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Transboundary Storm Risk and Impact Assessment in Alpine Regions

REPORT ON EXISTING STORM IMPACT (DAMAGE AND LOSS) DATA COLLECTION AND MAPPING METHODOLOGIES ACROSS EUROPE AND IN THE AUSTRIA/ITALY CROSS-BORDER REGIONS

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1 INTRODUCTION

This Report (Deliverable D3.1) provides an overview of existing storm damage and loss observation mapping techniques as well as data sources considering different data collectors / institutions e.g. such as civil protection authorities, research facilities (data from peer-reviewed and other publications) or associations. The techniques and data sources base on European, national and sub-national (e.g federal states) scales with particular interesest and focus on Austria and Italy. The storm damages and losses are related to meteorological causes like severe winds, havy rain, havy snowfall and related multi-hazard events.

The available documentation approaches and data sources are evaluated in terms of it´s scale (local, national, global), classification systems (e.g. level of standardization of impact types and severity), level of geocoding, relevance/compliance with respect to PDNA and DALA guidelines issued by national and transnational bodies (EU Commission, UN, the World Bank, WMO, etc.) and reference initiatives (e.g. GRADE from the GFDRR, NWS from NOAA).

Existing damage and impact classification systems will be compared and evaluated, and a recommendation for a harmonized cross-border classification system is proposed. Relevant scientific stakeholders where involved in the activities in order to reach the largest consensus.

2 STORM IMPACT DATA COLLECTION IN EUROPE

Storm generically refers to / implies severe weather, with potential for significant disruption but also great variability. In Europe we can observe for instance **extra-tropical cyclones** (XTC, or European windstorms), which cause the highest amount of catastrophe insurance loss and can be extremely impacting, especially on the north European countries. These are very large scale and complex events which can last for days and have footprint of hundreds of kms.

Mesoscale Convective Systems (MCS) can also be observed in Europe. These are complexes of organized thunderstorms but smaller than extra-tropical cyclones and can last several hours. Most form over the continent, some form during the second half of August and September over the western Mediterranean Sea. MCS triggering over Europe is also strongly tied to mountain ranges.
XTC and MCS often impact several countries, possibly with a wide range of observed consequences depending on several factors (evolution of the perturbation, geographical position and morphological characteristics of the territory, etc.).

Depending on the season and on the environmental conditions, specific phenomena can be observed that are relevant for risk assessment. For instance, winter storms can bring to Europe (both in the northern and also in the central and Mediterranean regions) **snowstorms** and freezing temperatures, as for instance in the case of the storm Filomena in January 2021, which brought to Spain more than 50 cm of snow and temperatures as low as -10.

On a more local scale different types of **thunderstorms** can be observed, ranging from **single-cell** to **multi-cell**, **squall lines** and **supercell**). Supercells are the least common and most severe. They are often isolated from other thunderstorms and can dominate the local weather up to 30 km away, lasting for 2-4 hours. Multi-cell clusters can last for hours, with each individual cell lasting 20 to 60 minutes. A squall-line (quasi-linear convective system) is a line of thunderstorms forming along or

ahead of a cold front, often bringing along heavy precipitation, hail and frequent lightning with strong *straight-line winds* (a type of *downburst*). Storms are hence complex events, where each of the considered phenomena (below) has a different way to impact on the exposed people, assets and systems:

- **Precipitation**
  - Rainfall
  - Snowfall
  - Hail
- **Strong Winds**
- **Lightnings activity**

In some case a direct, physical impact is the main cause of damage (and therefore loss), as in the case of strong wind, hail or lightnings. In these cases, therefore, the observed impact would include a description of the damaged assets, the related geographical coordinates and timestamp. In case of large-area impacts, impact information could be aggregated over a given boundary. In other case, direct impact is expected but rather associated to cascaded or triggered secondary hazards. For instance, intense rainfall can generate fluvial, pluvial and flash floods, or trigger landslides, mud-slides and debris flows. In this case, not only the sub-event directly responsible of damage / loss should be recorded (e.g. the flood), but also the one indirectly responsible (e.g. the rainfall associated with the storm).

Indirect impacts should also be accounted for and described, especially when they can generate significant disturbance. This includes for instance the disruption of utilities (electricity, water, gas) or the interruption of transport infrastructure (bridge or road closure).

Note: indirect, intangible impacts, although apparently less important for civil protection authorities, can drastically change the risk aversion and risk perception profile of the exposed people (e.g. see http://www.isdr.at/cms/veranstaltungen/asdr-naturgefahrentagung-2021/save-the-date-asdr-naturgefahrentagung-2021/view)

2.1 WHY DO WE NEED TO RECORD IMPACT, DAMAGE & LOSS

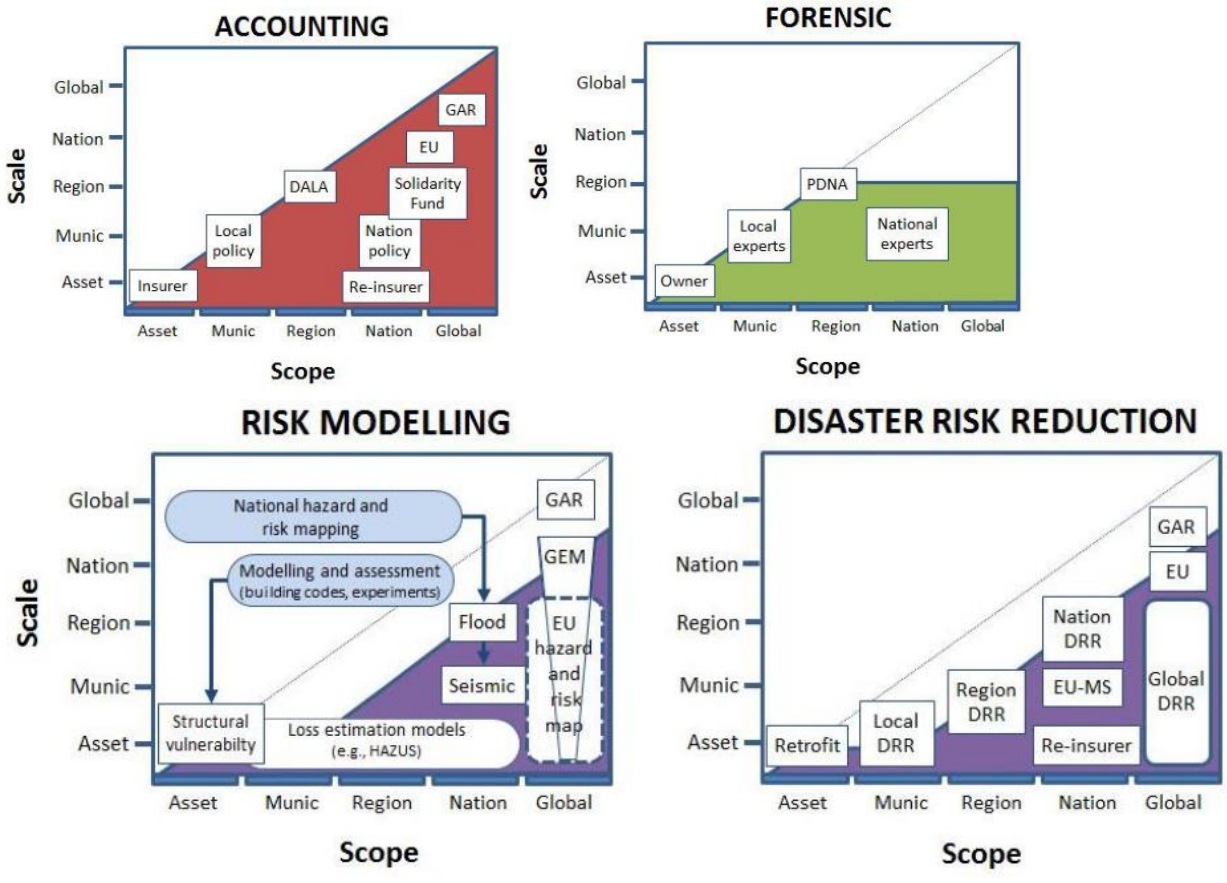
There are several good reasons to justify the increasing efforts in this direction. At least three different application frameworks can be mentioned:

- Risk modelling for early warning and risk mitigation support
- Disaster forensic
- Loss accounting

Each application framework has different objectives and different users and stakeholders are involved, at local, national or global level, as shown in the following figure (JRC, 2013).

	Loss Accounting	Disaster forensic	Risk modeling
Motivation			
Objectives	Recording of impact Measuring trends	Identifying the cause Learning from the past	Modelling future losses DRR and mitigation
Local users	Local policy (City mayor)	Local expert teams	Local research/policy
National users	National policy (National administration)	National expert teams	National research/policy (Regional GEM)
Global users	International policy (UN, donors, HFA, GAR) EU policy (DG ECHO)	International expert teams (PDNA)	International initiatives (GEM, GAR) EU policy

The combination of scale and scope is also different for the different application frameworks, as shown in the following figure (JRC, 2013)



In order to support risk modelling (and disaster forensic) at subnational and local scale, we note that the spatial and thematic resolution is a strong constraint: local data, usually at the asset level are needed to calibrate physical fragility and vulnerability models (for one or more selected hazards), while the scope for loss estimation range from the individual municipality to the national scale.
It is therefore clear that local users are paramount to establish efficient mechanisms for damage and loss collection, while at the same time using a suitable standardization and clear and simple operational protocols is equally important to ensure consistency of the collected information when aggregated at smaller scale. This is even more important considering cross-border applications, where different languages, policies and regulations, as well as common practices outline an additional burden.
We also observe that severe hydrometeorological events might have high damaging potential, with a variable spatial and temporal footprint. Storms such as Vaia / Adrian, for instance, can destroy large portion of forests in the alps. Very localized phenomena, such as for instance short-lived F4 tornado that occurred near Mira (Ve), in Italy in 2015 (see also this), can even go unnoticed unless they hit densely inhabited places. In these cases, the additional problem is that measuring the intensity of the phenomenon can be extremely challenging, and often its physical consequences are the only relevant proxies to the intensity (which is another reason to systematically collect such data).

