation of needs, the balance sheet of the victims and the humanitarian items (e.g., food, water). Therefore, it can prove to be handy during search & rescue activities.

Table 24: Global Terrorism Database

Resource/Database	Global Terrorism Database (GTD) [43][44]
Description	The Global Terrorism Database (GTD)™ is the most comprehensive unclassified database of terrorist attacks in the world. The National Consortium for the Study of Terrorism and Responses to Terrorism (START) makes the GTD available via the site in an effort to improve understanding of terrorist violence, so that it can be more readily studied and defeated. The GTD is produced by a dedicated team of researchers and technical staff and includes more than 200,000 terrorist attacks dating back to 1970.
Types of disasters included in this resource	Terrorist events
Categories of relevant data	Details of the disaster Casualties
Relevant data in detail	- Details of the disaster: GTD Id, data, country, city, perpetrator group, target type, region, attack type, weapon type - Casualties: number of fatalities, number of injured people
Scope	Global
Language	English
Data Update Frequency	The update frequency is not mentioned.
Public/Private data	Public - This database can be accessed for free for individual usage. Private - Users that plan to use this database for purposes other than personal research need to subscribe and pay a fee.
Type/format of the stored data	Unknown

Ways to extract the data	The data can be downloaded directly from the website upon registration.
Potential uses	This database provides information about past terrorist events. Hence, statistics can be created about the most common terrorist events, the weapons used, etc. These data can also provide information about the number of casualties, and thus they can help authorities make predictions concerning future casualties and needs.
Relevance	High - Global Terrorism Database is one of the few resources that provide information about past terrorist events.

2.1.2.3   Findings Evaluation

The examination of the identified resources that are relevant to past international incidents and large-scale disasters revealed that currently there are only a few resources/databases available that provide information about the needs, the used equipment, and the number of responders that were required for the search & rescue activities during each disaster. In addition, even those that include such data do not necessarily contain detailed information about the respective disaster and the casualties. However, by combining resources that provide information about the details of past disasters, with other resources that provide data about the casualties or the on-site procedures, the needs, and the used equipment, we could derive very interesting information. Therefore, it is supported that the identified external resources are enough as well as that it is possible to support crisis preparedness and search & rescue activities by extracting, fusing, and analysing the data of many of the identified resources.

As shown in Figure 7, 6 out of the 23 examined resources are not considered to be very relevant to the objectives of this project, while 10 resources could provide invaluable information that can be proved to be handy during crisis preparedness and Search & Rescue activities.
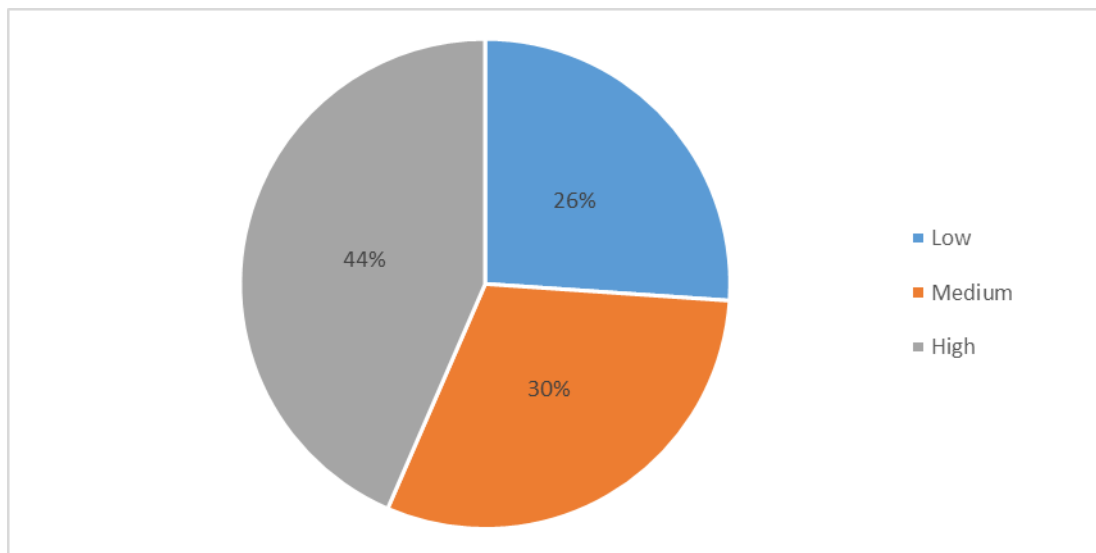
Figure 7: Relevance of resources to S&R Project

