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Risk Data Hub – web platform to facilitate management of disaster risks

Antofie, T., Luoni, S., Faiella, A., Marin Ferrer, M.

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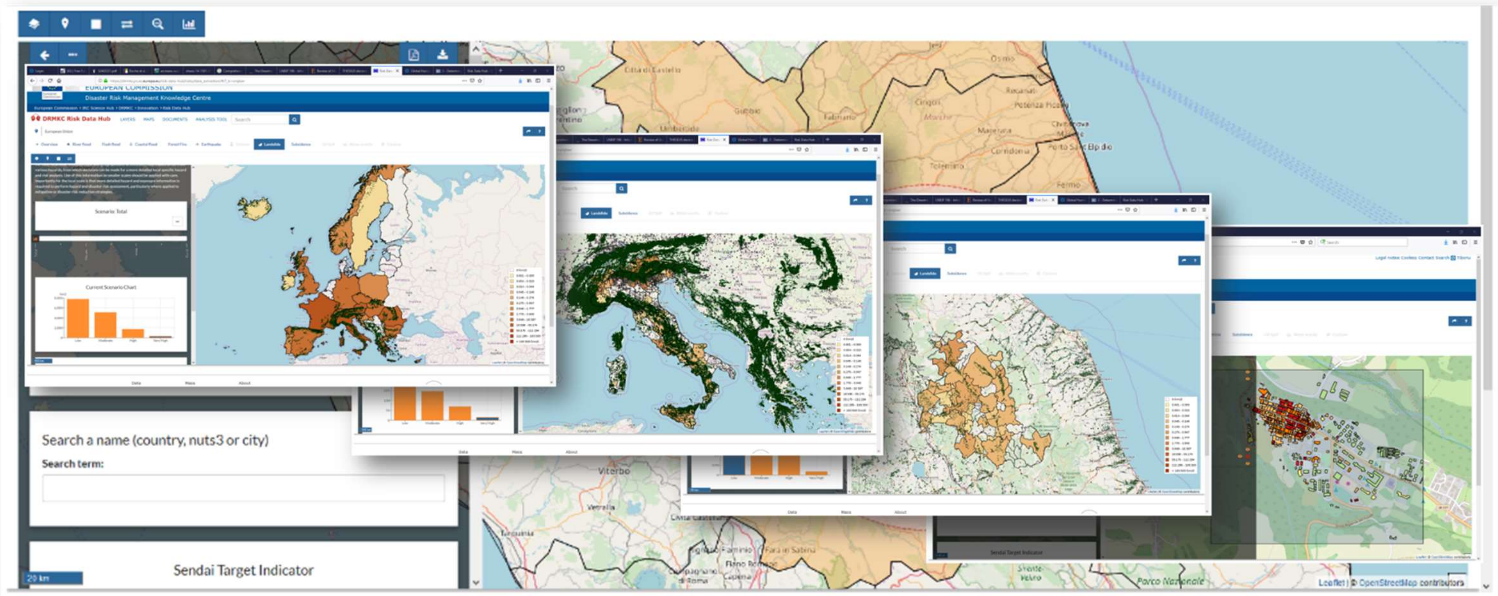

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Contents

Abstract

The management of disaster risks of different kinds (manmade, technological and natural) is regulated at European level by a number of policies covering various sectors (e.g. environmental, industrial, civil protection, security, health), scales (EU wide, regional, national) and operational actions (preparedness, mitigation, adaptation, prevention, response, recovery and restoration). A range of research and technological developments are motivated to support the implementation of these policies and actions across various scales reaching local level. However, the effectiveness of Disaster Risk Management (DRM) depends greatly on the efficiency of managing relevant information.

Complex forms of decision-making need technological support for achieving DRM objective of reducing risk. Disaster Risk Management Knowledge Centre (DRMKC) is currently developing a web-based geographical information system (WebGIS) aiming to support the implementation of international actions for DRM from global or regional level to local-national level. With this study, we present the DRMKC Risk Data Hub, a tool that improves the access and sharing of curated EU-wide disaster risk information relevant for DRM related actions. We also identify the key characteristics of a WebGIS platform needed to address in the most efficient way aspects of disaster risk management. Risk Data Hub acts as a knowledge hub bridging the gap between the collection of data regarding past impacts and the possibility to manage potential future impacts, i.e. to manage risk. The DRMKC Risk Data Hub links policy and practice through geospatial technology and mapping, combines top-down strategies with bottom-up methodological approaches and sets the bases for science-based information for DRM policies. Currently, Risk Data Hub structures the information into three modules that covers the: Exposure Analysis – as one of the main drivers of risk; Historic Events – as a EU-wide loss and damage database and Risk Analysis module - as collection of good practices (under development).

The DRMKC Risk Data Hub is a collaborative platform where, starting from a strong partnership across different scientific groups dealing with different hazards, the scientific information is harmonised and translated into evidences for policies. It also demands for the future work a strengthening of partnership and collaboration with local authorities and institutions, in order to establish a collaborative development that matches the needs and realities expressed at local level.

Foreword

The DRMKC Risk Data Hub is a platform for collaboration and for the development of collective knowledge. Only by bringing together the fragments of information nowadays spread across different actors (scientists, practitioners and policy-makers), different sectors (environment, economic, health, industry, security, nuclear, ….) and supported by different EU policies (among others we could mention the Decision No 1313/2013/EU of the European Parliament and of the Council on a Union Civil Protection Mechanism (UCPM)[1], Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks[2], Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An EU Strategy on adaptation to climate change[3]) and Global agreements (the Sendai Framework for Disaster Risk Reduction (SFDRR)[4], the approval of the Agenda 2030 sustainable development goals (SDGs)[5] and the entry into force of the Paris Agreement on Climate Change[6]) it will be possible to transform the information into knowledge and to become more resilient to future shocks.

Integration of data from and to different phases of the Risk Management cycle is an important aspect that needs to be addressed in future to ensure continuous improvement of modelling capacities. The DRMKC Risk Data Hub aims to share robust, scientifically founded methodologies with the intention of promoting an all hazard approach for disaster risk assessment, taking all phases of the DRM cycle into consideration. The diversity of disaster information sources provided within the RDH, could challenge the uncertainty that often characterises data, setting a range in the uncertainty by means of comparison.

The curated datasets in the Risk Data Hub will on the one hand stimulate the disaster risk community to propose new datasets to include and will on the other hand constitute a baseline for evaluating the quality of these new data sources. The input is expected to be provided by experts from different fields to allow a multi-disciplinary approach. To catalyse this process, the DRMKC will use its Support Service to actively work with National Authorities regarding their data needs. The Risk Data Hub portal can be accessed at: https://drmkc.jrc.ec.europa.eu/risk-data-hub.

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1401179579415&uri=CELEX:32013D1313
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1523606241167&uri=CELEX:32007L0060
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0216
[4] http://www.unisdr.org/we/coordinate/sendai-framework
[5] https://sustainabledevelopment.un.org/?menu=1300
[6] http://unfccc.int/paris_agreement/items/9485.php

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Executive summary

The effectiveness of Disaster Risk Management (DRM) depends greatly on the efficiency of managing relevant information. The Disaster Risk Management Knowledge Centre (DRMKC) is developing the Risk Data Hub (RDH) with the intention to improve the access and sharing of curated EU-wide risk data, tools and methodologies for fostering Disaster Risk Management (DRM) related actions.

The DRMKC Risk Data Hub allows the collection of pre- and post-event information to accelerate the assessment of potential losses and to register the actual losses. It supports the exchange of good practice while allowing National authorities to preserve, access and manage data and methodologies through dedicated national corners under the full responsibility and control of national bodies. Available tools, models and data at EU level are offered as a baseline but may be easily confronted with more accurate datasets and/or more appropriate models to the contextual situation. Establishing links at the local scale is relevant for this purpose. The Risk Data Hub is the result of scientific partnership and collaboration which includes also local authorities (e.g. Support Services[7] offered to local authorities through DRMKC), a collaborative development that matches the needs and realities expressed at local, national and Global level.

Policy context

The Risk Data Hub proposes a way to facilitate the link between practice and policy by creating a collaborative network for discovering already existing data, actions, and practices for DRM. The diversified set of policies and directives would benefit from a systematic approach on data management. Furthermore, in order to ensure efficient actions for disaster risk management, increased transparency and efficient networking should be considered.

There is an increasing number of global agreements and EU policies in the field of Disaster Risk Management that have recognised the need for more evidence-based policies:

The Sendai Framework for Disaster Risk Reduction (14-18 March 2015) sets global targets to reduce economic and human losses from disasters by 2030.

A new focus on resilience to natural, man-made, and other hazards was incorporated into the Sustainable Development Goals (SDGs – 25 September 2015). Social and economic vulnerability factors can be extracted from the SDGs, allowing a better understanding of some driving risk factors.

The UN Framework on Climate Change adopted in the Paris Climate Conference (30 November - 12 December 2015), where 185 countries agreed to act collectively to address climate change and build resilience, with 100 prioritizing economy-wide adaptation to climate change.

The Urban Agenda for the EU launched in May 2016 with the Pact of Amsterdam, addresses better knowledge and eventually better action plans (e.g. regulations and funding access) in order to stimulate growth, liveability and innovation in the cities of Europe. Supporting the Cohesion policy in its urban dimension could also have an important role in achieving the Sustainable Development Goals (SDGs).

The European Commission is committed to support the implementation of the global legislative frameworks. As part of its commitments for The Sendai Framework for Disaster Reduction 2015–2030, the European Commission aims to enhance disaster risk knowledge across all EU policies.

[7] The Support System is the resource implemented by the European Commission intended to provide National Authorities with technical advice in the field of disaster risk management. It aims to broker available expertise and good practice within the EU with the specific needs of a National Authority. For more info please access: https://drmkc.jrc.ec.europa.eu/innovation/SupportSystem

In April 2013 the European Commission adopted an EU strategy on adaptation to climate change which has been welcomed by the EU Member States. The strategy aims to make Europe more climate-resilient. One of the focuses of the strategy is to produce a better-informed decision-making by addressing gaps in knowledge. With the "Evaluation report on the EU Adaptation Strategy" published in November 2018 the need of an improved informed-decision making by addressing gaps in knowledge has been reinforced. The EU Covenant of Mayors[8] for climate and Energy is another initiative aiming in supporting the implementation of the EU climate change adaptation strategies.

In the context of the Union Civil Protection Mechanism (UCPM), the European Commission provides the legal basis to regularly produce an overview of natural and man-made risks the EU may face. National Risk Assessments (NRA) produced by EU Member States and participating states in the Union Civil Protection Mechanism are the main source of disaster risk evidence.

The Seveso directive (EU, 2012) aims at preventing major accidents involving dangerous substances. In support of the Seveso III directive, the Major Accident Hazards Bureau of the European Commission's Joint Research Centre has developed two major database reporting systems (eMARS - Major Accident Reporting System and eSPIRS- Seveso Plants Information Retrieval System), which are mandatory for EU Member States.

The flood directive was approved in 2007 (European Commission, 2007)[9] and requires Member States to undertake a preliminary flood risk assessment. The first national reports were due in 2012, and reports are to be provided every 6 years thereafter (the next reports are due by December 2018).

The EU directive on critical infrastructure (European Commission, 2008)[10] was mainly oriented to identify and designate European critical infrastructure (ECI) assets, mainly to protect these from terrorist attacks. In 2013 (European Commission, 2013)[11] this concept was broadened to protect ECI from other man-made and natural hazards. Although the envisaged connections with DRR activities at the EU level, in particular with the UCPM, are not evident (there are only a couple of minor references related to training and post-disaster recovery expertise), the directive classifies the major ECI into two major categories (energy and transport, disaggregated into more detailed subcategories), which ought to be taken in consideration for further activities on this field.