2.2 State of the art of impact (damage / loss) recording in Europe

In the last decade an increasing attention has been paid to damage and loss recording, in Europe notably advocated and pushed by the JRC with several reports, publications and activities since 2012:

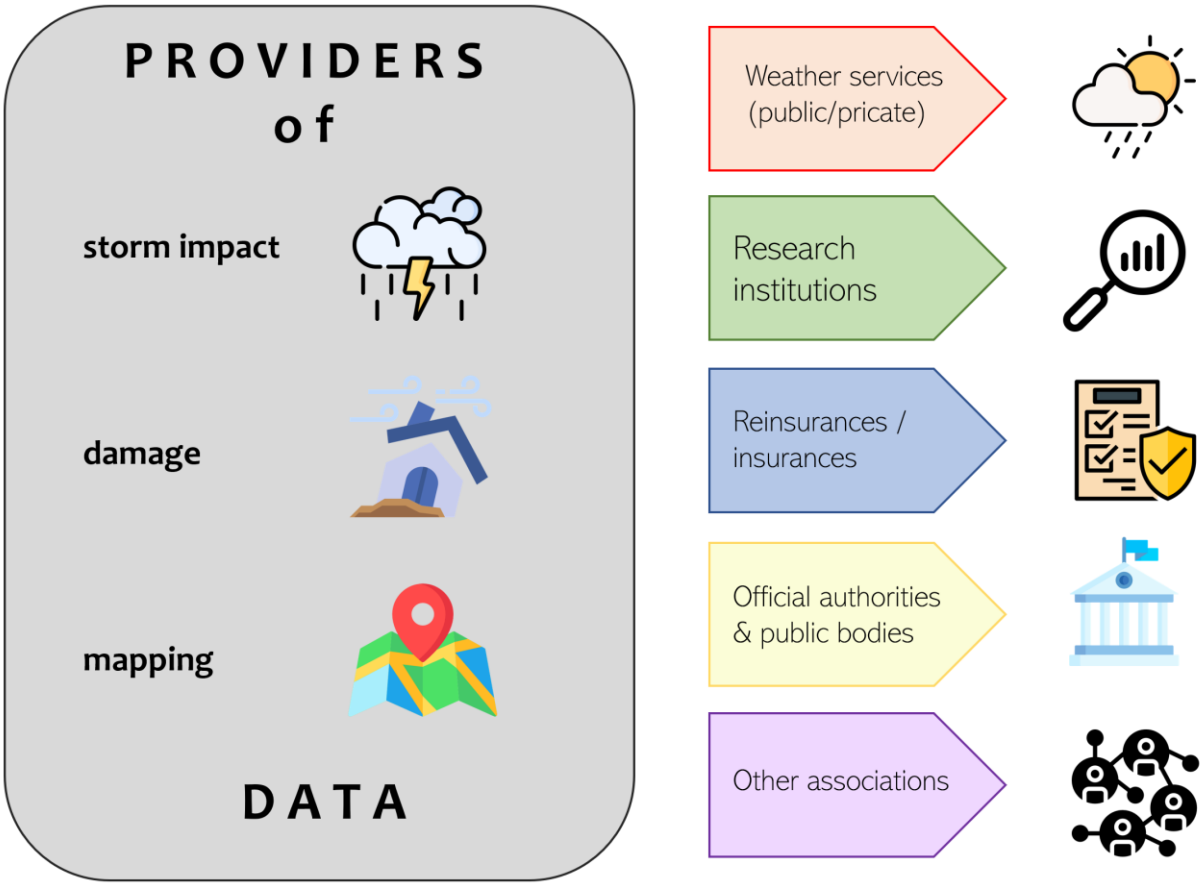
- JRC (2013) – Recording disaster losses (Recommendation for a European Approach)
- JRC (2014) – Current status and best practices for Disaster Loss Data Recording in EU
- JRC (2018) – Disaster damage and loss data for policy

Furthermore, in the DRMKC a specific working group on disaster loss and damage is active since 2013. Despite obvious well elaborated reports and established recommendations of e. g. how to record disaster losses, a broad variation of way´s and techniques of data acquisition over the alpine countries exists. This fact is shown in the sections 4 and 5 as well as in the annex (tabular evaluations of offered event and impact data).

2.3 Related Projects

→ LODE (Loss Data Enhancement for DRR & CCA Management)
→ IDEA (Improving Damage Assessment to Enhance cost-benefit analysis)
→ BORIS (Cross BOrder RISk assessment for increased prevention and preparedness in Europe)

3 RELEVANT INSTITUTIONS FOR STORM IMPACT (DAMAGE AND LOSS) DATA COLLECTION AND MAPPING METHODOLOGIES IN THE ALPINE SPACE



3.1 PRIVATE & PUBLIC WEATHER SERVICES (SELECTION)

short name	official name	geographical scope of operation
ZAMG	Zentralanstalt für Meteorologie und Geodynamik	Austria
ARPA	Regional Agencies for the Protection of the Environment	Italy, regional level
Meteo Aeronautica	Meteorological Service of the Italian Airforce	Italy, national level

3.2 RESEARCH INSTITUTIONS (SELECTION)

short name	official name	geographical scope of operation
EFI	European Forest Institute	EU
GBA	Geological Survey of Austria	Austria
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research WSL	Switzerland
JRC / DRKMC - RDH	Joint Research Centre of the European Commission – Risk Data Hub	EU

3.3 REINSURANCES & INSURANCES (SELECTION)

The insurance sector is historically very active in the field of Risk Analysis, as they provide financial tools for risk sharing (e.g., in terms insurance policies). Natural risks, and particularly storms and related secondary hazards account for a significant share of the yearly losses. Hence insurers and reinsurers through the process of claim settling regularly collect large data about damage and loss (although with some possible bias due related to their market coverage and penetration). Due to the significant economic impact of natural hazards, the market is dominated by large reinsurers, more resilient than smaller insurers to such financial shocks. The following table lists some of the most active institutions.

short name	official name	geographical scope of operation
Deutsche Rück	Deutsche Rückversicherung	Europe
Munich RE	Münchener Rückversicherungs-Gesellschaft	global
Swiss Re	Swiss Re Group	global
ANIA	Italian National Association of Insurers	Italy

3.4 OFFICIAL AUTHORITIES & PUBLIC BODIES (SELECTION IN CROSS-BORDER REGION)

In most European countries, as well as in Austria and Italy, most activities related to damage assessment are tasked to national and local authorities. In the following table an excerpt is provided of the public bodies in charge for at least some aspects of impact and damage assessment. In Section 4 the specific roles of the considered institutions are described in further detail.

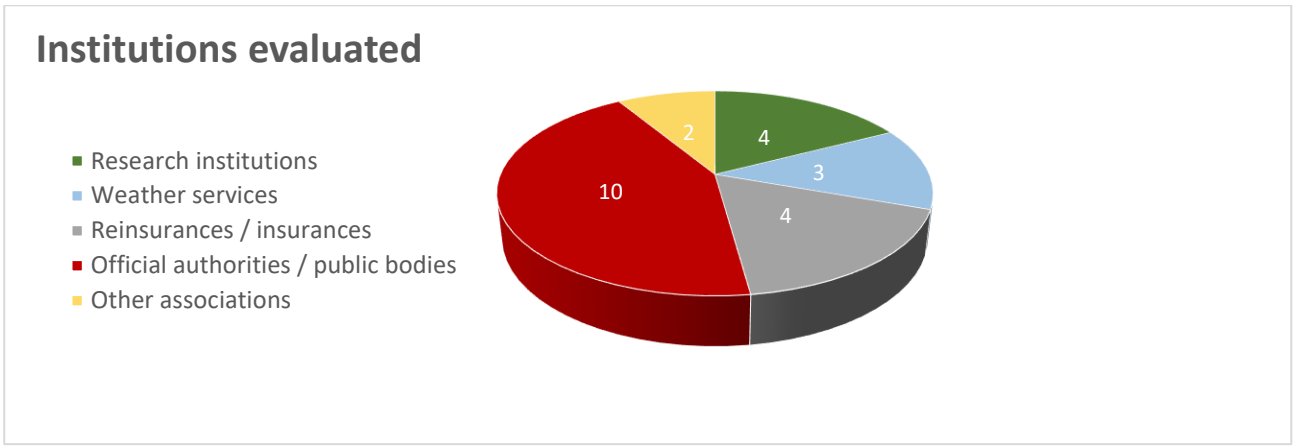
short name	official name	geographical scope of operation
WLV	Forest Engineering Service in Torrent and Avalanche Control	Austria
BMLRT	Federal Ministry for Agriculture, Regions and Tourism	Austria
LWD	Group Tyrolean Center for Crisis and Disaster Management –	Austria, regional (Tyrol)