The following table presents the classification of the resources according to their relevance to the objectives of the Search & Rescue project.

Table 25: Relevance of resources to the S&R project

Relevance of resources to the S&R Project		
Low	Medium	High

eMARS	Canadian Disaster Database	DesInventar Sendai
FEMA	OpenWeatherMap	PAGER
Sigma Explorer	USGS Earthquake Program	NATDIS
HURDAT	Risk Management Solutions	Global Ladnslide Catalog
ReliefWeb	Glide	Hellenic Fire Service
Property Claim Services	Global Internal Displacement Database	Copernicus Emergency Management Service
	U.S. Forest Service	EM-DAT
		GDACS and Virtual OSOCC
		Insarag Coordination Management System
		Global Terrorism Database

2.1.3 Next Steps

2.1.3.1 Resources Selection

The very next step is the selection of the resources that will be utilised by the Search & Rescue system. As mentioned in Section 2.1.2.3. the identified resources are able to provide enough and useful information that has the potential to support crisis preparedness and search & rescue activities. However, since many resources could be considered "complementary" to each other, it is of outmost importance to choose the combination of resources that will support crisis preparedness activities in the best possible way. Of course, we should also take into consideration the format in which the data are stored and the extraction process.

2.1.3.2 Data Extraction

The heterogeneous nature of the resources (databases, webs, etc.), data formats (csv, json, xml, html, etc.), and protocols (http, rss, etc.) calls for the design and development of a data extraction system. That system will be composed by different components and will be in charge of extracting data from different external resources/databases. More specifically, this system will be responsible for accessing each one of the desired resources, extracting their data (e.g., though the APIs provided by the owner of each resources, downloadable files, WebCrawlers), and providing ways for other systems to consume those data (e.g., APIs).

2.2 Aggregation of data coming from internal sources and devices

The Mediation system is responsible for filtering out the non-relevant data, aggregating the partial data records, and transforming the data as per the format is required. S&R Data Fusion and Mediation Systems will fuse the information coming from heterogeneous sources and will provide a more detailed and accurate situational\context awareness to the decision makers and to the C&C centres.

2.2.1 Data Aggregation Mediation System

2.2.1.1 Overview

The S&R Mediation System will retrieve data from Data Fusion servers to be able to handle complex critical events from multiple data streams. Mediation system will use a modality processing pipeline that

can transform heterogeneous data in real time by reducing the granularity from the signal/raw level to a semantic level.

The internal mechanism of the Data Aggregation components (Data Fusion and Mediation Systems) breaks down the envisioned functionality into several sub-components. The sub-components are interlinked with interfaces (RESTful endpoints) to allow interaction within and outside the Data Fusion and Mediation System components. The overall Data Aggregation component consists of a series of interfaces, allowing other components and data sources to post updated information towards the S&R datastore or to check and retrieve existing data. Internally it has an Aggregation Controller subcomponent to select the appropriate action or micro-service to deal with incoming data. The aggregation functions are implemented as a series of micro-services that handle merging different types of existing data with incoming data.