There are other EU programs and legislations that also deserve to be mentioned, not least for their contribution, more or less directly (as well as transversally), to the achievement of the abovementioned Global SDGs and of the SFDRR global targets, within the European Union like the EU Cohesion policy, the Cohesion Fund, the new Common Agricultural policy, the common fisheries policy, the European disability strategy, the European Solidarity Corps, the European Regional Development Fund, the seventh environment action program, the Horizon 2020 and in the next future the Horizon Europe, European Innovation Partnership on Smart Cities and Communities, Europe 2020 strategy, energy union, emissions trading system and the circular economy package.

Key conclusions

The DRMKC Risk Data Hub (RDH) considers in its development the common interests of climate change adaptation (CCA) and disaster risk reduction (DRR) platforms: reducing vulnerability and building resilience. This is important when users are expected to switch between different views of the same topic, such as the short-term risk management of

[8] https://www.covenantofmayors.eu/en/
[9] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF
[10] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:345:0075:0082:EN:PDF
[11] https://ec.europa.eu/energy/sites/ener/files/documents/20130828_epcip_commission_staff_working_document.pdf

extreme events versus long-term adaptation (CCA) to extreme events in a changing climate.

There is no authoritative loss database that can provide a trend at European level (De Groeve, 2015). At European level the loss and damage data are available through global multi-hazards databases such as NatCat SERVICE (Munich Re), Sigma (Swiss Re) and EM-DAT (Centre for Research on the Epidemiology of Disasters). The Risk Data Hub aims at becoming the reference point for data collection, developing a centralised pan-European platform for the collection of all-hazards loss and damages data.

The development of the Risk Data Hub addresses the needs at national level regarding disaster risk management related actions (e.g. national risk assessment, loss data collection, Sendai indicators reporting, Solidarity Fund request, improving risk management capabilities). The DRMKC Support Service is the resource intended to collect feedback from National Authorities while ensuring the co-development of a platform that facilitates disaster risk management knowledge.

The Risk Data Hub provides scientifically based data and analytical tools needed for policy formulation. Furthermore, it implements knowledge management strategies in order to turn policy advice into a complementary effort used to identify future research directions.

The target community of users for the RDH covers research, policy and operational actors, which have their own specificities but also need to converge towards the common DRM goals. The diversity and cross-disciplinary data and knowledge make all users as both data providers and also end-users. This creates a network for knowledge transfer.

Main findings

The Risk Data Hub benefits from a well-placed position within the Commission as no other source of knowledge does, exploiting the networked approach of the DRMKC across Commission, EU Member states and DRM communities.

The Risk Data Hub facilitates the link between practice and policy by creating a collaborative network for discovering already existing data, actions, and practices for DRM. Likewise, it offers means to assess the progress made and to identify gaps in scope for DRM.

It supports local/national authorities to finalize and implement the reporting of Sendai indicators, and offers means to evaluate and indicate events that leads to requesting financial support, as the EU Solidarity Funds. Offering access to data, methodology and implementation showcase, RDH helps Member States to meet risk management related agreements such as development of Disaster Loss Databases, National Risk Assessment and finally Risk Management Plans.

The Risk Data Hub provides support for the assessment of the economic efficiency of DRR measures and present solid denominators (e.g quantitative assessments, pre- and post-event economic analysis etc.) for promoting at local level investments in DRR.

Related and future JRC work

The DRMKC has been working since its launch in September 2015 in the challenging task of developing collective knowledge based on the establishment of solid partnerships involving scientists, policymakers and operational authorities. The DRMKC RDH has been developed to provide a concrete platform where these different communities could share and profit from this possibility of working together.

The architecture of the database of the DRMKC RDH has been developed on top of the database architecture developed for the collection of Damage and Loss Data (DLD) (please see De Groeve, et al., 2015, Rios Diaz, et al., 2018). The latest version of the

RDH architecture comes as a natural conclusion of a series of reports developed in collaboration with DG ECHO and national experts regarding the need of collecting, recording and sharing DLD.

The DRMKC RDH is also closely related to other DRMKC activities, as the Project Explorer (database of DRM related research projects and results), the Recommendations for National Risk Assessment in support to the preparation of Risk Management Plans and to the Science for DRM 2020 report, which is focused on impact assessment and identification of research solutions[12].

The need to have such multi-hazard platform to link science and policy, past and future, local and global dimensions was identified after having reviewed the National Risk Assessments prepared by the Union of Civil Protection Mechanism's participant countries and then submitted to the Commission. There was an evident gap between the knowledge developed by the scientific community and the one reaching this important deliverable due under the UCPM.

The Knowledge Centres launched by the Commission have as primary mission to work in the Science-Policy interface trying to bridge this existing gap between the scientific output and the evidence required for well-informed policies. The DRMKC Risk Data Hub is a concrete answer to this need but the only way to succeed on this objective is to be able to engage with the two ends of the bridge - scientists and policy-makers – to co-design and co-develop this common bridge.

One essential element to really succeed on sustainably bridging science and policy will strongly depend on how effective we will be in engaging with practitioners and how we will manage to translate their practical knowledge into tangible and sharable elements.

Quick guide

The report begins with an introductory section where a brief presentation of general role and objectives of WebGIS in DRM are presented. An overview on available frameworks and policies that guided the web application is presented too.

The following section places the Risk Data Hub within the DRM cycle and discusses the specific actions considered for achieving the scope of WebGIS for DRM. Strengths, use, processes and conceptual framework of the platform are discussed.

The third part is focusing on the development of the platform. We describe here the two applications: the Client web portal with a pan European perspective and the Country Corner Data Portal.

The fourth section of the report presents the methodological developments for the modules considered up to now: Exposure Analysis, Historical Event Module, Vulnerability and Risk Analysis module.

The last section collects a number of reflexions and conclusions.

[12] https://drmkc.jrc.ec.europa.eu/

1 Introduction

Web-based geographical information systems (WebGIS) have been developed to establish communication channels among providers of data (experts, researchers) and data users (non-experts, decision-makers, stakeholders). These systems have helped the first group in making more accessible the outcome of their work and the second group to understand the use of the data for the whole process of risk management starting from risk identification to risk reduction. While current WebGIS applications do not provide the full functionality of a typical desktop GIS, they extend desktop GIS capabilities to an internet environment, which are accessible, dynamic and interactive. In the DRM context, in particular, they offer the opportunity to release disaster managers from the tasks of data collection and map generation and allows them to focus on visualization and analysis (Lichter, et al., 2015).

Moreover, these technologies offer more flexible structures, more open communication protocols, as well as a more extensive interoperability (syndication via RSS, mashups and use of API—Application Programming Interface). They should not be perceived as technology developed solely for content delivery. Conversely they create a collaborative environment, a place where people, knowledge and data interact and relate (Fekete, A., et al., 2015).

The development of WebGIS, were mostly required by the decision-makers in their complex forms of decision-making, for the need of linking data and information with their policy formulation and implementation. The WebGIS becomes, in this sense, a solution that bridges the gap between disaster risk information and decision support systems (DSS) through sharing data, tools and methodologies required for decision-making (Rajabifard, et. al., 2013).

Geospatial technologies have been widely used, over the past decades, to support the management of disasters risks. Among the most used, remote sensing (RS), Geographic Information System (GIS), crowdsourcing and Global Navigation Satellite System (GNSS) techniques proved their vast applicability in creating information most often as geospatial data. It became challenging how to address and connect of all the information coming from different sources with an increase in quantity and diversity in order to satisfy the necessities of management of disasters risks.

An existing problem and challenge is to find a solution for managing amounts of heterogenous data, results and methodologies in such a way that they are accessible by a large variety of stakeholders and users (Veenendall, et al., 2017). An evaluation of the efficiency, sustainability and recognition of the existing WebGIS platforms would be a solution in order to understand the gaps that leads to losing the scope of these applications.

Legislative initiative and frameworks on disaster risk showed the tendency to require WebGIS capabilities for their implementation. The need to support the implementation of international actions for Disaster Risk Reduction, from global to regional and local level promoted the development of WebGIS platforms.

The Sendai Framework for Disaster Reduction 2015–2030[13], recognized the critical role of geospatial technologies in support of its Priorities 1 - "Understanding disaster risk" and 4 – "Enhancing disaster preparedness for effective response and to - Build Back Better - in recovery, rehabilitation and reconstruction". This recognition resulted in initiatives to use spatial information at all the stages of DRM covering all geographical scales (local, sub-national, national, regional).

EU Member States and associated countries are called, in the frame of the Decision No.1313/2013/EU of the European Parliament and of the Council on a Union Civil

[13] Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030: a disaster risk-informed approach for all EU policies, SWD(2016)205 final/2, 17.6.2016

Protection Mechanism (UCPM)[14], to prepare regular National Risk Assessments (NRA) and accordingly to assess their Risk Management Capabilities, while preparing their resultant Risk Management Plans. The preparation of evidence-based NRA requires a sound collection of disasters damage and loss data for a wide range of events of different nature.

In April 2013, the European Commission adopted an EU strategy on adaptation to climate change which has been welcomed by the EU Member States. The strategy aims to make Europe more climate-resilient. One of the focuses of the strategy is to produce a better informed decision-making by addressing gaps in knowledge. With the "Evaluation report on the EU Adaptation Strategy" published in November 2018 the need of an improved informed-decision making by addressing gaps in knowledge has been reinforced. New knowledge gaps have emerged and a better formulation sector-specific is required. Moreover, an improved platform for data sharing is recommended (e.g. including Copernicus service) and a more frequent exchange of methodologies and findings is addressed, targeting practitioners and relevant national and EU platforms. The assessment and mapping of social vulnerability to climate-related events it is also an action considered as an important aspect of the strategy. It was also recognised the need for a boost in the relationship between climate adaptation and disaster risk reduction services.

The enhanced partnerships, better knowledge and eventually better action plans (e.g. regulations and funding access) are also a need recognised in the Urban Agenda for the EU, launched in May 2016[15]. A WebGIS applications could facilitate such developments and offer the opportunity to answer to questions on how to secure and administer sustainable and innovative investment to urban areas. They could support the Cohesion policy[16] in its urban dimension and play an important role in achieving the Sustainable Development Goals (SDGs).

These policies and frameworks create a strong mandate for the development of the WebGIS tools and technologies, as a mean to accessing knowledge more easily, support and monitor policy implementation and create collaborative networks.

The purpose of this report is to describe how Risk Data Hub links policy and practice, its containing methodologies and potential use for DRM. We anticipate that such tool can play an important role not only for supporting policies implementation (in DRM) but also particularly for the local authorities in their activity for disaster risk reduction (DRR).

[14] Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, Official Journal of the European Union, L (347), 20.12.2013

[15] Urban Agenda for the EU: https://ec.europa.eu/futurium/en/urban-agenda-eu/what-urban-agenda-eu#Objectives

[16] The regional policy of the European Union (EU), also referred as Cohesion Policy, more info: https://ec.europa.eu/regional_policy/en/

2 Background

The Risk Data Hub benefits from a well-placed position within the Commission as no other source of knowledge does, exploiting the networked approach of the DRMKC across Commission, EU Member states and DRM communities.

The Risk Data Hub facilitates the link between practice and policy by creating a collaborative network for discovering already existing data, actions, and practices for DRM. Likewise, it offers means to assess the progress made and to identify gaps in scope for DRM.