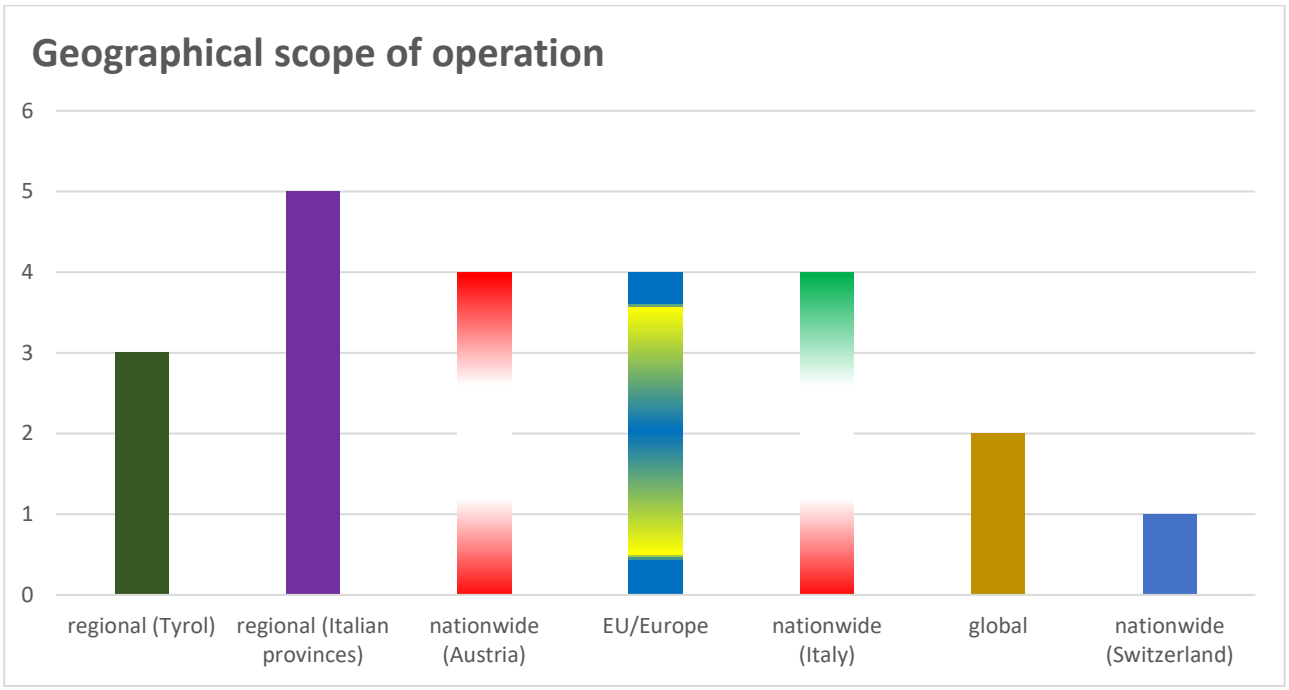
	Department of Hazard and Evacuation Management – Avalanche Warning Service	
---	Construction and technology group –Department of Water Management – Section Hydrography and Hydrology	Austria, regional (Tyrol)
BWV	Department of Water Management – Hydraulic engineering	Austria, regional (Tyrol)
ARPA	Regional Agency for Environmental Prevention and Protection	Regional, operates in most regions in Italy (e.g. in Veneto is named ARPAV, in Liguria ARPA Liguria, etc.)
Autorità Bacini Montani	Mountain Basins Authority	Regional, e.g. operates in Trentino / South Tyrol, Veneto, Lombardy, Val d'Aosta
Dipartimento di Protezione Civile	Dept. of Civil Protection	Operates at National and regional level.
Provincia Autonoma	Autonomous Province Authority	In Trentino and South Tyrol a more autonomous provincial status grants different powers to local authorities.
Direzione Difesa del Suolo – Regione Veneto	Land Conservation Department of Veneto Region	Regional, in the Veneto Region includes the functional center of the Civil Protection Dept.

3.5 OTHER ASSOCIATIONS (SELECTION)

short name	official name	geographical scope of operation
ESSL	European Severe Storms Laboratory.	Europe
MeteoNetwork	Associazione MeteoNetwork OdV	Italy
TornadoListe	TornadoListe (Deutschland)	Germany, Luxembourg

3.6 NATURE, ORIGIN AND SCOPE OF THE RELEVANT INSTITUTIONS





4. RELEVANT STORM IMPACT OBSERVATION, DAMAGE DOCUMENTATION AND MAPPING TECHNIQUES OF SPECIFIC INSTITUTIONS

In this section a more detailed description of the institutions collecting impact data are provided. Since both Austria and Italy feature a heterogeneous situation, in the case of Italy also depending on the specific region, two separate sections will describe each specific case.

4.1 EUROPE

4.1.1 EFI - EUROPEAN FOREST INSTITUTE: "DFDE"

The European Forest Institute is an international organisation, established by the European States. The head-quarter is in Joensuu / Finland. Further offices are in Barcelona, Bonn, Brussels and also beyond the European borders. The EFI conducts research and provide policy support on issues related to forests. It facilitates and stimulates forest-related networking and promotes the dissemination of unbiased and policy-relevant information on forests and forestry. It also also advocates for forest research and for the use of scientifically sound information as a basis for forest policies. The work in the field of policy support includes enhanced support for decision takers and policy makers. It hosts the EU FLEGT Facility which supports the EU Forest Law Enforcement Governance and Trade (FLEGT) process in developing countries, related to the implementation of the EU FLEGT Action Plan. It also hosts the EU REDD Facility, which supports partner countries in improving land use governance as part of their effort to slow, halt and reverse deforestation [1].

Relevant storm damage and impact data sources:

A database on Forest Disturbances in Europe, DFDE, allows searching historic information about disturbances in the forests of Europe. The DFDE has been elaborated by the institutions Alterra based in Wageningen, The Netherlands and EFI. After a quick registration, the database is online available and downloadable as a table in .csv-format [2].

Online access: http://dataservices.efi.int/authenticate.php

4.1.2 MUNICH RE: "NATCATSERVICE"

"Munich Re Group is one of the world's leading risk managers. Founded in 1880 in Germany, the company is now active on a global scale. Munich Re is on of the Top 50 global reinsurance groups since 2010, except for 2017. The portfolios of Munich Re Group and its business units comprise reinsurance, primary insurance, related services, and capital market solutions. Backed by a diversified structure and offices across 50+ countries, Munich Re employees take a holistic view while offering specialised expertise to the markets, companies and customers they serve, both locally and globally" [7].

Relevant storm damage and impact data sources:

"Munich Re's NatCatSERVICE is one of the world's most comprehensive databases for analysing and evaluating losses caused by natural disasters. For this service, Munich Re has for decades been systematically recording in detail all essential information on loss events worldwide. This is stored in a digital catalogue of events and damage" [8].

Online access: https://www.munichre.com/en/solutions/for-industry-clients/natcatservice.html

After contacting the MunichRE staff responsible for the "NatCatSERVICE", we received the following message:

"However, we regret to inform you that the NatCatSERVICE is currently not available. We are working on a solution and hope to be able to offer the NatCatSERVICE again soon (probably not this year). However, data on individual disaster events is no longer available." Therefore, a comprehensive analysis is not possible due to the lack of availability.

4.1.3 Deutsche Rück: online publication "Sturmdokumentation"

German reinsurance has been providing reinsurance cover to German public insurers for almost 70 years. Today, Deutsche Rück is one of the leading reinsurers in the German market. In 2009 the business territory was expanded to Europe. As a reinsurer with a focus on property & casualty, the Deutsche Rück Group, which also includes DR Swiss in Zurich, now writes reinsurance not only throughout the European market but also in selected international markets. Within the German reinsurers, this group offers special expertise in the area of natural hazards [10, 11].

Relevant storm damage and impact data sources:

Deutsche Rückversicherung offers storm documentation ("Sturmdokumentation") in the form of PDFs in the download area. These documents contain textual information on storm situations from the last 24 years, mostly referring to a calendar year for the area of Germany. They are available for free download [9].

Online access: https://www.deutscherueck.de/downloads

4.1.4 Swiss Re Group: online publication "Sigma"

The Swiss Re Group is a leading wholesale provider of reinsurance, insurance and other insurance-based forms of risk transfer. Dealing direct and working through brokers, the global client base consists of insurance companies, mid-to-large-sized corporations and public sector clients. From standard products to tailor-made coverage across all lines of business, they deploy their capital strength, expertise and innovation power to enable the risk-taking upon which enterprise and progress in society depend [15].

Relevant storm damage and impact data sources:

The Swiss Re Group offers publications about storm documentation for online downloads as pdf ("SIGMA"). E.g. information on the natural catastrophes in 2020 ("Natural catastrophes in 2020: secondary perils in the spotlight, but don't forget primary-peril risks") can be downloaded under stating the company and e-mail address.

Online access: https://www.swissre.com/institute/research/sigma-research/sigma-2021-01.html

4.1.5 ESSL – European Severe Storms Laboratory: "ESWD"

"The European Severe Storms Laboratory started as an informal network of European scientists in 2002 initiated by Dr. Nikolai Dotzek. In 2006, European Severe Storms Laboratory e.V. became a non-profit registered association under German law with seat in Wessling, Germany. A subsidiary association, the European Severe Storms Laboratory – Science and Training, also with non-profit status, was founded in 2011 and has its seat in Wiener Neustadt, Austria. It is the legal body for the "ESSL Research and Training Centre" in Wiener Neustadt. ESSL's vision is to improve the preparedness of European society for the impacts of severe storms by advancing scientific understanding, building human capacity, and fostering cooperation within Europe in this field. ESSL's mission is provide training to forecasters, scientists, and policymakers on topics related to convective weather. ESSL participates in research projects and organizes the European Conference on Severe Storms to improve and stimulate the exchange of knowledge on severe convection. ESSL aims to establish and maintain close relationships with NMS and research institutes to strengthen pan-European collaborations. ESSL maintains the European Severe Weather Database, to support research based on observations of severe convective weather or any related impact" [20].