2.2.2 High Level architecture of Data Aggregation

This section describes the high-level architecture of Data Aggregation within the Search and Rescue project. Figure 8 defines the overall architecture of Data Aggregation.
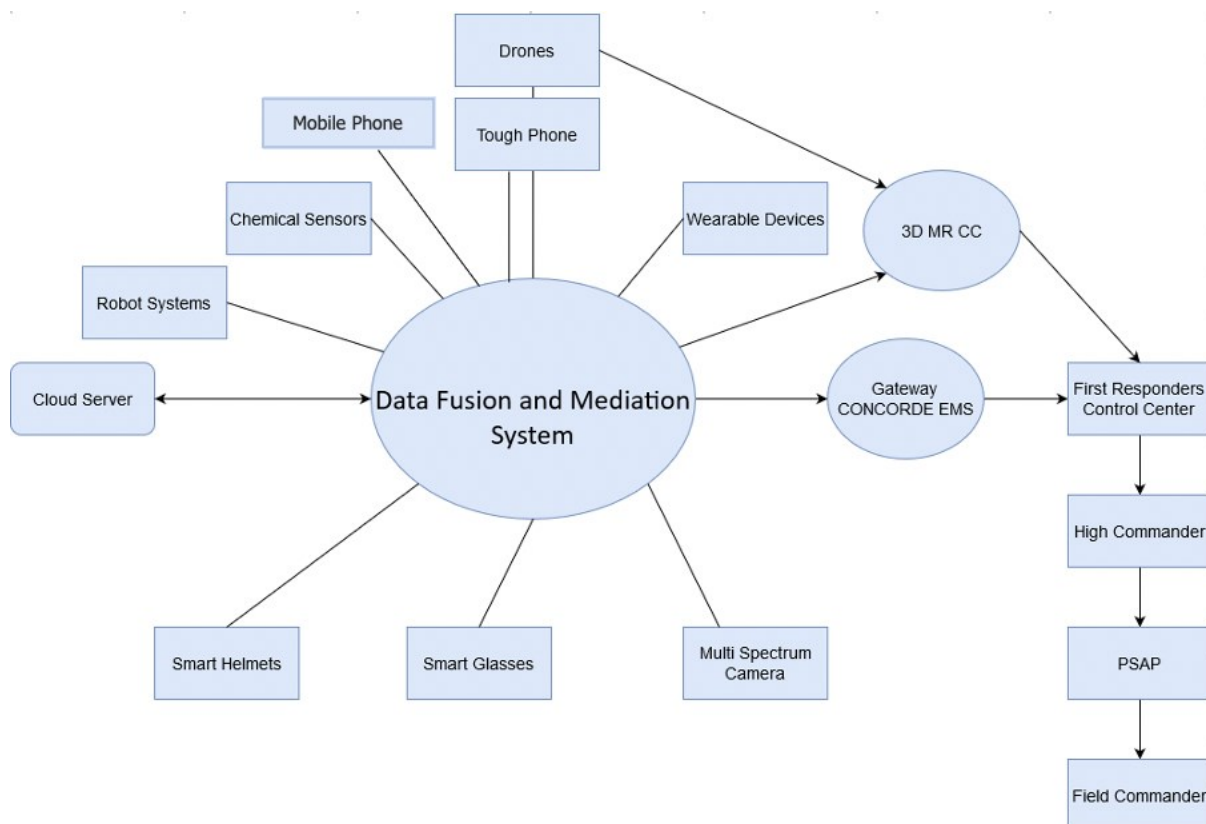
Figure 8: Data Aggregation Architecture

The heterogeneous devices connect to the central Data Fusion servers and the Mediation System filters out the non-relevant data, aggregates the partial data records, and transforms the data to the required format and send data through Restful APIs. The data are stored in a Cloud Server and the same time through gateway and CONCORDE EMS are distributed to Control Center and First Responders in order to be sent to High Commander, PSAP and Field Commander. The heterogeneous devices will send data through Wi-fi, Bluetooth, Restful APIs. The exchange of the data between First Responders, Control Center, PSAP and Field Commander will be done through Restful APIs.