Offering access to data, methodology and implementation showcase, RDH helps Member States to meet risk management related agreements such as development of Disaster Loss Databases, National Risk Assessment and finally Risk Management Plans. It supports local/national authorities to finalize and implement the reporting of Sendai indicators, and offers means to evaluate and indicate events that leads to requesting financial support, as the EU Solidarity Funds.

The Risk Data Hub provides support for the assessment of the economic efficiency of DRR measures and present solid denominators (e.g quantitative assessments, pre- and post-event economic analysis etc.) for promoting at local level investments in DRR.

Policies for disaster risk reduction and management have evolved from defence against hazards to a more comprehensive, integrated risk management approach that includes prevention, preparedness, response and recovery (UNISDR, 2015a). The implementation of this approach is currently taking place at both international and national level.

DRM and DRR are considered as complementary and interchangeable actions, meaning that DRM describes the actions that aim to achieve the objective of reducing risk. Disaster risk and loss data are essential for implementing informed DRM actions, including for identifying risk drivers, measuring them, creating awareness and communicating risk information.

Because there are many uses and formats for risk and loss data, it is not trivial to collect, store and disseminate the data in a unique way. The Risk Data Hub aims at doing so for a selected number of tasks. Among the tasks identified (UNISDR, 2014), we mention:

- Impact of actions. Insufficient levels of implementation of actions, frameworks, policies due to the lack awareness (publically and at governmental level) or because much of developments take place in the informal sector.

- Penetration to local level. Many disaster impacts, prevention mechanisms and risk factors are local in scope where disaster risk information should be linked.

- Short-term risk management view. A common interest of disaster risk reduction requires a stronger consideration of climate change which brings a long-term management view.

- Political and economic involvement in DRM. Policy makers are in need of clear evidence-based disaster risk information (risk assessments, cost-benefit analysis, disaster risk factors etc.).

- Coordination between stakeholders, poor link between DRR and DRM. Which is exhibited in the lack of information sharing, including with respect to risk assessment, monitoring and evaluation, response and other phases of DRM phase.

Figure 1. Diagram of the disaster risk management cycles

Source: adapted from DRMKC, 2018

DRM is the systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster (UNISDR, 2015).

The Risk Data Hub intends to cover all the cycles of disaster risk management (Fig. 1), but the pilot version addresses the pre-event phase of prevention and mitigation and the post-event phase of recovery. In the prevention and mitigation phase, we focus on anticipation of disaster events in order to reduce, or avoid, the potential losses. In the recovery phase, we focus on gathering lessons learned and loss data.

Integration of data from and to different phases of the Risk Management cycle is an important aspect that needs to be addressed in future to ensure continuous improvement of modelling capacities. The DRMKC Risk Data Hub will share and propose robust, scientifically founded methodologies (e.g. scientific reports and publication will be associated with datasets and analysis hosted on RDH) with the intention of promoting a more scientific approach on disaster risk assessment, taking all phases of the DRM cycle into consideration. Helping policy makers understand uncertainty is essential. By offering a variety of data sources, the Risk Data Hub provides a broader landscape of risk scenarios. None of the sources of information will be 100% certain, but by direct comparison of all the available information it should be possible to understand the range of uncertainty to take into account when deciding on risk reduction investments.

An essential gap identified, that the RDH aims to bridge, is the lack of available practical knowledge such as lessons learned and “near misses” data from filed reports. Various studies have discussed the relationship between near miss incidents and actual accidents, pointing out that less severe human, economic and environmental impact occurs when these reports are considered. Nevertheless, investigations are often not precise enough in terms of the impact or the collected datasets are even not shared within the community for some of the hazards. Systematically collecting the reports produced after each event and to benefit from the lessons learnt on disaster management would significantly improve the risk management process. This is a well-established practice in the technological hazards sector under the SEVESO directive, where the lessons learned reports are produced also on the basis of the "near misses" (an unplanned event that did not result in injury, illness, or damage – but had the potential to do so)[17].

Disasters become “teaching moments”. An essential gap is the availability of practical knowledge and near missed data. Investigations are often not precise enough in terms of the impact or the collected datasets are even not shared within the community for some of the hazards. Systematically collecting the reports produced after each event and to

[17] https://osha.europa.eu/en/wiki-page/near-misses

benefit from the lessons learnt on disaster management would significantly improve the risk management process. This is a well-established practice in the technological hazards sector under the SEVESO directive, were the lessons learned reports are produced as well on the basis of the "near misses".

Collecting and producing an inventory of relevant datasets will set the bases for qualitative evaluation of the data and will locate and propose alternative sources. The input should be provided by experts from different fields to allow a multi-disciplinary approach. Therefore, the Support Service of the DRMKC will be dedicated to collect feedback from National Authorities regarding their specific needs when collecting data and accessing tools used for the disaster risk management related activities.

2.1.1 Conceptual framework of the platform

A successful DRM results from the combination of top-down strategies with bottom-up methodological approaches (a concept suggested in the domain of climate change risk management, IPCC Fourth Assessment – Carter et al., 2007). The top–down approach refers more to administrative directives, and reflects more the policy component. The bottom-up approach is linked to the analyses of the causal factors of disasters, including exposure to hazards, vulnerability, coping capacity, institutional capacity, and reflects more the practice component. In the context of disaster science, policy and practice are often disconnected (Gaillard et al., 2013) as a gap in the scale of actions and knowledge (Wisner et al., 2012). This is evident in the dominant top-down DRM strategies utilizing global actions on one hand and the context specific nature of the bottom-up approach based on local action and practice. The Risk Data Hub proposes a way to bridge the gap between practice and policy by developing a decision support system (DSS) based on a WebGIS. It becomes a tool and a way of discovering data, actions, practice from local level and transforming it in knowledge for the decision support system (DSS) using a common ground. In this aspect The Risk Data Hub can become a "battlefield of knowledge and actions" (Long et al., 1992; Gaillard et a., 2013).

The geospatial information hosted on the Risk Data Hub is built on the relation exposure – hazard. This approach offers a more complete insight for practitioners and policy makers dealing with disaster risk management. Besides, it provides evidence based information for decision makers, risk-reduction strategies and adaptation plans either to mitigate the disaster risk or to target adaptation measures.

Disaster risk is a spatio-temporal phenomenon, as all components of disaster risk vary across space and time (Herold et al., 2012; Westen et al., 2010). Thus, knowing where things are is fundamental for understanding, reducing and managing risk (Alexander, 2002). The Risk Data Hub proposes the identification of impact areas from spatial coincidence of the hazard with the exposure layers. The scope is to anticipate the areas expected to suffer significant impact from hazards. By integrating hazard data and mapping areas of potential impact, we provide means that serve as a starting point for prioritized local case studies on impacts from maritime to natural/technological hazards, as well as the basis for the development of mitigation strategies.

The vulnerability and the exposure are the main drivers of risk (Cardona et. al., 2012) that need to be measured or quantified. Conceptual frameworks shows the importance of reducing the risk by reducing vulnerability and mitigating hazard (as it is the case of climate related hazards) even before a risk can manifest itself. From the various dimensions of vulnerability (please see Vogel and O'Brien, 2004), the Risk Data Hub proposes to measure the physical, environmental and socio-economical dimensions as proximity or predisposition to damage from hazardous event.

The across-scale approach for viewing disaster risk data considers administrative units as aggregation stages. In the case of maritime risk management the aggregation is done upon the exclusive economic zone (EEZ)[18] while in the case of the natural hazards the aggregation is done at the level of LAU, NUT3, NUT2 and countries. This is an important approach knowing that the management of the risk reflects more the policy component which is linked with administrative directives, organizations and operational skills coordinated at level of administrative entities. It is a way of assessing accountability, capabilities and resources.

Furthermore, the disaster risk information is linked across scale down to individual assets/exposed elements and can be easily integrated with preparedness (e.g. disaster management planning), resilience and financing schemes (top-down actions) that should be linked locally at this level of assets (Jongman et. al., 2014). In the context of disaster risk management, a multi-scale approach is of high relevance, mainly due to the fact that it tackles the gap in the scale of policy and practice (Gaillard et al., 2013).

The hazard mapping within the Risk Data Hub considers return periods and scenarios (climate change, economic and socio-demographic scenarios). Consequently, the socio-economic and environmental exposure and potential impacts from extreme events are structured on return periods and climate change scenarios (RCP2.6, RCP4.5, and RCP8.5)[19]. This approach suggests the probabilistic methodological approach (risk is the probability of the impact) in disaster risk assessment that is considered across climate scenarios. It also proposes a harmonized (across-hazards) likelihood structuring of the extreme events. It is a standard statistical concept allowing calculation of events and its consequences in a probabilistic manner. Moreover, this way of structuring the data supports management plans and strategies for DRM considering the needed climate change adaptation (CCA). This is important as it switches between different views of the same topic, such as the short-term DRM of extreme events versus long-term adaptation to extreme events in a changing climate.

Adopting a cross-disciplinary approach, Multi-Hazard risk assessment capabilities are embedded in the Risk Data Hub. This suggests an alignment of methodological approaches and data used for disaster risk across different hazards. It also helps on identifying potential impact areas from multi-hazard occurrence, implementing four factors of the multi-hazard potential framework defined by Gill, et.al 2014: identification, coincidence (spatial and temporal) vulnerability and interaction among various hazards.

Losses and damages records from historical events and lessons learnt are considered in the Risk Data Hub. Loss databases are established to track the expenditures from disasters and to plan disaster reduction strategies (De Groeve, 2015). Availability and accessibility of loss and damage information offer the necessary link to evaluate whether the hazard metrics can predict impacts. Being designed to consolidate disaster risk knowledge, the loss datasets creates the basis for studies relating physical characteristics of the natural hazard events to their various impacts.

Loss data accounting is now in demand at all levels from national, to European and international (Do Ó, et a., 2018). This goal is best addressed at national and subnational level by the governmental departments or institutions addressing crisis management. However, there is no authoritative loss database that can provide a trend at European level. The Risk Data Hub proposes to contribute in loss data collection, developing an interface for centralised collection of loss and damages data with national scope and local scale (still under development for maritime area).

[18] The United Nations Convention on the Law of the Sea (A historical perspective)". United Nations Division for Ocean Affairs and the Law of the Sea. Retrieved 30 April 2009.

[19] Three emissions scenarios, termed Representative Concentration Pathways (RCP) by the Intergovernmental Panel on Climate Change (IPCC). All scenarios specify radiative forcing relative to pre-industrial conditions. The RCP8.5 scenario is the most severe, with greenhouse gases continuing to increase through the next century, resulting in radiative forcings of 8.5 W/m2 , CO2 concentrations of 1370 pppm and a temperature anomaly of 4.9 ◦ C by 2100. The RCP4.5 scenario represents a medium future scenario, where greenhouse gases and therefore radiation stabilize by the end of the century with an overshoot at 4.5 W/m2 , 650 ppm CO2, and a temperature anomaly of 2.4 ◦ C. The least severe future scenario is the RCP2.6, which includes a mid-century peak at 3 W/m2 before declining to 2.6 W/m2 , 490 ppm CO2, and a temperature anomaly of 1.5◦ C.(Moss et al., 2010).

2.1.2 Use and users

In its development, the Risk Data Hub considers a set of administrative frameworks and policies (Union Civil Protection Mechanism, Sendai Framework for DRR), data sharing initiatives (OpenDRI) and spatial data infrastructures (INSPIRE). The implementation of international actions from global or regional level to local level is one of the goals of the Risk Data Hub. In addition, it is expected to support the local/national authorities' access to cohesion instruments able to finance risk-prevention measures as the European Union Solidarity Fund (EUSF) or European Regional Development Fund (ERDF).