Relevant storm damage and impact data sources:

The "ESWD" is a European Severe Weather Database with the objective to collect and provide detailed and quality-controlled information on severe convective storm events over Europe. In collaboration with severeal partners including networks of voluntary observers, meteorological services and general public, many tens of thousands of reports have been collected [23].

Online access: https://eswd.eu/cgi-bin/eswd.cgi

4.1.6 JRC – DMKRC (Disaster Risk Management Knowledge Centre)

The Disaster Risk Management Knowledge Centre (DRKMC) is a platform developed and maintained by the Joint Research Centre of the European Commission (JRC) since 2016 and aimed at collecting risk-related information for a wide set of natural hazards in Europe. Within the platform, a specific component named "risk data hub" stores damage and loss data integrated from different open sources. The platform can be accessed at https://drmkc.jrc.ec.europa.eu/risk-data-hub/#/damages and provides an interactive web-gis interface to explore available disaster loss data. The platform is still in development and currently does not include any loss and damage data related to severe hydro-meteorological events, although this option is foreseen in the development roadmap (see, e.g., https://publications.jrc.ec.europa.eu/repository/handle/JRC119500). The

RDH component´s spatial data infrastructure is based on a set of free, open-source software packages (see specifications here: https://drmkc.jrc.ec.europa.eu/doc/18150).

4.1.7 TORNADO LISTE (DEUTSCHLAND)

The TornadoListe (Deutschland) is a web-based blog founded by a group of meteorologists that collects and share regularly information on tornadoes spotted in Germany and in Luxembourg (see https://tornadoliste.de). The blog provides narrative description of the observed alleged tornadoes, along with accounts of damages and losses, if reported or observed. The observations are provided by different sources, including many citizens and "storm chasers". In several cases damages are not directly reported but can be indirectly inferred by the assessed intensity of the phenomenon, e.g., on the Fujita or on the Torro intensity scale. The TornadoListe has collaborations with both the similar ESSL and SKYWARN platforms, as well as with private institutions such as the Deutsche Rück insurance company.

4.2 AUSTRIA

4.2.1 ZAMG: "VIOLA"

The ZAMG offers a broad range of services, from weather forecasts to climate and earthquake monitoring as well as the constant analysis and prediction of atmospheric pollutants. The outstanding team collaborates with universities and research institutions around the globe to maintain high-quality measurement facilities and services. ZAMG provides state-of the-art in-house supercomputer facilities and powerful databases containing quality-controlled meteorological measurements to calibrate their models and perform ongoing climate change assessments. ZAMG also represents Austria in major international organizations such as the World Meteorological Organization (WMO) and EUMETNET, a cooperative network of 26 European weather services [5].

Relevant storm damage and impact data sources:

ZAMG offers information on severe weather events in Austria since 1961 via the web service "VIOLA". The focus is on heavy rain, hail, lightning strikes, floods and much more. Since 1948, ZAMG has recorded damage-causing extreme weather events on the basis of media reports and published them as an annual severe weather chronicle in the ZAMG yearbooks or on the ZAMG website. The records were kept in tabular and text form until the end of 2015, and these data were not recorded in a database.
The VIOLA (Vlolent Observed Local Assessment) project has been developing a digital severe weather platform since 2014. In the first year of the project, a categorisation scheme was developed to build a database. This was done taking into account the existing severe weather data stock and in accordance with the procedural guidelines of international organisations such as ESSL (European Severe Storms Laboratory) and EUMETNET (European Meteorological Network). The database was then linked to a suitable input application, which is available in the internal area of ZAMG. The application enables the input and query of severe weather events and offers differentiated filtering options. The collected damaging events are based on media reports. An interactive web presentation for the publication of severe weather events on the ZAMG website is being developed. The Web-VIOLA 1.0 version forms the basis for the conceptual follow-up developments. The VIOLA severe weather chronicle web servis is available at "https://www.zamg.ac.at/cms/de/klima/klima-aktuell/unwetterchronik?jahr=2021&monat=7" [6]. GIS

compatible raw data can be ordered e.g. for research projects directly from ZAMG under signing a data usage agreement.

Online access: https://www.zamg.ac.at/cms/de/klima/klima-aktuell/unwetterchronik?jahr=2021&monat=7

4.2.2 GBA - Austrian Geological Survey: "INSPIRE Gravitational Massmovements – Observed Events (Media) Austria"

"The Geological Survey of Austria collects and interprets geoscientific information in Austria, lays the foundation for the sustainable use of the geogenic potential and provides them to the public in a systematic manner. The Geological Survey of Austria creates maps and reports on all geological aspects of the earth, dedicated to the exploration of mineral deposits, groundwater, natural hazards and geothermal energy, operates a geological information service acts as a service for the public administration and participates actively in international research projects, in particular with neighboring countries, part. The Geological Survey of Austria represents the national interests on the international geoscience, especially at European Level" [3].

Relevant storm damage and impact data sources:

The GBA provides a dataset of Natural Risk Zones which is implemented in the EU Inspire geoportal. The events recorded are gravitational mass movements which were identified on the basis of media and literature information. The data can be integrated into a GIS as a WMS layer or downloaded via the INSPIRE download service [4].

Online access:
https://inspire-geoportal.ec.europa.eu/download_details.html?view=downloadDetails&resourceId=%2FINSPIRE-61494ff5-6fad-11e8-b649-52540023a883_20210910-151402%2Fservices%2F1%2FPullResults%2F801-850%2Fdatasets%2F49&expandedSection=metadata

WMS source:

https://gis.geologie.ac.at/geoserver/nz_risiken/wms?version=1.3.0

4.2.3 WSL: "Flood and landslide damage database"

The Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) is concerned with the use, development and protection of natural and urban spaces. The focus of it´s research is on solving problems to do with the responsible use of landscapes and forests and a prudent approach to natural hazards, especially those common in mountainous countries. WSL also provides groundwork for sustainable environmental policies in Switzerland. The WSL maintains experimental and research plots for monitoring the effects of climate change on forests and sites damaged by storms or fires. The impact of natural hazards is beeing investigated [31].

WSL is a research institute of the Swiss Confederation and part of the ETH Domain. The WSL also includes the institute for Snow and Avalanche Research SLF in Davos. SLF employees develop tools and guidelines for

authorities, industry and the public in order to offer them support in natural hazard risk management and in the analysis of climatic and environmental changes [31].

Relevant storm damage and impact data sources:

Since 1972 the Swiss Federal Research Institute WSL has been systematically collecting (based on newspapers) and analysed damage caused by storms on behalf of the Federal Office for the Environment FOEN. This data is collected in the "Swiss flood and landslide damage database". Damage originating from naturally triggered floods, debris flows, landslides and (since 2002) rockfalls have been considered. Not considered was damage from avalanches, snow pressure, earthquake, lithening, hail, windstorm and drought. The corresponding weather conditions were also noted in the database. In this way, a database with currently more than 20'000 entries has been generated. The spatial distribution of the damage from 1972 to 2019 and during some large events can be viewed on the interactive map of the "Swiss flood and landslide damage database". This database can be analysed in terms of location, extent, causes and the temporal and spatial distribution of the storm events. The results are published yearly in the Journal "Wasser Energie Luft". The damage data are provided to official institutions on request as a broad information basis for hazard assessment [32].

Online access: https://www.wsl.ch/en/natural-hazards/understanding-and-forecasting-floods/flood-and-landslide-damage-database.html

4.2.4 WLV – Austrian Torrent & Avalanche Control: "WLK"

As a federal organisation, the Torrent and Avalanche Control stands for sustainable protection against natural hazards in the area of torrents, avalanches and erosion. The unity of analysis, assessment and management of natural hazards results in positive synergies in the knowledge of processes in the natural environment and in dealing with natural hazards. Cooperation with partners at federal, provincial and municipal level, as well as with business and science, ensures integral, preventive solutions for the protection of the population. The tasks of the WLV include the collection, processing, evaluation, data management and provision of information on natural hazards, the preparation of expert opinions and statements within the framework of official procedures, hazard zone planning and the planning and implementation of measures [12].

Relevant storm damage and impact data sources:

The torrent and avalanche cadastre (WLK) of the WLV is a digital geoinformation-technological management system / event portal for the standardised, spatial management and recording of natural hazard information. The creation and maintenance of a torrent and avalanche register is provided for in §102 para. 5 lit. d of the Austrian Forest Act 1975 (ForstG 1975). The input portal and all the information contained therein are only accessible to employees of the or users on behalf of the same [13, 14]. GIS compatible raw data can be ordered e. g. for research projects directly from WLV under signing a data usage agreement.

Online access: https://naturgefahren.die-wildbach.at/V3/index.aspx

4.2.5 BMLRT – Austrian Ministry for Agriculture, Regions & Tourism: "HORA"

The Austrian Federal Ministry of Agriculture, Regions and Tourism has a broad remit and is responsible for agriculture, forestry and water management as well as telecommunications and postal services, mining, regional policy, tourism and the civil service. The Ministry is subdivided into several sections and departments, with the Forestry and Sustainability Section being particularly relevant for natural hazards and risk management [16, 17].

Relevant storm damage and impact data sources:

HORA (Naturual Hazard Overview & Risk Assessment Austria) is an online visualisation of various natural hazard processes, their appearance in space and time (events), and their potential occurrence (e.g. flood zoning). HORA offers information ranging from earthquake hazard maps, to storm events, to hail damage events subdivided into property damage and damage in agriculture [18]. The homepage is available at https://www.hora.gv.at/.
Excursus Hail Documentation: "From the storm chronicle kept by the ZAMG, reports are selected which report hailstorms with major damage to industry. Industrial damage includes hail damage to windows, glass houses, motor vehicles, real estate with damage to roofs and facades. With the help of the "TORRO Hail Intensity Scale", the hail damage / hail intensities / hailstorm sizes are classified from the descriptions in the storm reports. For the compilation of a hail risk map of Austria for the last 30 years (1977 to 2006) of the total of 260 events, 136 hailstorms with resulting industrial damage were classified according to TORRO" [29].