2.2.2.1 Cloud Server

Cloud Server allows to monitor the heterogeneous devices and their resources. All the devices communicating in IoT network will talk to each other using the same Internet Protocol (IP). A Cloud Server is a virtual server running in a cloud computing environment. It is built, hosted and delivered via a cloud computing [45] platform via the internet, and can be accessed remotely. They are also known as virtual servers. Cloud servers have all the software they require to run and can function as independent units. The heterogeneous devices are fixed at the selected remote location and are connected to the gateway device. Communication establishes through the gateway device in WAN mode. WAN mode helps the gateway device to interact directly with the internet. Once the communication mode is set and the cloud server is configured, the communication initiates between the sensors and the cloud server. The established communication allows the monitoring of the data from any location.

2.2.3 Core Services

Core services provide APIs for applications and services working with diverse data sources, such as their discovery and data access.

2.2.3.1 Mediation System

Mediation system is responsible for filtering out the non-relevant data, aggregating the partial data records, and transforming the data as per the format required by the data consumers. The S&R Mediation System provides a way to share information between the actors of an incident (PSAP, High Commander, First Responders, Field Commander, etc.) on time. Using the S&R Mediation System the information is filtered and the relevant one is kept and is sent to Control Center and First Responders for effective emergency response. By following the High-Level architecture, Mediation System will establish the communication inside the system. Additional to processing the information of the heterogeneous devices and sending them for storage to Cloud Server, the Mediation System is also capable to aggregate them, filter them in real-time or near real-time, and send the filtered information to all actors and help them to make better decisions. S&R Mediation system supports a various number of communication protocols in order to facilitate the distribution of information between the actors of an incident.

2.2.3.2 CONCORDE EMS

An Emergency Management System includes activities to prepare for, respond to, recover from and mitigate future potential harm. CONCORDE EMS is a Cloud-based platform, suitable for the activities above. CONCORDE EMS capturing the information and handling during the emergency response in order to improve coordination.
In CONCORDE EMS information handling was divided in 3 broad categories.

- **Interactions** refers to communication exchange between the actors in workspace, caller and higher command. The main interactions are:
  1. *Receive information*: means that information is sent to an actor without a prior request on his/her part. The information can be of any kind. Notifications and alerts on any actor's device are also in this group.
  2. *Request Information*: means that the actor wants to obtain information of any kind that is already available and take steps to obtain it.
  3. *Provide information*: means that the actor has information and make this information available to other actors.
- **New information creation** the main functionalities are:
  1. *Gathering of new information*: means that the actor gathers information usually from the moment of approaching the incident scene onwards.
  2. *Decisions= Total information processing resulting in the criterion of new information*: refer to decisions made based on processing information which is gathered.
- **Information Documentation** refers to documenting any written or recorded information gathered during the incident management for handover and post-action evaluation.

The emergency management process is started as PSAP receives a call to the emergency telephone number. Usually, the First Responder provides basic information about the incident including the type and the location of the incident and injured if any. PSAP reports the received information to the CONCORDE EMS and determines also a priority dispatch code for the event. Subsequently, PSAP may analyse the data to make the final decision about the resources that are invited and dispatched. Next, PSAP communicates the dispatch information to selected EMS members and, additionally, informs hospitals. After that, the Field Commander should compare the incident details (e.g., the number of patients) against dispatched resources and evaluate whether the required resource estimations are accurate and justified. If necessary, both of the aforementioned actors can decide to dispatch additional resources for the incident. The field commander also performs task allocation of available sources. Based on the incident type, injuries of patients and/or the existence of possible hazards and critical tags the field commander may decide to insert information about required external experts CONCORDE EMS. Also, through CONCORDE EMS field commander knows about hospital capabilities (available beds, doctor specialties, etc.). CONCORDE EMS provides all the available information and a direct communication between the actors.