The Risk Data Hub aims to:

- Link policy and practice through geospatial technology and mapping: successful DRM results from the combination of top-down strategies (e.g. formulation and implementation of policy) with bottom-up methodological approaches (e.g. analysis of the causal factors of disasters).
- Identify practices associated with risk data information (data, tools, methodologies) that enhance the link between scale and scope in DRM.
- Support the use of local data in risk assessment applications with local benefit.
- Encourage loss/damage and exposure database development with national scope and local scale.
- Facilitate disaster risk mapping as an essential component of risk management.
- Present good practice of technologies (GIS web-platforms) that have proven to be highly effective tools for fostering DRM.
- Promote uptake of research expertise in the process of national risk assessment (NRA).
- Provide a first estimation of damages and losses from extreme events, anticipating the access to instruments able to finance risk-prevention measures (e.g. EUSF).
- Facilitate of complement Sendai reporting.
- Capitalise on the existing knowledge, networks, tools, methods and data and support their broad dissemination and technology transfer to optimize resources and to move to a more homogeneous approach.

The community of users for the DRMKC Risk Data Hub is formed by various communities covering research, policy and operational actors, which have their own specificities but also present a common goal of overall risk management. The diversity and cross-disciplinarity of the community of users make them often both data providers and also end-users.

The end-users represent a complex and ambitious challenge to address, as they involve a wide variety of stakeholders. The user community of the DRMKC is multinational, involving scientist from many disciplines, policy-makers and practitioners. They are dispersed into different disciplines and sectors and often they are working independently on overlapping crisis situations. Consequently, the DRKMC Risk Data Hub becomes an operational tool which creates a network for information transfer among various involved communities. They can be divided in four main categories of users:

Policy Makers. At EU level, the main policy DGs concerned with Disaster Risk Management are DGs, ECHO,CLIMA, ENV, DEVCO, HOME, REGIO, etc.

At local level, Ministries of Defence, Interior, Foreign Affairs, Civil Protection, Industry, Agencies as well as Regional Authorities all benefit from research outputs.

Benefits:

- Use of curated and scientifically based data needed for policy implementations.
- Compare implementation development among countries and regions.
- Get an overview of research results in disaster risk management.

Scientists. Disaster risk assessment research involves a wide range of scientific disciplines which have to interact, ensuring complementarity and building

interdisciplinary networks. Different types of scientists are considered (University, Research Institutes, research units linked to Defence/Interior ministries or agencies);
Benefits:
- Publish and share EU and regional data to turn their research into operational services and policy advice;
- Identify cross-border platform and data commonly used by Policy-Makers and Practitioners;
- Participate in multi-disciplinary cross-border scientific partnerships and offer expertise to civil protection and disaster risk management authorities.

Private Sector. Various industry branches and stakeholders in the areas of infrastructure, energy, defence, civil protection etc.
Benefits:
- Access tested innovative solutions for crisis management and practical advice on adoption of new research and technology.
- Be aware of curated and updated data and initiatives from EU organisations;

General public. Various NGOs, public at large and users form the Education (schools) and training bodies.
Benefits:
- Get situation awareness and general information on disaster risk from regional to global disasters;
- Join a Community of Users, collaborating to share data, and even help in developing database on losses and damages

2.1.3 Spatial definition of risk

The Risk Data Hub identifies measureable and geographically defined impact areas from multi-hazard using geospatial analysis. In the context of disaster risk assessment, it is assumed that an element or system is at risk if it is located in the spatial range of a hazard. Based on this assumption we establish the spatial extent of the hazardous event where it becomes accountable for a potential impact and we provide the spatial location of the specific elements that are exposed. In this way, we link hazard metrics with exposure attributes and take the opportunity to suggest and link to existing tools, methods and data from diverse sources. In the same time, we describe what hazard becomes accountable for which potential impact.

2.1.4 Strengths and limitations

Strengths:
- Provides Multi-Hazard Approach. Host and share multi-risk spatial and numerical data per hazard type.
- Offers a first-step assessment of potential impacts from hazardous events.
- Offers means for centralised data collection and access European-wide.
- Uses Open-Source Technologies and Guarantee Open Data Access. Easy to manage for future developments, offers possibility for own installations.
- Assures Multi User authorization level (the development of the country '''corner'' allows national authorities to manage create, update and publish data and information)
- Compliant to INSPIRE Directive. Metadata and web services standards (WMS, WFS, etc.), are INSPIRE compliant ensuring geo-spatial open data interoperability.

Limitations include:
- No binding other than the scientific partnership is liable for data collection.
- Discrepancy in the alignment of methodological approaches and data used in disaster risk
- Vulnerability is currently not included in the risk assessment methodology.

3 The Risk Data Hub development

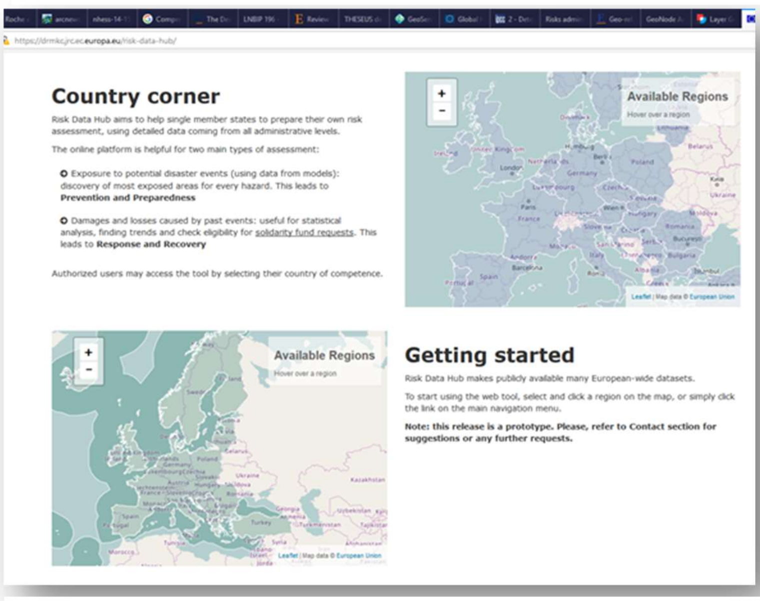
A basic WebGIS system consists of a server and a client and is divided in three main parts: a (geo-) database, maps server and a web viewer. Using spatial information requires the support of specific formats that is implemented at all levels of the platform. The spatial data support is achieved by extending the database with spatial capabilities which converts spatial data into formats known by the web server. An additional server (e.g. a map server) is added to the system in order to allow spatial queries and functions. For client-side visualization the browser is accompanied by a common protocol for spatial data that can express the location, extent and typology of the spatial data.

The main criteria for the development of the Risk Data Hub was to use only open-sources software. For this reason, currently RDH is implemented based on the GeoNode open-source software architecture. However, being a web platform dedicated to management of the disaster risk, the Risk Data Hub hosts and allows visualisation of modelled outputs. As stated before, the Risk Data Hub identifies measureable and geographically defined impact areas considering exposure, vulnerability, risk analysis from multi-hazard geospatial analysis and various scenarios. The analysis covers different geographical scales accessible on cascading relation (from country to municipality levels) and across hazards and socio-economic/environmental sectors. The outputs of the geospatial analysis is saved in a comma separated variable (CSV) format and becomes associated with vector data (e.g. polygons of administrative units and point data of event location) and eventually viewed in the web viewer. In order to enable the publishing of this kind of data and allow a practical interpretation of the outcome a client front-end (web viewer) was implemented as complementary to the GeoNode software. The usability of the GeoNode and the client web viewer are described in the subchapter 2.2.2.

3.1.1 Client Web portal

The client Web portal of the Risk Data Hub is still in prototype phase. It could be classified as a web application that displays static maps and analysis composed off the fly. The interface is developed in JavaScript and it was created to resemble a common GIS desktop application.

Figure 2 The Country Corner and the European-wide Data access portals



Source: Risk Data Hub 2018

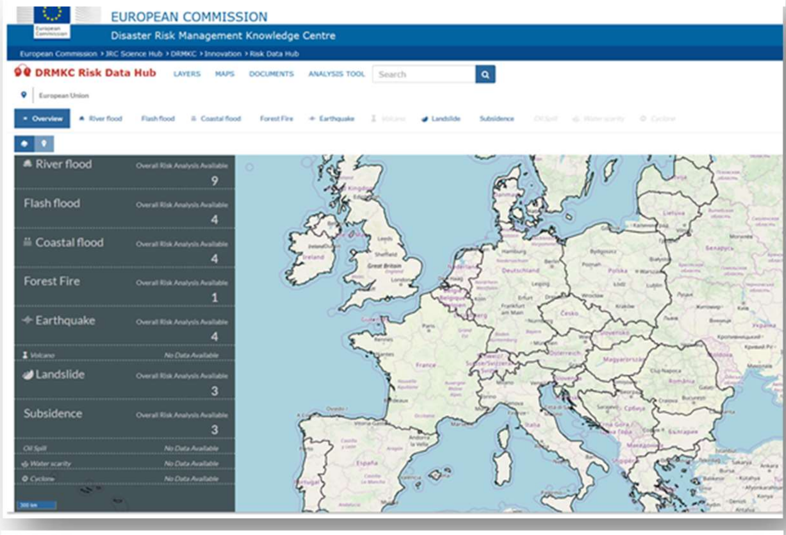
The client development includes a Web Application that offers the access to two complementary Data Portals. *The European wide Data Portal* –intended to improve the access and sharing of curated European-wide risk data, tools and methodologies for fostering Disaster Risk Management (DRM) related actions. *The Country Corner Data Portal* is created as a solution of accessing, storing and managing disaster risk data used by national authorities (Fig. 2). To access a particular country corner, user rights and passwords are needed.

3.1.1.1 The European-wide Data Portal

The European-wide Data Portal is a simple interface to freely visualize access, download and link geospatial data. It presents the geospatial information in a homogeneous way across Europe considering continental Europe and its maritime area, in two distinct sections. The continental Europe section covers the member states of the European Union, EFTA (European Free Trade Association) and IPA (Instrument for Pre-Accession Assistance) countries from Southeast Europe and Turkey. The maritime area covers the exclusive economic zone (EEZ)[20].

The interface of the European–wide Data portal is structured equally for both sections: continental and maritime.

Figure 3 The interface of the continental European-wide data portal



Source: Risk Data Hub 2018

A GIS web application typically provides a visualization section, where active layers and a set of tools to interact with the map are provided. The RDH map interface (Fig.3) summarizes the DRM-relevant information per hazard type offering access to 8 hazard sets and further to 2 analysis modules (classes). As hazard sets, currently the Risk Data Hub hosts the following natural hazards: river floods, flash floods, coastal floods, forest fire, earthquake, landslides and subsidence. A hazard set is composed from various layers that represent various dimensions such as return periods or levels of susceptibility. For the maritime area, the oil spill man-made hazard is considered. The fully functional analysis modules are Historical Events and Exposure Analysis. Under development two more modules will be integrated on the Risk Data Hub: Vulnerability Analysis and Risk Assessment (from good practices). A detailed description of the methodological approach and data used for the developed classes up to now is offered in the chapter 4. As follow we will describe only the functionalities of the interfaces that correspond to the analysis modules.

3.1.1.1.1 The Exposure Analysis module

The Exposure Analysis module is based on the identification of the potential impact areas by means of exposure analysis. Hazard layers and exposure layers of a selected analysis type are loaded on the map viewer as associated information. The selection of the layers and exposure analysis is done by navigating across hazards and analysis modules, types and sub-types as presented in Figure 4.