Online access: https://www.hora.gv.at/

4.2.6 LWD – Tyrolean Avalanche Warning Service: "LAWIS"

The Avalanche Warning Service Tyrol is part of the Department of Hazard and Evacuation Management and has been informing the public about the current snow and avalanche situation in the Tyrolean mountains for more than 50 years. In doing so, the Avalanche Warning Service collects, evaluates and interprets a wide range of information on snow cover and weather. All information and interpretations ultimately result in the central warning product of the avalanche warning service, the now cross-border avalanche report [24].

Relevant storm damage and impact data sources:

The avalanche warning service does not maintain a real "severe weather database" in the strict sense. However, every avalanche reported (by alpine police officers, mountain guides, laymen, etc.) that is associated with property damage or personal injury is documented. For this purpose, there are tables with all these avalanches, which are fed into the "LAWIS". "LAWIS" is a cross-border (e.g. Austria, Italy, Slovenia, Slovakia, Czech Republic, Switzerland, Russia, Andorra) portal for sustainable data collection, dissemination and communication of avalanche-related information. It comprises a freely accessible online information tool for avalanche issues based on citizen involvement and participation, Open Government Data (OGD) and applied research. "LAWIS" is aimed at the general public and is available worldwide. It is currently actively supported by the seven Austrian avalanche warning services and jointly coordinated by the University of Vienna. LAWIS consists of a worldwide collection of continuously updated data for weather stations, snow profiles and avalanche events. The cooperation between avalanche warning services and the University of Vienna has proven to be highly productive and sustainable. Both a deepening of national contacts and a further international expansion of "LAWIS" are desirable, as the standardization of work processes, visualization as well as up-to-date communication of avalanche-relevant information need to be further advanced [21, 22].

Online access: https://www.lawis.at/

4.2.7 Land Tirol - Section Hydrography and Hydrology: "Hydrological overviews"

The Hydrography and Hydrology Division of the Province of Tyrol is subordinate to the Water Management Department. This in turn is subordinate to the Construction and Technology Group. The Hydrography and Hydrology Division focuses on the general survey of the water cycle, flood forecasting and flood information services [25].

Relevant storm damage and impact data sources:

The Hydrological Overviews are published monthly and describe the most important components of the hydrological cycle in Tyrol. For this purpose, the data of own and external measuring stations are subjected to a rough evaluation and compiled for initial information on the current hydrological events (such as floods that have occurred, heavy precipitation events, etc.). The data given in the monthly overviews are to be regarded as "preliminary", verified data will be published in the Hydrographic Yearbook of Austria. The current monthly report is published in the second half of the following month. The archive of hydrological overviews starts with the review of the year 1996. Austria-wide information on hydrological events can be found on the pages of the BMLRT / Department of Water Resources [26].

Online access: https://www.tirol.gv.at/umwelt/wasserwirtschaft/wasserkreislauf/hydrologische-ueber-sichten/

4.2.8 LFV & Leitstelle Tirol - State Fire Brigade Association & Control Centre of Tyrol

The Tyrolean Fire Brigade Association (LFV-Tirol) is responsible for the technical and organisational measures to fulfil the tasks assigned to the fire brigades. The LFV Tyrol comprises 337 voluntary fire brigades, 20 company fire brigades and one professional fire brigade. With more than 32,000 members, the LFV Tirol is the largest operational organisation in the province of Tyrol [33].

The Tyrol Control Centre is a subsidiary of the Tyrolean governmental office and the central control centre of the Tyrolean blue-light organisations. It receives the emergency calls (fire brigade, alpine emergency, and rescue services) and coordinates the emergency services. A total of almost 100 employees works at the Tyrol control centre. The need for an integrated and supra-regionally coordinated response coordination became particularly obvious after the avalanche accident in Galtür in 1999. The aim was to create a control centre from which the alerting, coordination, dispatching and operational support of all Tyrolean emergency services (with the exception of the police) could be carried out. This was the foundation stone of today's Tyrol control centre [34].

Relevant storm dagmage and impact data sources:

Yet no data available at time of report deadline.

4.2.9 BWV – Hydraulic engineering Tyrol: "HWFDB"

The Department of Hydraulic Engineering at the Province of Tyrol is actually a subordinate agency of the Federal Ministry of Agriculture, Regions and Tourism. The umbrella organisation of the Department of Hydraulic Engineering is the Federal Hydraulic Engineering Administration. In the federal states, this is located at the federal state governments or the district administrations (building district office). The area of responsibility includes river engineering of federal and interested parties' watercourses, watercourse supervision, water management issues in land use planning, flood protection, etc. In the individual federal states (e.g. Tyrol) a further task is the recording, reporting and documentation of flood events in the responsibility of the Federal Water Engineering Administration. Via the water information system WIS (event register), the event data are transferred to the nationwide flood database (HWFDB) via an interface [27, 28].

Relevant storm damage and impact data sources

To handle data exchange between the federal government and the federal states and for reporting obligations to the European Commission within the framework of the EU Floods Directive 2007/60/EC, the Federal Environment Agency has set up the "Hochwasser-Fachdatenbank". Data on funding, flood events, risk management plans and hazard and risk maps are managed in the "Hochwasser-Fachdatenbank". The database is accessible within the administration and to the responsible departments. Data on reporting statuses of the EU Floods Directive are published via WISA [36].

4.3 Italy

4.3.1 MeteoNetwork – Associazione MeteoNetwork OdV: "Storm Report"

MeteoNetwork was founded by friends and weather enthusiasts as an unregistered association on 6 April 2002 in Seregno (MB). Almost a year later, on 5 April 2003, the association was officially registered in Mantua, where its registered office is located. MeteoNetwork is a non-profit organisation with the task of spreading knowledge in the field of meteorology and climatology [30].

Relevant storm dagmage and impact data sources:

Storm Report is a database in which users can enter reports of violent weather phenomena resulting from thunderstorms, in a very easy, fast and intuitive way. The project aims to make a scientific collection of storm-related phenomena for research purposes. The Storm Report is supported by an Expert Meteorological Observer (OME) Team. Composed of Italian storm chasers, regional and/or local meteorological associations, public/private bodies or volunteers. Among other things, the data collection of the Storm Report is also linked to the ESSL (European Severe Storms Laboratory) or the ESWD (European Severe Weather Database) [37].

Online access: https://www.meteonetwork.it/tt/stormreport/; https://pretemp.stormreport.it/

In the following sections the reporting of severe hydrometeo events is analysed for the 7 northern cross-border regions: Trentino / South Tyrol, Veneto, Friuli Venezia Giulia, Lombardia, Piemonte, Val d´Aosta and Liguria:

4.3.2 TRENTINO REGION

In autonomous province of Trento (Trentino) the main agencies are the "Servizio Bacini Montani" (mountain basins service) and the Meteorological agency (Meteotrentino, https://www.meteotrentino.it/).

Post event reporting:

Weather. Weather report is produced systematically by the Meteotrentino.
Ground effects. Ground effects are included in the reports in brief: e.g. avalanches and landslides are reported with reference to the area, with no additional detail.
The Servizio Bacini Montani (Mountain basins service) sistematically collects data related to water streams and debris flow. They use a recently digitalized form. The final report is for internal use of the Province of Trento, it is not for public use.
Damage to Forests. The Servizio Foreste (forest service) does not act sistematically for trees damages. Data collection after VAIA: they tried to get data from Sentinel, but with unsatisfactory results. They then asked the collaboration of the forest technicians of each municipality, to get maps of the damaged areas, through a dedicated form. Drones were used for remote or excessively wide areas (e.g. Val di Fassa).
Avalanches. Agency: Meteotrentino. Post-VAIA: they used the collected data of the fallen trees to run a simplified model to identify new avalanche sites (revised Carta del Pericolo(vulnerability map).
Data availability. Aerial surveys are carried out after intense events, using drones (made available by the firefighters) or helicopters (by province of Trento). Several Lidar flights were done after VAIA event.

4.3.3 SOUTH TYROL

In the autonomous province of Bolzano (a.k.a. "Alto Adige" or "South Tyrol") the main agencies dealing with natural hazards have been brought under the control of the Agency for Civil Protection. This includes (among others) the geological office, the Forest department, the civil protection department, the hydrological department, the meteorological department, and the coordinating "provincial functional center".

Pre-event alerting:

Weather. From September 2021 a new alerting system is operational. Through a web-interface (see https://lwz.afbs.it/en/reports/risk-potential/map, in German, Italian and English) the system provides a forecast of potential for harmful events for the current and the subsequent 3 days, highlighting the area of the province where alert are issued. The alert report is also disseminated through email (see e.g. an example https://cms-lwz.afbs.it/fileadmin/pdf/2021-09-29_RISK_POTENTIAL_SOUTH_TYROL.pdf, in Italian and German). The alert considers 7 types of hazards, namely "hydrogeological", "severe thunderstorm", "flood", "snow in the valley","strong wind", "extreme temperatures" and "forest fire".
Ground effects. For each of the considered hazards the alerts indicated in the bullettin are color-coded according to a scale of risk which describes some of the expected impacts. The criticalities and alert codes are compatible with the ones used by the Italian Department of Civil Protection at national scale.