2.2.3.3   3D Mixed Reality Command Centre

The main purpose of the 3D Mixed Reality Command Centre is the 3D spatial visualization of relevant information that will allow better situation awareness. The 3D MR CC will provide the following capabilities:

- Stereoscopic 3D visualization
- Multi-user support
- 3D representation of the incident area
- Image registration for presentation of heterogeneous visual data sources of information (e.g. GIS, Satellite imagery, live camera and thermal camera feed from drones and rescuers.)
- Sensor data presentation registered in the 3D model
- Interaction with drones
- Communication with rescue units
- Rescue units and victims' position and health condition presentation.
- Distress call position and information presentation.

2.2.3.4   Mobile phone

The mobile phone will host the volunteer application. The volunteer application will be responsible to provide mainly two functions:

1. The registration; the process where the volunteers will be signed up by filling in details such as:

   - Personal data (name, surname, date of birth/age)
   - Contact (telephone number, email, chat info)
   - Special abilities of a volunteer (Driver, diver, crane operator)
   - Deployment limitations e.g. max work hours or heavy gear for a particular task
   - Experience
2. The matching
   - Requirements for volunteer deployment
   - Categorise volunteers to regular staff and relief units according to their registration data

The volunteers can use the application during any operation. The mobile device built-in features will be taken into account for identifying their current position; this will provide additional assistance to the rescuers and commanders for managing the participant volunteers during the operation.

2.2.4   Integration of sensors to S&R Mediation System

The integration of sensors to S&R Mediation System will be done through the cloud server. The heterogeneous devices will be connected with the Data Fusion and Mediation System through Restful APIs. The heterogeneous devices will send the data to Data Fusion and Mediation System in order to channel to Control Centre, First Responders through a gateway.

2.2.4.1   Wearable devices

Wearable devices are a category of electronic devices that can be worn as accessories, embedded in clothing, implanted in the user's body, or even tattooed on the skin. The devices are hands-free gadgets with practical uses, powered by microprocessors and enhanced with the ability to send and receive data via the Internet. In Search and Rescue project will be used various Wearable devices such as GPS Tracker and smartwatches. All these devices help to identify characteristics of the scene such as the body and environment temperature, possible chemical emissions, the vital signs or a person, etc. Moreover, they can capture the weather conditions on the scene. All the data will be gathered and sent to the Mediation and Fusion System in order to be filtered and sent to the right people in order to make better decisions. The exchange of data will be done in a variety of ways such as Wi-Fi, Bluetooth, Restful APIs etc.

2.2.4.2   Chemical sensors

A chemical sensor is a device that detects and converts chemical information (such as concentration, pressure, activity of particles) into an electrical signal to obtain qualitative or quantitative time- and spatial-resolved information about specific chemical components. Chemical sensors are used in hundreds of applications, such as medical, automotive, nanotechnology, environmental, indoor analysis, etc. Among the chemical sensors that will be developed inside SnR is the RESCUE-MIMS device. RESCUE MIMS can be used as an early warning system for the rescuers (safety use), as well as for detecting chemical compounds under the ruins in near-real time that can be correlated with human presence (SAR use). It is portable and can also be used as a payload on-board robotic platform, like DFKI ground robot, serving as a screening tool of hazardous environment in the disaster scene. Chemical sensors will send data to Data fusion and Mediation System through Wi-Fi, Ethernet, etc.

2.2.4.3   Robot Systems

Robot systems are unmanned ground vehicles (UGVs) that can be remotely controlled through software-controlled mission plans in their embedded computing platform working in conjunction with onboard sensors and sensor fusion algorithms. Coyote III robotic platform, provided by DFKI, is a micro rover with high mobility performance in unstructured terrains. Equipped with its own power source, on-board sensor suite and computer it is able to perform autonomous mission tasks. The communication subsystem allows to cooperate with other systems. It is equipped with standardized electro-mechanical interfaces, allowing to dock additional payload elements, such as chemical sensors and obstacle detection items. Robot systems will send data to Data Fusion and Mediation System using Wi-Fi, Bluetooth, Restful APIs, etc.