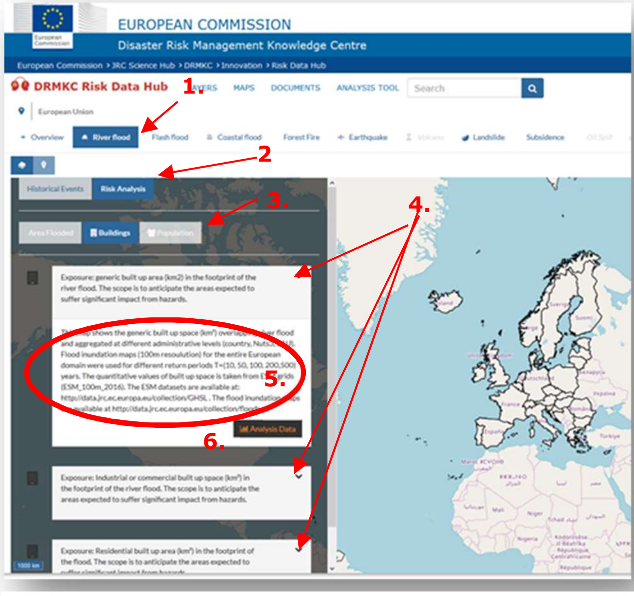
While the visualization window (Fig. 5) offers access to the spatial representation of the exposure analysis, the access to the associated information (datasets and metadata) for the exposure layers (population, built-up, habitats, protected area etc.) and hazard layer is made available using function *Open details.* The association of the supporting information to the corresponding analysis is done automatically while selecting the type

[20] The United Nations Convention on the Law of the Sea (A historical perspective)". United Nations Division for Ocean Affairs and the Law of the Sea. Retrieved 30 April 2009.

of analysis. An abstract of the analysis is presented prior the access to the actual data of the analysis, spatially represented on the map viewer.

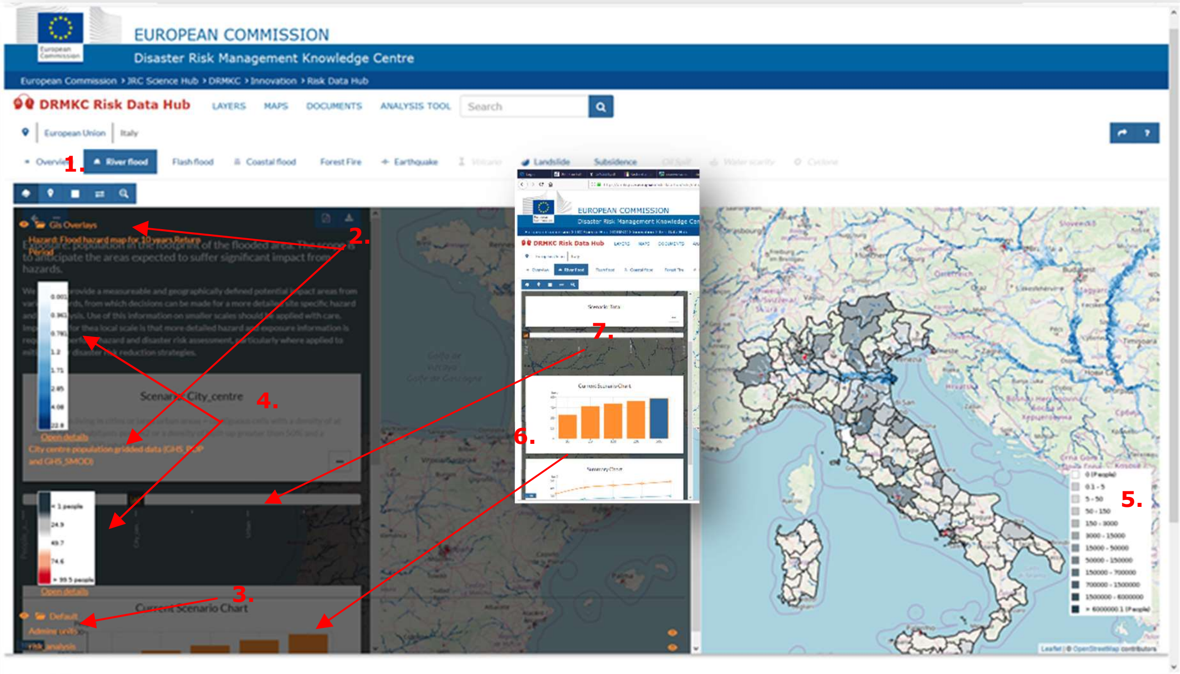
Since the maps are structured as multiple scales and in order to have a comparative spatial distribution of the data an across geographical/administrative scales navigation function (from countries to local administrative units) is enabled. It connects information across 4 administrative scales, in a "bottom up" approach with the purpose of bring up-scale information from local level. First a local view is possible given by the high resolution layers followed by aggregations at LAU, NUTS3, NUTS2, and country level (please see subchapter 4.1.2.1.). In order to compare the potential exposure of a single region to multiple hazards an across-hazards comparative navigation is enabled by only selecting the hazard we are interested to see.

Figure 4 Navigation across: 1.Hazard types; 2 Analysis modules; 3. Analysis type; 4. Analysis Data; 5 Abstract of analysis type 6. Accessing data analysis



Source: Risk Data Hub 2018

Figure 5 Exposure analysis interface: 1. Multi hazard list; 2.Associated layers; 3. Exposure Analysis Layer visualized on the map viewer; 4. Associated layer legend; 5. Exposure analysis legend; 6. Aggregated representation per hazard return period or scenario; 7. Urbanization scenario slider

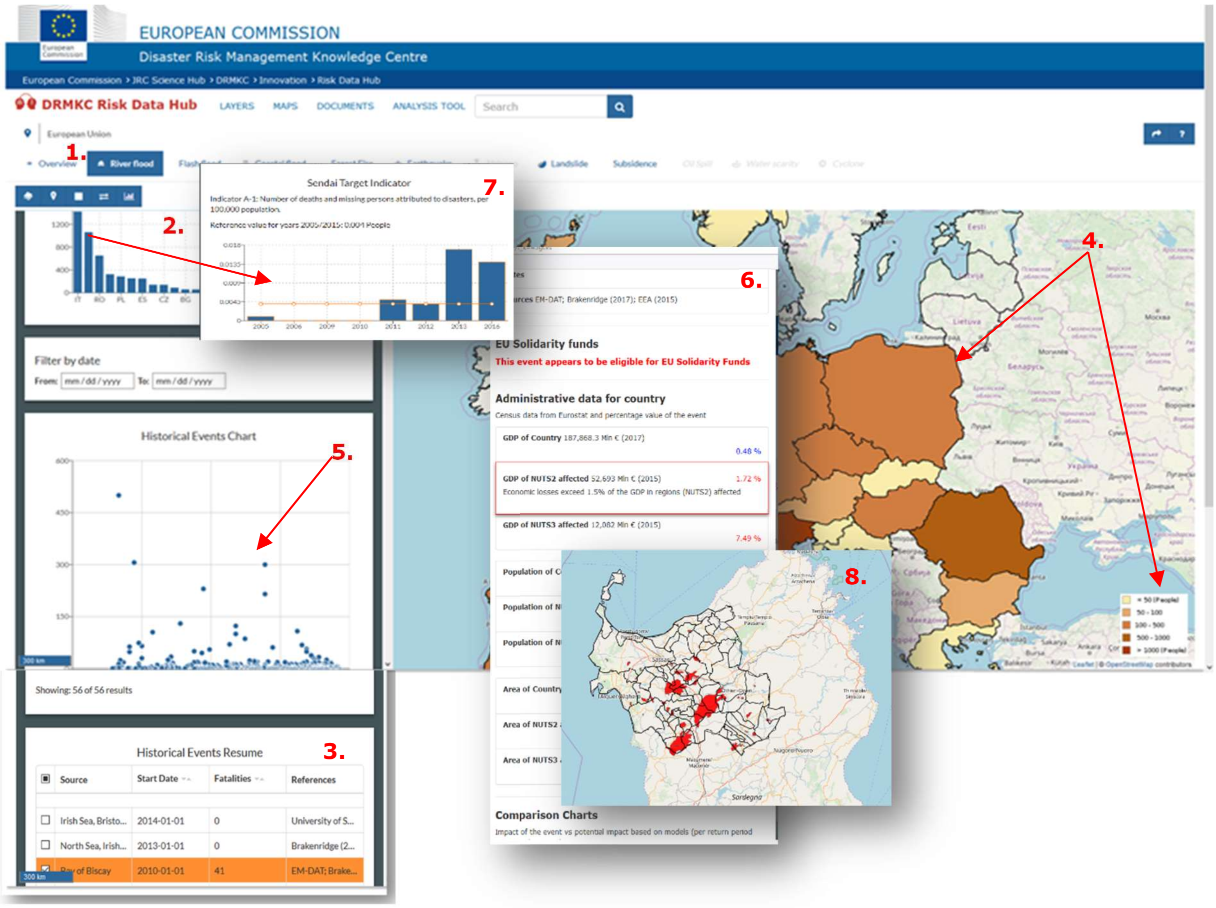


Source: Risk Data Hub 2018

3.1.1.1.2 The Historical Events module

The Historical Events offer the access to the available historical loss and damage data. The module offers a collection of past events with records on impacts quantified as losses and damages and spatial data identifying the geographical location and extension of the event. This module makes use of inventoried data from various sources. They are combined in order to make available following information related with a past event: event identification, impact records and eventually the geospatial layer. Furthermore the input is used into analysis that serves as evidence based information for DRM or serves as associated information for various contexts (e.g. financial - EUSF or reporting – Sendai indicators reporting). For methodological aspects of the analysis please see chapter 3.3. As follows we present the map viewer of the historical events module.

Figure 6 Historical events module interface: 1.Multi-hazard list; 2.Aggregated analysis per country; 3.Table of the events attributes; 4.Spatial aggregation analysis and legend; 5. Events magnitude analysis; 6. Event detail analysis; 7. Sendai indicator analysis; 8. Location and areal extension of the event.



Source: Risk Data Hub 2018

The flow of selections follows the same structure of the analysis modules. The access to statistical and spatial data is done by, first selecting the hazard type, then the module and the analysis type. The map viewer will eventually display the spatial analysis with the country aggregation analysis and events magnitude analysis, backed up by the table with the attributes of the event (Fig.6). The associated information can be accessed within the next level either by further clicking a country (and obtain the Sendai indicators aggregation/country) or by successive clicking on the event and graph icon (and obtain the Event detail analysis for the EUSF).

Using different sources, within the Risk Data Hub we present also the areal extent and geographical location of the events. A description of the methodology used to map different types of spatial data can be consulted in subchapter 3.3.1.2. By selecting the event from the graphical representation of the events' magnitude (no.5 in Fig.6) the map viewer brings the user either to the level of country or subnational administrative unit where the event is located or at the level of areal extent of the event (as in no.8 from Fig.6). Most often the impact areas and damage records are linked to an administrative unit (e.g. NUTS3). Where geospatial data is available, the areal extent of the hazard is made accessible. Generally it is a vector layer, the result of spatial analysis done on satellite imagery product (e.g. MODIS satellite imagery).