Post event reporting:

Weather. A monthly report is provided (https://meteo.provincia.bz.it/pubblicazioni.asp, in Italian and German) In case of extreme events, special reports are issued (as, in the case of VAIA:

https://meteo.provincia.bz.it/pubblicazioni.asp?publ_action=4&publ_article_id=385106 in Italian and German).
Ground effects. Ground effects different from the following ones are not systematically collected
Landslides and floods. Landslides are collected following the IFFI standard italian landslides event repository format, while floods are collected following a specific format called ED30. Geospatial information related to location and partly to size are collected. Indications about the type of impact are provided (e.g. if people or infdrastructure were involved) but with no specific detail.
Damage to Forests. The department for forestry is collecting data about impact of wind and snow on trees. The data are based on manual field and remote-sensing based observations.
Avalanches. Avalanche information is collected following the LAKA standard (similar to IFFI and ED30).
Data availability. All collected data is available to local plannning and decision-makers authorities. Part of the data is also openly available through public geoservers. Impact data is not openly available, nor the multimedia information. A yearly report is made available which summarizes all noticeable events in the year, including a textual list of events and their characteristics (https://www.provincia.bz.it/sicurezza-protezione-civile/bacini-montani/eventi.asp, in Italian and German).

4.3.4 VENETO REGION

In autonomous province of Trento (Trentino) the main agency is the “Direzione Difesa del suolo” (Land Conservation Department).

Pre-event alerting:

Weather. In case of alert, the centro funzionale/civil protection sistematically publishes every 6 hours a weather nowcasting bulletin. This contains the description of the actual situation, with precipitation of the last 6 hours, and a forecast of the upcoming 6 hours, with the foreseen levels of precipitation

Ground effects. Contained in the same nowcasting bulletin: it reports the variations of the water levels registerd by ARPAV real-time telemetry network, and possible ground effects. A WebGIS based application has been developed to report ground effects in real time to the operative room of the Centro Funzionale and Civil Protection. The Application is not yet operational, and it will be used by the Genio Civile and the Forest Service division.

Post event reporting:

Weather. A report is produced by the Centro Funzionale within a few days after the end of the event, the "Scheda post evento". It describes in detail: the weather phenoma; the registered precipitations, with related return period; the water level of the main water streams in the region and comparison with the maximum level ever registered for each section taken into account; a description of the registered ground effects (e.g. https://www.regione.veneto.it/static/www/protezione-civile/postevento/scheda_evento_PLUVIO_IDRO_121129_rev_1.pdf, in Italian).

Ground effects. Reported ground effects are described in the post event report by Centro Funzionale.
Landslides and floods. Data about landslides are used to update the IFFI (national database of landslide phenomena). When ground effects are particularly widespread across the territory, a task force is created between techicians coming from the regional land conservation department (difesa del suolo), Genio Civile,

Forest Service Division and ARPAV. Technicians are required to fill a specific post-event form, where they can describe the main damages, give brief indications of possible risk mitigation intervention and their priority. Every recommendation comes with a georeferenced map and several pictures.
Damage to Forests. A special procedure for fallen trees does not exist. Relevant damages are reported in the same form used to map landslides.
Avalanches. All new avalanches sites have been mapped by the Centro Valanghe di Arabba (ARPAV). The same office gives support to local administration with surveys and decision support. Furthermore, it updates the avalanches WebGIS.
Data availability.

4.3.5 Friuli Venezia Giulia Region

In the region the main agency is the Department of Civil Protection.

Pre-event alerting:

Weather. In case of an allert, bulletins are created sistematically, reporting a summary of the weather information, e.g the precipitation registered until that moment.
Ground effects. The Centro Funzionale decentrato/Civil Protection and the Regional Operation Room (SOR) creates update bulletins, containing the ground effects and a summary of the weather situation, described also in the update meteo bulletin.

Post event reporting:

Weather. Within few days-weeks, a report is produced, called "Rapporto di Evento Meteoidrologico"(weather-hydrological event report), including, among the rest, data related to wind.
Ground effects. After every event leading to an allert, a report is sistematically created, describing the ground effects related to the hydraulic and hydrogeological risk.
Landslides and floods. Data related to hydrogeological instability are reported in SIDS (land conservation (difesa del suolo) Information sistem). Non available to the public.
Damage to Forests. After VAIA, the Regional Forestry corps took charge of surveying and mapping the forestry area affected by the storm.
Avalanches. Data related to avalanches are sistematically reported in SIDS (land conservation (difesa del suolo) Information sistem)
Data availability. Lidar and aerial surveys made by the Region after VAIA in the most affected valleys are available upon request.

4.3.6 Piemonte Region

In the region the main agency is the ARPA Piemonte.

Pre-event alerting:

Weather. The Centro Funzionale/Civil Protection writes bullettins on a daily basis, reporting the weather forecast and the hydrological situation. Data are derived from the telemetry network and modelling.
Ground effects. During the event, the main informations about ground effects are collected, coming from warnings by Civil Protection, local authorities or press review. (e.g., http://www.arpa.piemonte.it/rischinaturali/centro-funzionale/centro-funzionale/sistema-allerta/sistema-allerta.html, in Italian).

Post event reporting:

Weather. In case of an orange or red allert, or of particularly significant weather events, a report is issued few days after the event, with an analysis of the weather situation.
Ground effects. In case of relevant ground effects, ARPAV and the Region cooperate for the necessary surveys: ARPA mainly takes care of damages, while the Region is in charge of the processes analysis. Data are collected in the information system and a preliminary report event is published, describing the synopsis of the ground effects (see http://www.arpa.piemonte.it/pubblicazioni-2/relazioni-tecniche/analisi-eventi, in Italian).
Landslides and floods. ARPA and Region cooperate for the systematic collection of ground effects. ARPA mainly takes care of damages, while the Region is in charge of the processes analysis and the homogenisation of data within ARPA information system. Data are published on ARPA WebGIS, and a follow-up event report is issued, when necessary (https://www.regione.piemonte.it/web/temi/protezione-civile-difesa-suolo-opere-pubbliche/calamita-naturali/rapporti-sugli-eventi-alluvionali-piemonte, in Italian).
Damage to Forests. There is no systematic and standardized procedure for fallen trees.
Avalanches. Significant events are described in the event report. Data are collected by the Snow and Avalanches office of ARPA Piemonte, with the support of the Local Avalanches Committees, and reported in SIVA (Avalanches information system).
Data availability. Data are stored and managed within the information system of ARPA Piemonte. In case of significant events, further remote sensing data may be collected (drones, aerial pictures, satellite imaging, http://www.arpa.piemonte.it/approfondimenti/temi-ambientali/geologia-e-dissesto/bancadatiged/processi-ed-effetti, in Italian).

4.3.7 Liguria Region

In the Liguria Region the main agency is the ARPA Liguria.

Pre-event alerting:

Weather.
Ground effects.

Post event reporting:

Weather. Within few days-weeks, a report is produced, called "Rapporto di Evento Meteorologico" (weather event report), including, among the rest, data related to wind. The report is published online for public use

Ground effects. The report includes the maximum water level registered for water streams, and, when present, a summary of reported ground effect and relevant damages.
Landslides and floods. Landslides: the database is updated monthly. Data are available for other regional agencies and for the National Civil Protection Department, in case of a national allert. Furthermore, there is a google map, for internal use only, where landslides are reported as points and all useful information collected during and after each event are described (especially related to damages). Institutional web portal Zerogis by the Civil Protection of Liguria Region: public institutions can report occurred damages. The Settore Assetto del Territorio (regional planning) of Regione Liguria is in change of the evaluation of landslides extension and maps update.
Damage to Forests. There is no systematic and standardized procedure for fallen trees
Avalanches. Significant events are described in the event report. Data are collected by the Snow and Avalanches office of ARPA Piemonte, with the support of the Local Avalanches Committees, and reported in SIVA (Avalanches information system)
Data availability. Data are stored and managed within the information system of ARPA Piemonte. In case of significant events, further remote sensing data may be collected (drones, aerial pictures, satellite imaging, see also http://www.arpa.piemonte.it/approfondimenti/temi-ambientali/geologia-e-dissesto/bancadatiged/processi-ed-effetti, in Italian).

4.3.8 Val d´Aosta Region

In the Val d´Aosta region the main responsible agency is the "Centro Funzionale Valle d'Aosta" / Civil Protection Department.

Pre-event alerting:

Weather. In case of an allert, bulletins are created sistematically, reporting a summary of the weather information, e.g precipitation registered until that moment.
Ground effects. Members of the Regional Forestry corps patrol the territory during critical events, reporting relevant ground effects. The bulletin reports data from hydrometers, reported landslides, etc. (see an exaple of the bullettin: https://cf.regione.vda.it/allegati/bollettini/aggiornamento/2020/ottobre/Bollettino_aggiornamento_2020-10-02_07.pdf, in Italian)

Post event reporting:

Weather / Ground effects. Post-event surveys are a product of the collaboration between Centro Funzionale, Geological service, the mountain basin service, and the agency responsible for hydraulic works. Each agency writes its own forms and reports, in a second moment the Centro Funzionale collects all the material and writes a final report with all the events of hydrological instability and reported damages (see, e.g. https://cf.regione.vda.it/rapporti_di_evento.php, in Italian).
Landslides and floods. Members of the Regional Forestry corps patrol the assigned area and directly report any damage via an APP. The frequency of the patrols increases as it increases the severity of the allert (see https://cf.regione.vda.it/dissesti.php, in Italian).
Damage to Forests. There is no systematic procedure for fallen trees, mainly trees disrupting viability are reported.

Avalanches. Avalanches are under the responsibility of an independent office. The Centro Funzionale takes the avalanche forecast and includes it in its bulletins.
Data availability. There is an agreement between the Centro Funzionale and the Firefighter corps for the use of drones. Some data about ground effects comes from the firefighter corps database, but this procedure is not sistematic, is not easy to use and they are currently doing a trial about using it.