2.2.4.4   Drones

A drone, in technological terms, is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UASes). Essentially, a drone is a flying robot [46] that can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems [47], working in conjunction with onboard sensors [48] and GPS [49]. Drones will send data to Data Fusion and Mediation System using Wi-Fi, Bluetooth, Restful APIs, etc.

2.2.4.5   Multi Spectrum Camera

Multi spectrum cameras capture image data at specific frequencies across the electromagnetic spectrum. The wavelengths may be separated by filters or using instruments which are sensitive to specific wavelengths, including light from frequencies beyond our visible sight, such as infrared. Spectral imaging also allows the extraction of additional information which the human eye fails to capture. The Multi spectrum cameras will send data to Data Fusion and Mediation System through Wi-Fi, Bluetooth, Restful APIs, etc.

2.2.4.6   Tough Phone

A Tough Phone is a device that combines cellular and mobile computing functions into one unit. They are distinguished from feature phones by their stronger hardware capabilities and extensive mobile operating systems, which facilitate wider software, internet and multimedia functionality, alongside core phone functions such as voice calls and text messaging. Tough Phones typically contain a number of metal–oxide–semiconductor (MOS) integrated circuit (IC) chips, include various sensor that can be leveraged by their software (such as a magnetometer[50], proximity sensors, barometer, gyroscope, or accelerometer), and support wireless communications protocols (such as Bluetooth, Wi-Fi, etc.). The Tough Phone will send data to Data Fusion and Mediation System through Wi-Fi, Bluetooth, etc.

2.2.4.7   Smart Glasses

Smart Glasses are visual devices worn by operators to help them on their daily job by overlapping to reality useful information coming from the main information system of the company. Their main functionalities are to present information or alerts to the operator in his field of view, to enable audio communications with remote senior workers, to raise an alarm in case of high level of noise within the working environment, to stream video from an on-board camera to remote workers and to show objects' temperature in the field of view by means of an on-board thermal camera. The Smart Glasses will send data to Data fusion and Mediation System through Wi-Fi, Bluetooth, Restful APIs, etc.

2.2.4.8   Smart Helmet

Smart Helmets using Advanced Augmented Reality technologies will be developed by SIMAVI. The new computing medium will allow first responders personnel to make use of the physical environment and digital information at the same time. The blended environment will become a new reality and this new perception of the mixed reality world will transform the way the first responder will interact and receive information from team members and other sensor networks deployed by the system, the communication between team members will add to a better coordination in specific scenarios. Another key feature of using Smart Helmets is the see-thru and hands-free abilities which doesn't restrict the personnel's body movements when performing a simulation or in a real-life scenario. The Smart Helmets will send data to Data fusion and Mediation System through Wi-Fi, Bluetooth, Restful APIs, etc.

3 Conclusions

In this deliverable, 23 resources that are relevant to past incidents and large-scale disasters have been identified. Many of those resources include quite similar information, while information about the needs and the used equipment is quite scarce. However, by combining a handful of those resources we can extract the valuable information that has the potential to fully support crisis preparedness and search & rescue activities as well as facilitate the provision of common information to all interested parties, which is of outmost importance. In addition, the examination of the resources revealed that each resource stores different kind of data in totally different formats and uses different protocols. Hence, we need to design develop a data extraction system responsible for extracting data from difference sources.

The data within Search and Rescue Project will come from heterogeneous sources. The Mediation System will gather and filter all the data and store them to a Cloud Server. After that, it will send the data through a gateway to First Responders and Control Center in order to be sent to High Commander, PSAP and Field Commander, in order to help make better decisions. The heterogeneous sources will send data to Data Fusion and Mediation System through a variety of ways such as Wi-Fi, Bluetooth, Restful APIs etc.

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