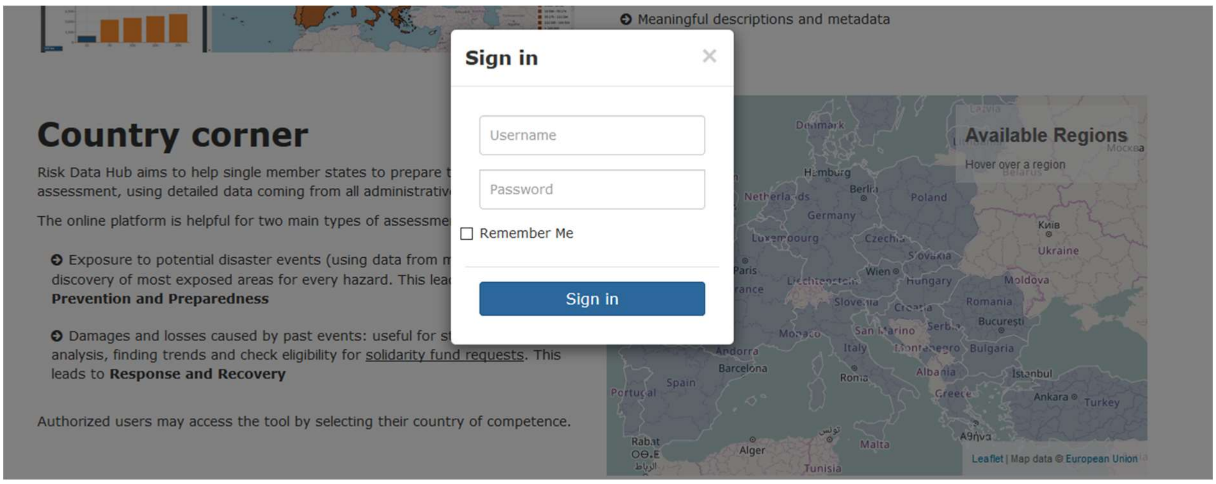
3.1.1.2 Country Corner Data portal

One of the most important functionalities of the Risk Data Hub is the Country corner (Fig. 7). It serves the scope of making accessible for national authorities a way of storing and managing disaster risk information with local scale. It can be analysis, spatial data layers or documents. The purpose of the portal is to assist national authorities in creating local, easy to access information usable in disaster risk management. It offers a way of accessing data from various sources usable at national level to perform analysis (vulnerability, impact, Sendai reporting, risk assessments etc.).

Using national corner local authorities can accelerate actions for developing and implementing international and local strategies on disaster risk.

National Risk assessment (NRA) reporting can be assisted with data and methodologies capitalized from good practices hosted on the Risk Data hub. Access to these data is allowed within the Country corner by importing them from the database existing in the European–wide Data Portal. Uploading and managing documents is also enabled.   It is an alternative solution for data accessibility and methodological approach for disaster risk data with local scale and national scope.

Figure 7 Country corner data portal (access page)



Source: Risk Data Hub 2018

Country corner portal is an "empty box" that induces a methodology of organising and analysing data for DRM. The structure of the country corner replicates the structure of the European–wide Data Portal. It creates in this sense the possibility of comparing and linking data and methodologies applied to opposed geographical scales, European and local. With one input various analyses are automatically supported, such as in the case of structuring the loss and damage data according to Sendai targets. With the same input an initial analysis for accessing to financial schemes such as EU Solidarity Funds (EUSF) is proposed.

The targeted users are national and sub-national authorities. Access and authorisation can be adapted, according to administrative levels. For instance, a user with national or municipal scope will be able to store and share data within the corresponding administrative level only. Access to data for other users within the country will be granted upon request-authorization. The user role is foreseen to have national/local competency. Therefore it will have the character of national or subnational contact point.

4 The Risk Data Hub implementation

The Risk Data Hub supports the identification, implementation and evaluation of prevention and preparedness actions for DRR. In the context of extreme events and to support risk management decision-making, information on socio-economic, environmental and land use are presented as potential impact. Being designed to consolidate risk management, the Risk Data Hub creates a basis for analysis approaches that relates physical characteristics of the hazard to their various potential impacts. In this way, linking hazard characteristics with their effects on society, economy, environment and land use, at large, it establishes a data source that can be used for disaster risk management. It may also provide the necessary link to evaluate which hazard metrics can predict impacts

The data hosted on the Risk Data Hub is divided in four modules: Exposure Analysis, Vulnerability Analysis (ongoing work), Risk Analysis (ongoing work) and Historical Events. The user can select within these modules the domain of analysis represented by sector-structured exposure (e.g. population, economy, area protected, built up space, infrastructure etc.) and their attributes (the metrics of the domains, e.g. demographic metrics).

4.1 The Exposure Analysis module

The exposure Analysis module is based on the identification of the impact areas by means of exposure analysis. Links to various exposure layers (population and built-up gridded data, Open Street Map layers etc.) and hazard layer from various sources are made available for the user to discover and compare. Across geographical scales (countries or local administrative units) and across-hazards spatial data analysis is enabled.

4.1.1 Methodological aspects

4.1.1.1 Exposure analysis

The geospatial information provided in this analysis is built on the relation exposure – hazard. The spatial extent of hazardous events' metrics, such as severities, frequencies or intensities is overlapped with exposure layers. The overlapping analysis accounts as a measure of presence of various hazards exposure within a considered area. With this approach, we describe the "hazardousness" of a location (Hewitt et al., 1971).

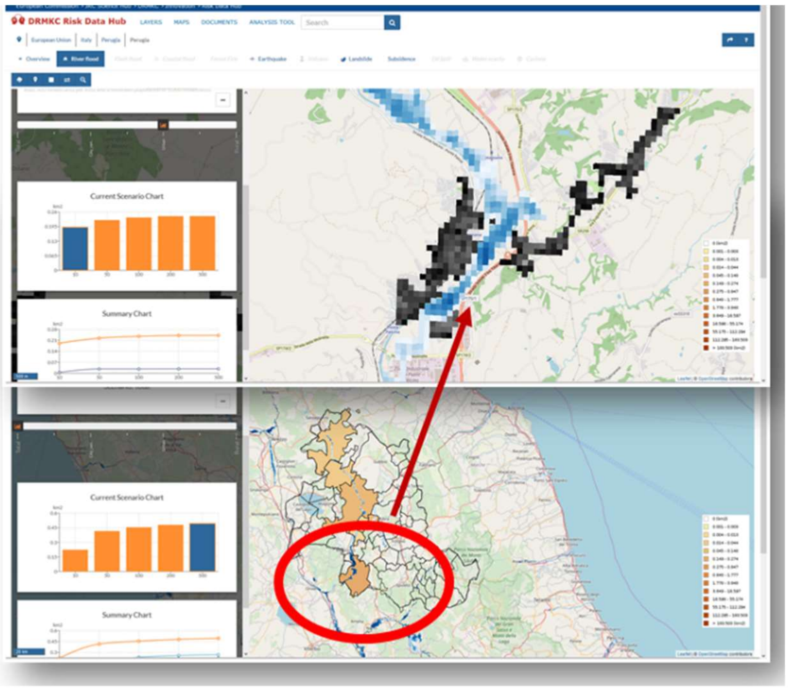
This method proposes a shift in the approach for the disaster risk management (DRM) from risk mitigation to risk prevention. It is acknowledged that assessing the potential impacts of natural hazards on communities requires an understanding of which specific elements are exposed. These elements can be anything from individuals, households, communities, buildings and infrastructure, as well as agricultural commodities and environmental assets. Exposure as a spatial concept is an IPCC-influenced perspective (IPCC, 2012) used in disaster risk assessment to evaluate the spatial distribution of impacts and hazards. Accordingly, understanding the exposure will contribute to effective preparation, monitoring and response to various hazards and will increase communities' resilience to disasters.

Nevertheless, some hazards have a different geography of exposure and implicitly potential impact. It is acknowledged (Cardona,et. al., 2012; Kepses, 2012) that within given hazardous areas (seismic hazard as well as for the climate-sensitive hazards) there are other characteristics, not only the geographical location (concept of location placed in the centre of the risk assessment Kepses, 2012), that will have a significant impact on whether or not exposed elements (or systems) are likely to experience harm. In this context, most important are the attributes of exposure that consequently will influence, within the hazardous area, upon the vulnerable elements that are becoming most likely to be harmed (concept of vulnerability placed in the centre of the risk assessment (Kepses, 2012).

4.1.1.2 Identification of the impact areas.

Currently the Risk Data Hub is mapping exposure for two types of impact areas: at grid level (pixel), reporting the information at the finest local scale and at the geographical scale of interest (Fig. 8). (A finer level of information will be available with the integration of the vector data in the exposure analysis. This would be possible by implementing the Open Street Map layers on the Risk Data Hub, which is foreseen for the next year – 2019.) Impact areas considered at the level of areal dimension (e.g. administrative units) account for a quantified exposure within administrative units. We use the European administrative boundaries (Eurostat/GISCO) as our geographical scale of interest. Therefore, the quantified presence of exposure to hazards is evaluated at different administrative levels: Country (NUTS 0), regions (NUTS 2), provinces (NUTS3) and LAU (Local Administrative Units) level. Our approach draws multi-hazard views of regions at comparable scale, in this case the administrative level. Approximating impact areas at the geographical scales allows a further methodological development within the Risk Data Hub, namely multiple-hazard impact areas based on coincidence considered at areal dimension.

Figure 8 Impact areas quantified at the grid and administrative areas (dark – build up space, blue – flood areas)