5 EXECUTIVE SUMMARY (RELATED TO DATA AND DATA PROVIDERS FROM SECTION 3 & 4 - TEXTUAL SUMMARY OF TABLES)

In this document we have briefly reviewed the current situation in terms of data collection and mapping of storm impact in Europe and more specifically in Austria and Italy (in the latter case focusing on the neighbouring regions). This is the first part of a two-part report, the second part of which is in progress and will be presented in the deliverable D3.2. In the following a few remarks are provided to summarize our preliminary findings.

In this report (see Annex 1), 11 different institutions - which offer data on storms, their occurrence, secondary phenomena and impact in some form - were analysed in detail. Due to the different nature, objectives & purposes of the institutions, the evaluations of the available data naturally varied greatly. A brief overview is given below.

Data availability & kind of data format/documentation:

Around 80 % of the data sources examined are available online as open source data, at least for basic use. Data details or uses beyond pure online visualization (e. g. metadata, shapefiles, tables, etc.) can also be obtained in 80% of cases upon request or within the framework of a user agreement. Only one institution charges fees for data provision in principle and also for research purposes. With regard to the 11 providers/institutions examined, the data are offered exclusively in digital form. The data are visualized at least as a web application in 70% of the providers examined. More than half of the institutions also offer data in the form of tables or GIS-compatible files. 30 % of the data sources are available in the form of PDF files (textual information) that are difficult to use.

Event documentation:

More than half of all event information is explicitly spatially located, although some of it may be inaccurate or only roughly listed (e. g. in resolution at municipality level). A temporal assignment (date/time) is provided for almost all event data (80%), at least with a resolution down to the day. For some of them, however, the duration of the event is not clearly indicated. The reason for this may also be the nature of the process. An indication of the duration for spontaneous landslide processes or avalanches is hardly feasible or not practical. On the other hand, the duration of precipitation events or storms is usually given. 6 of 11 event databases refer geographically to the national level. 3 collections cover the EU area or the European continent. One collection describes events globally.

Data acquisition:

The ways of data acquisition are manifold. 3 collections are obtained purely from research in media. Accordingly, reporting, terminology, indication of duration, size, damage, etc. should also be treated with caution. In 6 cases, the collection is done through measurements or fieldwork. In 3 other cases, reference is made to official publications or reports. In 2 cases, the acquisition / origin of the information cannot be determined. In almost all cases, the acquisition is done by experts, even if media reports are used. Then, at least in one example, a quality control is added. While some event data is only collected by experts in closed databases, there are also databases that are fed by laypersons or hobby observers.

Hazard process details:

In 8 of 11 cases, a more or less clear distinction is made between different natural hazard processes. Overall, the event data contained information on continuous rain, heavy rain, drought, heavy snowfall, ice accumulation, hail, thunderstorms, various storms (tornadoes, funnel clouds, gustnados, whirlwinds, etc.), lightning, various types of avalanches (slab, loose, wet, dry), mass movements/landslides (falls, topples, slides, flows), floods, pluvial floods, groundwater, heat and cold waves, wild fire, rime, deadwood. It was striking that none of the databases dealt with multihazards or cascade effects in detail. The survey of the meteorological variables, as part of the cause-effect relationship, is only partial. In certain cases, precipitation in mm, wind speeds or temperatures are addressed. The magnitude/intensity of events is cited in over 60 % of the data collections. The description of damage is less detailed. Although half of the collections contain information on the damage caused, only one third of the cases deal with the quantification of the damage.

Adherence to standards, guidelines, recommendations:

The inclusion of or reference to internationally standardised thresholds or scales is obviously still lagging somewhat behind. Reference to the Fujita, Torro or EAWS scales is made in only one third of the data collections. There is also a lot of catching up to do in terms of compliance with international guidelines and reference initiatives. Only 3 out of 11 databases or event collections analysed can be directly linked to the EU Commission, for example.

5.1 PRO-ARGUMENTS | ADVANTAGES | "BEST PRACTICE" CASES

In Europe, in general, there is an increasing understanding of the need to systematically collect data related to the impacts of natural (and anthropogenic) events on socio-ecologic systems. This is clearly visible in the efforts devoted on this topic by the EU Joint Research Centre, which between 2012 and 2017 has published several technical reports even proposing detailed solutions in methodological and technological terms. This is slowly albeit noticeably taken up by several countries, often with specific solutions that must adapt to the individual existing functional and operational structures. It is also important to note that by "impact" is usually interpreted as the broad set of effects of a given "root" phenomenon (e.g., a storm). This includes mostly cascaded hazards such as

landslides and debris flows, fluvial and flash floods, and avalanches. A combination of custom-tailored and standardized methodologies is used to record these impacts, with the latter gaining ground due to both Europe-wide projects (e.g., the EU Floods directive, which prompted the collection of floods events) and nation-wide harmonization efforts (e.g., the Italian IFFI database of mass movements). The geographical scope, thematic and spatial resolution, quality control approaches and operational protocols vary widely among the different countries and across the different institutions involved in these activities. Among the countries showing a "best practice" approach we can highlight the case of Switzerland and Slovenia, where more systematic and structured impact data collection is being implemented.

Apparently, most of impact data conveying information on damage and loss is collected from personal testimonies, newspaper and media, and direct witnesses. A good example of an operational system based on such approach is the VIOLA system implemented and operated by ZAMG in Austria, which provides an informative overview of the observed impacts (including damages and affected people) along with meteorological data.

5.2 CONTRA-ARGUMENTS | DISADVANTAGES | "MAJOR OBSTACLES" | GAPS

Several gaps can be highlighted, which would deserve attention:

- The ultimate impacts in terms of damages to people, buildings, infrastructure are noticed but usually not systematically collected and recorded. Information on these impacts is sparse and fragmented. Some particularly structured reporting protocols (e.g., for landslides and floods) are allowing the recording of information on affected people or physical damage to structures, although this is in most cases not detailed enough to inform fragility or vulnerability models, nor provided with a sufficient spatial resolution to allow for further analysis. Damage data from e. g. insurance companies can only be acquired with difficulty or not at all. The reason for this could be the increasing sensitivity regarding data protection.

- In cases of damages related to strong windstorms, lightnings and other secondary causes damages are usually not systematically collected. Other types of impacts, for instance related to cascaded phenomena, such as traffic disruption, business interruption, power outages are not collected at all, although they are certainly recorded by some specific public or private body.

- Although open data is on the rise, storm (and in general) impact data and information even when collected systematically is not freely available and / or accessible. Often there is certain public basic data, provided by corresponding institutions. However, details or sensitive data such as casualties/deaths are usually not disclosed.

- The information extracted from media channels is often used to populate impact databases. This is usually a manual activity which is relatively time- and resource intensive, but poses several problems related to the validation of the reported information, the consistency across different reporting sources and the accuracy of the data.

- The attribution to impacts to events besides the direct effect of the related hazards is challenging. This makes more difficult to track indirect damage and loss, especially when they stretch over extended timeframes.

- In many cases, especially when dealing with regional and local public institutions the information on impacts due to severe storm events is still publicly provided only in textual form as a PDF document, usually in a single language. The underlying data is often not easily available or accessible, therefore preventing a systematic analysis at regional and national scale. Furthermore, the use of the country language only would discourage practitioners from other (possibly neighbouring) countries from accessing this narrative information.

6 RECOMMENDATIONS (FOR HARMONIZATION AND STANDARDIZATION OF EXISTING EUROPEAN EVENT IMPACT AND DAMAGE INFORMATION)

A few preliminary recommendations can be proposed in the following

- Use of standardized, well-structured methodologies for data collection, recording, validation and storing would be highly desirable. This is not easy to implement in resource-scarce public institutions with well established (sometimes complex) operational protocols already in place. As trade-off solution the implementation on lightweight interoperability interfaces is proposed, to carefully extract subset of the available data in accordance to European or regional standards and share them publicly. These interoperability interfaces could be implemented on top of existing databases and solutions and would allow to achieve reasonable data sharing without disrupting existing workflows.
- Where no systematic collection of impact data is not yet in place, simple operational solutions could be adopted (e.g., based on subset of existing damage reporting templates) in order to start a systematic data collection activity without impacting significantly on available resources.

- An open, FAIR approach to data and information should be pursued as long as sensitive data are not concerned.

- In general, and more specifically in regions which are close to national borders information and reports on impacts and damage should be provided also in English or in the language(s) of the neighbours. This would allow an easier circulation and sharing of relevant information with clear mutual benefits.

- A thorough analysis of impacting mechanisms related to different hazards and their conditioning factors should be carried out to better understand (and formalize) the causal relationships leading to complex impacts and allowing a more consistent attribution of direct and indirect impacts to their root causes in the case of complex, extreme events. This would also allow to track indirect impacts over longer timeframes and well beyond the extent of

the causative hazards (e.g., the increase in frequency of avalanches in a given area could be traced back to a former windstorm downing trees).

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Funded by the European Union

8 ANNEX 1 – TABULAR EVALUATIONS OF OFFERED EVENT AND IMPACT DATA

In the following for the cross-border institutions which undertake at least some impact data collection activities a resuming table is preliminarly provided.