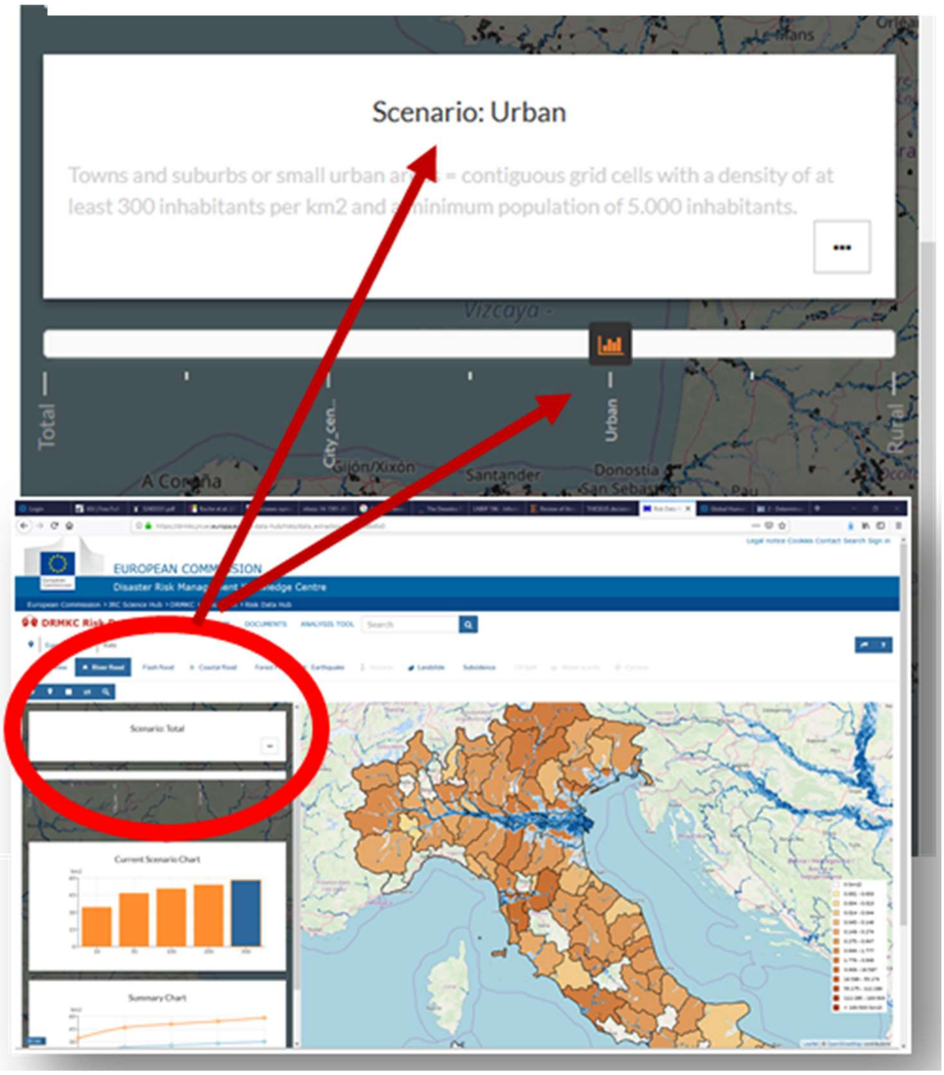


2Source: Risk Data Hub

4.1.1.3 Considering "urbanization" scenarios

In order to assign the exposure analysis to different urbanization scenarios, the exposure layers (e.g. European Settlement Map - ESM, Global Human Settlement Layer - GHSL gridded data, infrastructure etc.) are masked by the "degree of urbanization" layer, selecting in this way 3 types of scenarios: Rural, Urban and City centres. We also present the "Total" exposure as a sum of the 3 scenarios (Fig. 9). The "degree of urbanization" layer has been generated by integration of built-up areas produced from Landsat image, and built up data derived from the CIESIN GPW v4. In this assessment, the REGIO-OECD model (L. Dijkstra et al. 2014) concerning the selection of the "high density clusters" (HDC), "low density cluster" (LDC), and rural areas (BASE) have been considered. For further information please consult http://ghsl.jrc.ec.europa.eu/. The "HDC" is defined as: contiguous cells with a density of at least 1.500 inhabitants per km2 or a density of built-up greater than 50% and a minimum of 50.000 inhabitants. The LDC is defined as: contiguous grid cells with a density of at least 300 inhabitants per km2 and a minimum population of 5.000 inhabitants. The "Base" is defined as grid cell outside high-density clusters and urban clusters.

Figure 9 Selecting the type of urbanisation scenario



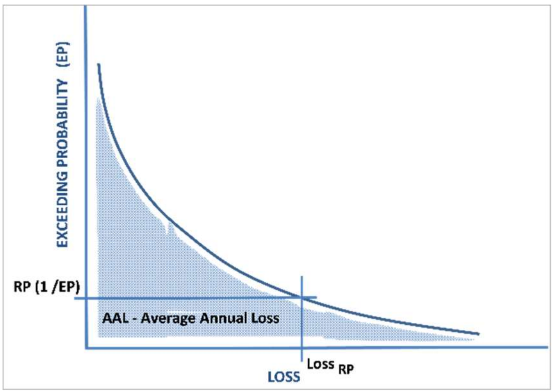
Source: Risk Data Hub 2018

4.1.1.4 Considering temporal probability

The Risk Data Hub supports through the mapping methodological approach, in using a probabilistic/quantitative risk assessment based on the relation: exposure, hazard, and vulnerability/coping capacity. The risk is considered as a probability of the impact/damage, a plot of a temporal probability against the total consequences (risk curve).

In probabilistic risk assessment the following statistical concepts are encountered: Uncertainty, Return Period, Exceedance Probability, Loss-Frequency Curve, and Average Annual Loss (Fig. 10).

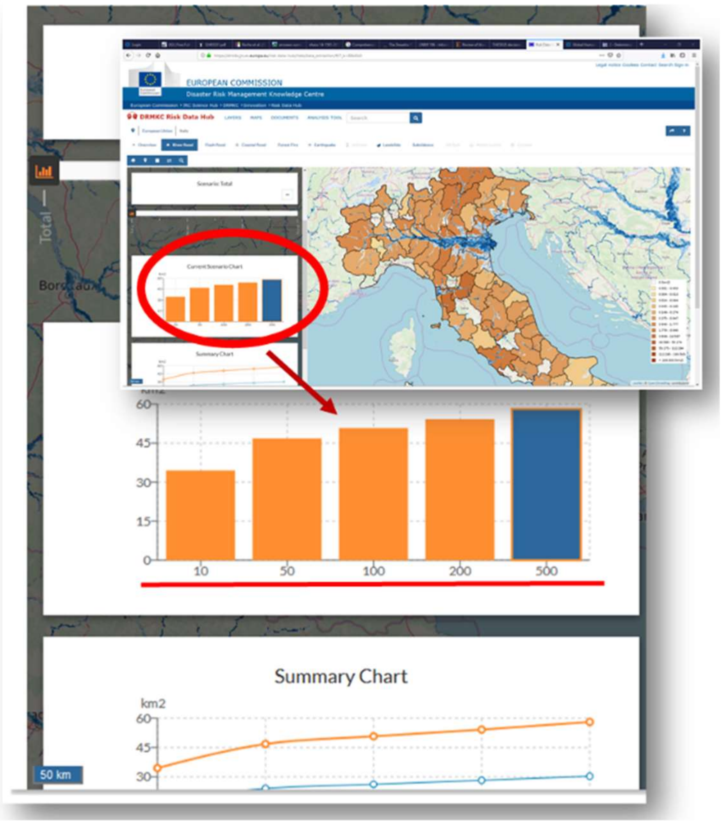
Figure 10. Risk modelling of disaster risk provides quantitative risk metrics that capture the severity and frequency of the loss distribution. For example, an EP curve portrays the probability of exceeding a given level of loss, the area under the curve represents the average annual loss (AAL), return period (RP) is the reciprocal of the exceeding probability, while Loss RP is the loss for a given return period



Source: Stojanovski, P., 2015

Return period (RP) also known as a recurrence interval is an estimate of the interval of time between events. It measures on average the return period of an event (hazardous event). This means that an event with 100 years' recurrence interval will not happen regularly, every 100 years, but it will on average only occur once every 100 years. The event can occur more than once but the probability of such occurrences is low. In order to avoid misinterpretation, *the exceedance probability (EP)* is often a better concept than the return period. The return period is the inverse of the probability that the event will be exceeded in any one year (RP=1/EP). For example, a 100-year flood has a 0.01 or 1% chance of being exceeded in every year and a 50-year flood has a 0.02 or 2% chance of being exceeded in every year ([Stojanovski, P, 2015](#)). The aforementioned probabilistic concept applied to the assessment of the disaster risk is represented in the Risk Data Hub by quantifying the exposure on the *Return Period* graphic (Fig. 10). By considering the likelihood (probability) of occurrence of each event and

Figure 10 Estimated exposure considering different Return Periods



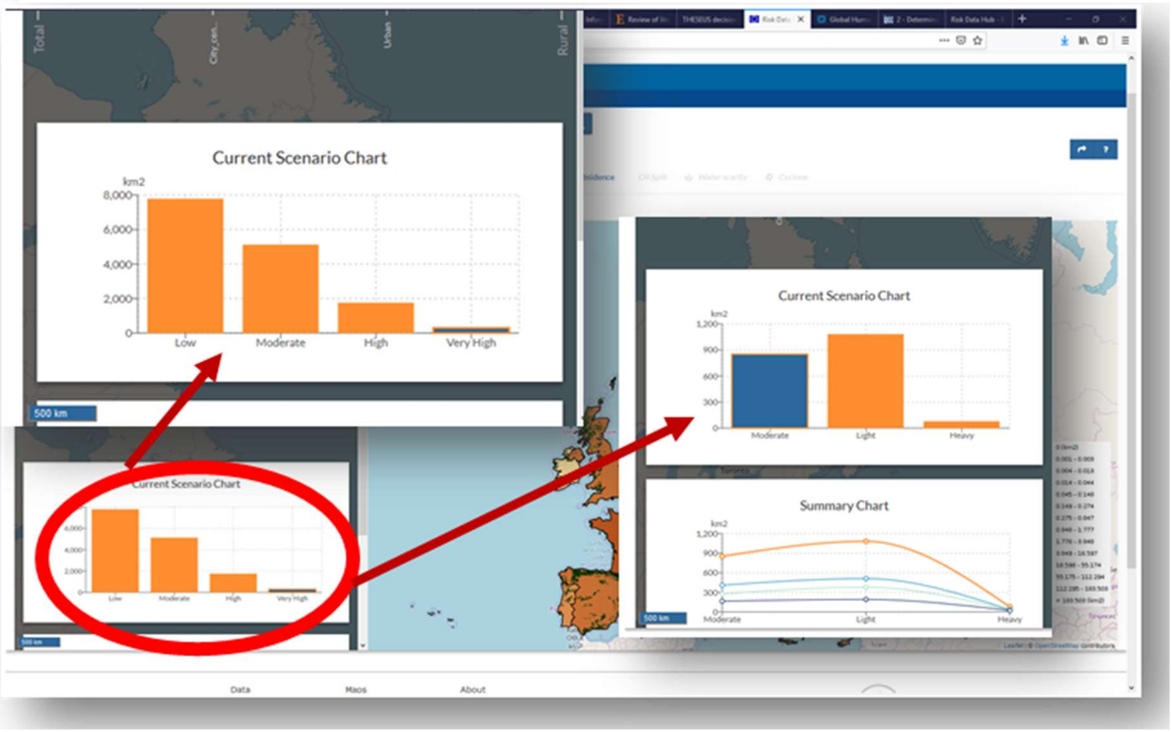
Source: Risk Data Hub 2018

the magnitude (severity) of the possible adverse consequences, a probabilistic risk analysis brings together all the potential sources of risk as well as their uncertainties. Further analysis on the accepted/not accepted risk can be made, by balancing the exposure (which can be quantified in monetary value) with the relegated probability.

4.1.1.5 Considering spatial probability

The main target of a hazard assessment is to identify areas that are more prone to hazardous events than others. These events are commonly describing the probability of occurrence within a specified period of time and within a given area, and have a given intensity (UN-ISDR, 2004). However, depending of the type of the statistical technique the meaning of the probability changes (Guzzetti, F., 2005). The discriminant analysis or logistic regression within given areas, applied on different parameters (e.g. elevation, slope, land use, etc.) assigns that the area pertains to a susceptibility level of hazardousness or not. For example the spatial probability of the landslide occurrence, is also known as susceptibility (Brabb, E., E., 1984). The susceptibility can be described qualitatively, by levels of magnitude as: very high, high, medium and low. As it is the case of landslides, subsidence and even earthquakes (please see 4.1.2.3.4) within the Risk Data Hub, susceptibility maps are used to describe the areas potentially exposed to hazards (Fig.11).

Figure 11 Estimated exposure considering spatial probability defined hazard



Source: Risk Data Hub 2018

The landslide and subsidence map shows the susceptibility levels: "low", "moderate", "high" and "very high". For the landslide the levels are derived from heuristic-statistical modelling of main landslide conditioning factors using also landslide location data (Wilde, M., et. al., 2018). For the subsidence susceptibility different classes were assigned considering surface textural class of the Soil Typological Units (STUs) (Panagos, et.al, 2012): very high (clay > 60 %), high (35% < clay < 60%), medium (18% < clay < 35% and >= 15% sand, or 18% < clay and 15% < sand < 65%) and low (18% < clay and > 65% sand) (please see 3.1.2.3.6).

For the seismic hazard (please see the SHARE project, Woessner et al. 2015), we delineate in the Risk Data Hub, potential damage zones as: "Light" potential damage zones = Intensity scale VI, "Moderate" potential damage zones = Intensity scale VII and "High" potential damage zones = Intensity scale VIII. The derive these zones we use an analogue approach that relates the physical ground motion parameters (such as PGA) with actual levels of damage derived from Instrumental Intensity scale developed by United States Geological Survey (USGS) (Worden, C. B., et. al., 2016).