ZAMG: "VIOLA"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☒	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☒	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☐	NO ☐	approximately ☒	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☒	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☒	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☒	measurements/fieldwork ☐	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: precipitation (continuous rain, heavy rain, droughts, heavy snow fall, hail, thunder-storms), wind, lightning, avalanche, grav. massmovements, pluvial flood, heat and cold waves, other				

Recording / documentation of meteorological variables

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☒	NO ☐	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☐	partly ☒	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ESSL (European Severe Storms Laboratory), EUMETNET (European Meteorological Netweork)			

EFI - European Forest Institute: "DFDE"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☐	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☐	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☐	NO ☒	approximately ☒	not determinable ☐

Timestamp available

YES ☐	NO ☒	approximately ☒	not determinable ☐

Documentation of event duration

YES ☐	NO ☒	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☐	transnational (e.g. EU) ☒	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☐	publications/reports ☒	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: wind, snow, rime, fire, drought, deadwood				

Recording / documentation of meteorological variables

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☒	NO ☐	partly ☒	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☒	NO ☐	partly ☒	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

GBA - Austrian Geological Survey: "INSPIRE Gravitational Massmovements – Observed Events (Media) Austria"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☐	as GIS-file (shp) ☒	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☒	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☒	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☒	not determinable ☐

Documentation of event duration

YES ☐	NO ☒	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☒	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☒	measurements/fieldwork ☐	publications/reports ☒	not determinable ☐
by experts ☐	by volunteers/laymen ☒	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: fall/topple, slide/glide, flow, massmovement (general e.g. mixed)				

Recording / documentation of meteorological variables

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☒	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

MunichRE: "NatCatSERVICE"

GENERAL

Data availability / privacy

online open source ☐	online for a fee ☐	data transfer on request / user agreement ☐	other ☒
Analogue ☐	Digital ☐	data no longer available	

Type of data format

as web application ☐	as table (e.g. .xlsx, csv., …) ☐	as GIS-file (shp) ☐	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☐	tables ☐	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☐	NO ☐	approximately ☐	not determinable ☐

Timestamp available

YES ☐	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☐	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☐	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☐	publications/reports ☐	not determinable ☐
by experts ☐	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☐	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one:				

Recording / documentation of meteorological variables

YES ☐	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☐	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☐	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☐	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☐	partly ☐	not determinable ☐
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☐	partly ☐	not determinable ☐
If YES, which one:			

Deutsche Rück: online publication "Sturmdokumentation"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☐	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☐	as table (e.g. .xlsx, csv., …) ☐	as GIS-file (shp) ☐	as PDF ☒	other ☐

Type of documentation

textual report ☒	graphical visualization/map ☐	tables ☐	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☐	NO ☐	approximately ☒	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☒	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☒	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☐	NO ☐	multi-risk / cascading effects ☐	partly ☒	not determinable ☐
If YES, which one: hail, heavy precipitation, flood, lightning, tornados, wind storms				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☒ precipitation ☒ windspeed ☒ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☒	NO ☐	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☒	NO ☐	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: Fujita-Torro scale			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☐	partly ☐	not determinable ☒
If YES, which one:			

Swiss Re Group: online publication "SIMGA"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☐	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☐	as table (e.g. .xlsx, csv., …) ☐	as GIS-file (shp) ☐	as PDF ☒	other ☐

Type of documentation

textual report ☒	graphical visualization/map ☐	tables ☐	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☐	NO ☒	approximately ☐	not determinable ☐

Timestamp available

YES ☐	NO ☒	approximately ☐	not determinable ☐

Documentation of event duration

YES ☐	NO ☒	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☐	transnational (e.g. EU) ☐	global ☒

Way of event data acquisition

media ☐	measurements/fieldwork ☐	publications/reports ☐	not determinable ☒
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: severe convective storms, floods, wildfires, secondary perils				

Recording / documentation of meteorological variables

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☒	NO ☐	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☒	NO ☐	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☐	partly ☐	not determinable ☒
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: Data from the European Commission			

WLV – Austrian Torrent & Avalanche Control: "WLK"

GENERAL

Data availability / privacy

online open source ☐	online for a fee ☐	data transfer on request / user agreement ☒	other ☒
Analogue ☐	Digital ☒	WLV internal online platform	

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☒	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☒	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☐	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☒	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☒	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: water, avalanche, landslide, rockfall, precipitation				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☒ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☒	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☐	partly ☐	not determinable ☒
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

BMLRT – Austrian Ministry for Agriculture, Regions & Tourism: "HORA"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☐	as GIS-file (shp) ☒	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☒	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☐	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☐	NO ☒	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☒	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☐	publications/reports ☐	not determinable ☒
by experts ☐	by volunteers/laymen ☐	not determinable ☒	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: landslides, wind storms, hail				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☒ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☒	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: Torro scale			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

LWD – Tyrolean Avalanche Warning Service: "LAWIS"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☐	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☒	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☐	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☐	NO ☐	approximately ☐	not determinable ☒

Scope of hazard event acquisition

local ☐	regional ☐	national ☐	transnational (e.g. EU) ☒	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: avalanche types (wet, dry, slab release, loose release, etc.)				

Recording / documentation of meteorological variables

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☒	NO ☐	partly ☐	not determinable ☒

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: European Avalanche Danger Scale & EAWS sizes			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

Land Tirol - Section Hydrography and Hydrology: "Hydrological overviews"

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☐	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☐	as table (e.g. .xlsx, csv., …) ☐	as GIS-file (shp) ☐	as PDF ☒	other ☐

Type of documentation

textual report ☒	graphical visualization/map ☐	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☐	NO ☒	approximately ☐	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☒	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☒	national ☐	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☐	NO ☐	multi-risk / cascading effects ☐	partly ☒	not determinable ☐
If YES, which one: floods, precipitation, groundwater				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☒ precipitation ☐ windspeed ☒ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☐	partly ☒	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

BWV – Hydraulic engineering Tyrol: "HWFDB"

GENERAL

Data availability / privacy

online open source ☐	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☐	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☒	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☐	tables ☒	other ☐

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Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☒	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☒	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☐	NO ☒	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: floods only				

Recording / documentation of meteorological variables

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one: ☐ precipitation ☐ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☒	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☒	NO ☐	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☐	NO ☒	partly ☐	not determinable ☐
If YES, which one:			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: EU commisison (EU Floods Directive)			

ESSL – European Severe Storms Laboratory: "ESWD"

GENERAL

Data availability / privacy

online open source ☐	online for a fee ☒	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☐	as PDF ☐	other ☐

Type of documentation

textual report ☐	graphical visualization/map ☒	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☐	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☒	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☐	national ☐	transnational (e.g. EU) ☒	global ☐

Way of event data acquisition

media ☒	measurements/fieldwork ☒	publications/reports ☒	not determinable ☐
by experts ☒	by volunteers/laymen ☒	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: tornado, severe wind, large hail, heavy rain, funnel cloud, gustnado, lesser whirlwind, heavy snowfall/snowstorm, ice accumulation, avalanche, damaging lightning				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☒ precipitation ☒ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☒	NO ☐	partly ☐	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: Fujita Scale, EAWS			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☐	partly ☐	not determinable ☒
If YES, which one:			

Autonomous Province of Bolzano

GENERAL

Data availability / privacy

online open source ☒	online for a fee ☐	data transfer on request / user agreement ☐	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☒	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☒	as PDF ☐	other ☐

Type of documentation

textual report ☒	graphical visualization/map ☐	tables ☐	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☒	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☒	not determinable ☐

Documentation of event duration

YES ☐	NO ☒	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☐	regional ☒	national ☐	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☒	not determinable ☐
If YES, which one: tornado, severe wind, large hail, heavy rain, funnel cloud, gustnado, lesser whirlwind, heavy snowfall/snowstorm, ice accumulation, avalanche, damaging lightning				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☒ precipitation ☒ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☐	partly ☒	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☒	NO ☐	partly ☒	not determinable ☐
If YES, which one: EAWS			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)

YES ☐	NO ☐	partly ☐	not determinable ☒

If YES, which one:

ARPA Veneto

GENERAL

Data availability / privacy

online open source ☐	online for a fee ☐	data transfer on request / user agreement ☒	other ☐
Analogue ☐	Digital ☒		

Type of data format

as web application ☐	as table (e.g. .xlsx, csv., …) ☒	as GIS-file (shp) ☐	as PDF ☐	other ☐

Type of documentation

textual report ☒	graphical visualization/map ☐	tables ☒	other ☐

EVENT-DOCUMENTATION

Spatially explicit located

YES ☒	NO ☐	approximately ☐	not determinable ☐

Timestamp available

YES ☒	NO ☐	approximately ☐	not determinable ☐

Documentation of event duration

YES ☐	NO ☐	approximately ☐	not determinable ☐

Scope of hazard event acquisition

local ☒	regional ☒	national ☐	transnational (e.g. EU) ☐	global ☐

Way of event data acquisition

media ☐	measurements/fieldwork ☒	publications/reports ☐	not determinable ☐
by experts ☒	by volunteers/laymen ☐	not determinable ☐	

Differentiation of process types (hail, lightning, heavy precipitation, landslide, flood, etc.)

YES ☒	NO ☐	multi-risk / cascading effects ☐	partly ☐	not determinable ☐
If YES, which one: , severe wind, large hail, heavy rain, heavy snowfall/snowstorm, avalanche,				

Recording / documentation of meteorological variables

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: ☒ precipitation ☒ windspeed ☐ temperature			

Determination of the hazard intensity / magnitude (precipitation rate, cumulated amount, speed of wind gusts, snow heights, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐

Documentation of damages / impacts

YES ☐	NO ☐	partly ☒	not determinable ☐

Quantification of damages / impacts (e. g. financial loss)

YES ☐	NO ☒	partly ☐	not determinable ☐

Inclusion of international standardized scales / thresholds (e. g. Fujita-Torro, Beaufort, European Avalanche Danger / EAWS, etc.)

YES ☒	NO ☐	partly ☐	not determinable ☐
If YES, which one: EAWS			

Compliance with respect to international guidelines and reference initiatives (PDNA, DALA, GRADE, GFDRR, GLIDE, EU commission, UN, WMO, …)			
YES ☐	**NO** ☐	**partly** ☐	**not determinable** ☒
If YES, which one:			