4.1.1.6 Considering climate change scenarios

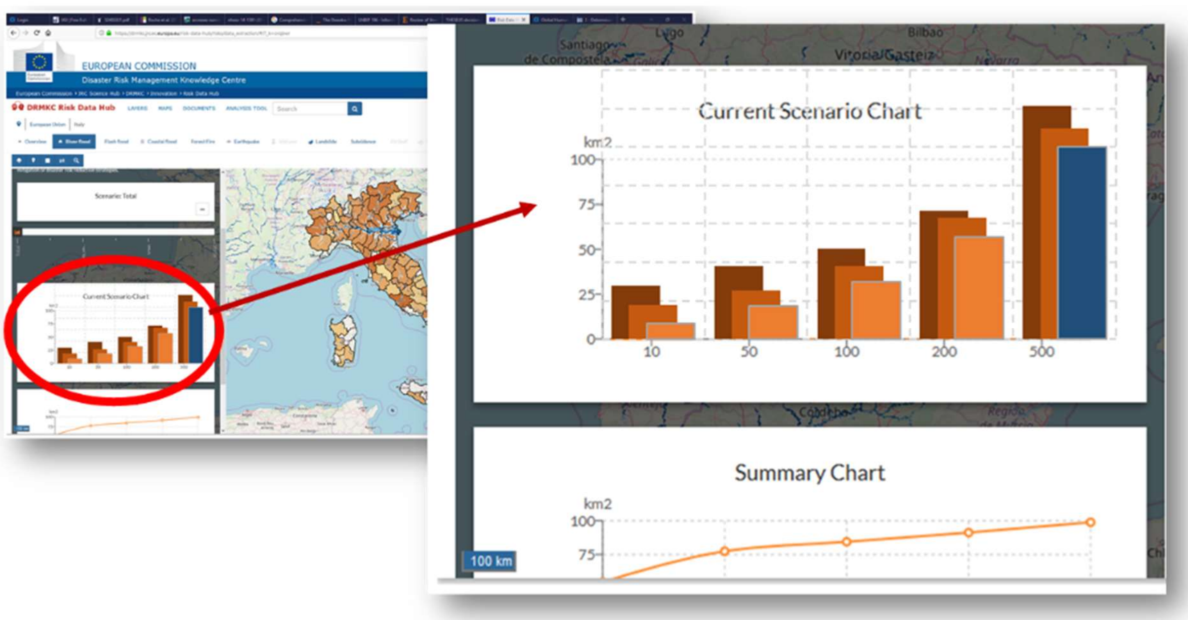
Even though various platforms have been operating for DRM purpose only, the DRMKC Risk Data Hub (RDH) considers in its development the common interests of climate change adaptation (CCA) platforms: reduce vulnerability and building resilience.

As a knowledge hub, the RDH is expected to create stronger relationship among DRM and CCA communities, disseminating common views on data, tools and methodologies. Challenges associated with competition for the same space regarding provision of data and knowledge, targeted users and actions has always been present. A way forward would be to provide the incentives and resources that enable the common interests: integration of climate, environment as well as socio-economic data and scenarios when addressing disaster related risks. This is important when users are expected to switch between different views of the same topic, such as the short-term risk management (DRM) of extreme events versus long-term adaptation (CCA) to extreme events in a changing climate.

To confront this scope and to support the related complex forms of decision-making, RDH provides the technological development and suggests an efficient mechanism that may be considered.

In conceptual terms, vulnerability and disaster resilience are closely related. Some authors see vulnerability as the opposite of disaster resilience, while others view vulnerability as a risk factor and disaster resilience as the capacity to respond.

Figure 12 Quantify exposure considering climate scenarios (Baseline, RCP 4.5, RCP 8.5)



Source: Risk Data Hub

In practice, the Risk Data Hub provides incentives for both conceptual sides (Fig. 12). It maps the context of whose resilience is being built such as a social groups, socio-economic system or environmental context but also focusses on their vulnerabilities. It offers access to data and methodologies to assess the disturbances (natural and manmade hazards) and supports the view of long-term adaptation to extreme events in a changing climate (stress).

4.1.2 Data

The geospatial information hosted on the Risk Data Hub is built on the relation exposure – hazard. The spatial coincidence of hazards with the exposure layers is evaluated at different administrative levels: Country (NUTS 0), regions (NUTS 2), provinces (NUTS3) and LAU (Local Administrative Units) level. In the following section, we outline the geographical scale, exposure and hazards considered in the Exposure Analysis Module and the methods applied to describe the data.

4.1.2.1 Administrative units

To enable spatial comparison among the exposure datasets across the different hazards at common spatial scale the exposure data is aggregated at the level of administrative units. We consider two types of aggregation schemes: the sum of the exposed asset and the ratios of the exposed assets (share of the exposure compared to the total amount of the exposed asset in a specific region.)

The areal dimension considered throughout all steps of the analysis hosted on the Risk Data Hub is represented by Country (NUTS 1), regions (NUTS 2), provinces (NUTS3) and LAU (Local Administrative Units) level. The Geographical extent of the Risk Data Hub covers the economical territory of European Union 28, and the EFTA countries. This dataset comes from the statistical office of the European Union and represents pan European administrative boundaries down to commune level version 2013. Communes are equivalent to Local Administrative Units, level 2 (LAU2). The Nomenclature of Territorial Units for Statistics (NUTS) and the LAU nomenclature are hierarchical classifications of statistical regions that together subdivide the EU economic territory into regions of five different levels (NUTS 1, 2 and 3 and LAU 1, 2, respectively, moving from larger to smaller territorial units). The NUTS classification has been officially established through Regulation (EC) No 1059/2003 of the European Parliament and of the Council and amendments. The LAU classification is not covered by any legislative act (Eurostat, http://ec.europa.eu/eurostat/web/NUTS/overview).

4.1.2.2 Exposure data

Different disciplines provide data for exposure modelling: geography science, economics, remote sensing and socio-demographics. Among these disciplines various types of elements at risk, and also many different ways to classify them can be found. One classification example from ITC, University of Twente (Westen, 2009), is presented below:

- Physical elements. Buildings: Urban land use, construction types, building height, building age, total floor space, replacement costs. Monuments and cultural heritage
- Essential facilities. Emergency shelters, Schools, Hospitals, Fire Brigades, Police,
- Transportation facilities. Roads, railway, metro, public transportation systems, harbour facilities, airport facilities.
- Life lines. Water supply, electricity supply, gas supply, telecommunications, mobile telephone network, sewage system.
- Population. Density of population, distribution in space, distribution in time, age distribution, gender distribution, handicapped, income distribution
- Socio-economic aspects. Organization of population, governance, community organization, government support, socio-economic levels. Cultural heritage and traditions.
- Economic activities. Spatial distribution of economic activities, input-output table, dependency, redundancy, unemployment, economic production in various sectors.

Physical elements and population, which are the main groups of the exposure analysis, are represented currently across types of analysis and hazards within the Risk Data Hub. The sources of the two types of exposure layers are ESM (European Settlement Map, 2016) for the build-up space, Global Human Settlement Layer (GHSL, 2016) for the population and the Corine Land Cover (CLC 2016) for the typology of the land use.

The *European Settlement Map (ESM)* is a spatial raster dataset that is mapping human settlements in Europe based on SPOT5 and SPOT6 satellite imagery. It has been produced with GHSL technology (Pesaresi, et al., 2013) by the European Commission, Joint Research Centre Institute for the Protection and Security of the Citizen, Global Security and Crisis Management Unit. The European Settlement Map 2016 (also referred as 'ESM2016') represents percentage of built-up area coverage per spatial unit (Florczyk, et. al., 2015).

The *GHS population grid* (GHSL, 2016) is spatial raster dataset that depicts the distribution and density of population, expressed as the number of people per cell. Population estimates for target years 1975, 1990, 2000 and 2015 provided by CIESIN GPWv4 were disaggregated from census or administrative units to grid cells, informed by the distribution and density of built-up as mapped in the Global Human Settlement Layer (GHSL) global layer per corresponding epoch (Freire, et al.2015).

In order to disaggregate the typology of the ESM and GHS layers, the Corine Land Cover (CLC 2016) is used on the artificial areas, it quantifies the residential, industrial and commercial areas and consequently the residential population exposed to different hazards. The type of industrial and commercial built up space (km2) is given by CLC 2016 - CLC code 3.121, while the residential build up space is given by the CLC code 1.111 and 2.112

The importance of the exposure data lays in the identification of potential impacts of natural hazards on communities which requires an understanding of which specific elements are exposed at risk. The exposures' location information and the spatial extension of the hazard are a minimum required set of data used for this purpose. However more basic information is needed to model the exposure *of a physical element* such as: occupancy, construction type, length or density (roads and railways) and replacement value (estimate of the direct loss). Other additional structural information are: square footage, shape, height (height above ground of the first occupied floor – for hydrology), age, roof type, irregularities, material and mechanical properties. These are the attributes of the exposure assets. They are important as the vulnerability assessment is explicitly link with attribute/metrics of exposure.

For developing demographic exposure most exposure data sets at the national scale or above use the spatial *distribution of population* as a proxy. However, incorporating the temporal variation in human exposure (movement of population through the course of a day or season) can be a key factor in determining the impact of rapid hazards events (earthquakes, landslides, or tsunami) (Coburn, et al., 1992). These are aspects that are considered in the analysis implemented on the Risk Data Hub along with the expansion of the exposure datasets used.

4.1.2.3 Hazards data

We were limited in the selection of the hazard by their availability at the moment of our publication. We considered the following hazards: forest (wild) fire, subsidence, river flood, storm surge, landslide and earthquake. Some characteristic of the datasets can be consulted in the table 1.

Table 1. Hazard datasets considered in the Risk Data Hub and characteristics

Component	Scenario	Description	Spatial resolution	Data type	Data source

River flood	Return periods T=(10, 50, 100, 200,500) years.	Areal extent of the flood prone areas	100m	gridded data	EFAS (European Flood Awareness System), KULTURisk project
Landslide	Landslide susceptibility layers for different classes: very high, high, moderate and low susceptibility	Areal extent of physical characteristics of various terrain factors that provides high predisposition to landslide occurrence (ELSUS_2 100 layer)	200m	gridded data	ESDAC
Storm surge	Return periods T=(10, 50, 100, 200,500) years.	Areal extent of the extreme total water level (TWL) result of the contributions from the mean sea level (MSL), the tide and the combined effect of waves and storm surge.	100m	gridded data	HELIX project, JRC CoastalRiskandGAP-PESETAII projects
Earthquake	Potential damage zones considered: Light, Moderate", High potential damage zones.	We established the potential damage zones relating a physical ground motion parameter - Peak ground acceleration (PGA) - with levels of potential damage developed by United States Geological Survey (USGS) (Worden, C. B., et. al., 2016)	1000m	gridded data	SHARE project (http://www.share-eu.org/)
Subsidence (from drought)	Subsidence susceptibility for different classes: very high (clay > 60 %), high (35% < clay < 60%), medium (18% < clay < 35% and >= 15% sand, or 18% < clay and 15% < sand < 65%) and low (18% < clay and > 65% sand).	Areal Extent of fine and very fine soil texture (particle < 2 mm size) and with clay content greater than thresholds (presented in the scenario column).	1000m	gridded data	ESDAC (https://esdac.jrc.ec.europa.eu/content/european-soil-database-derived-data)
Forest fire	Wildland–Urban Interface area (WUI)	WUI areas within 10 km limit range from the historical burned areas (2000-2017)	100m	gridded data	EFFIS (http://effis.jrc.europa.eu/)

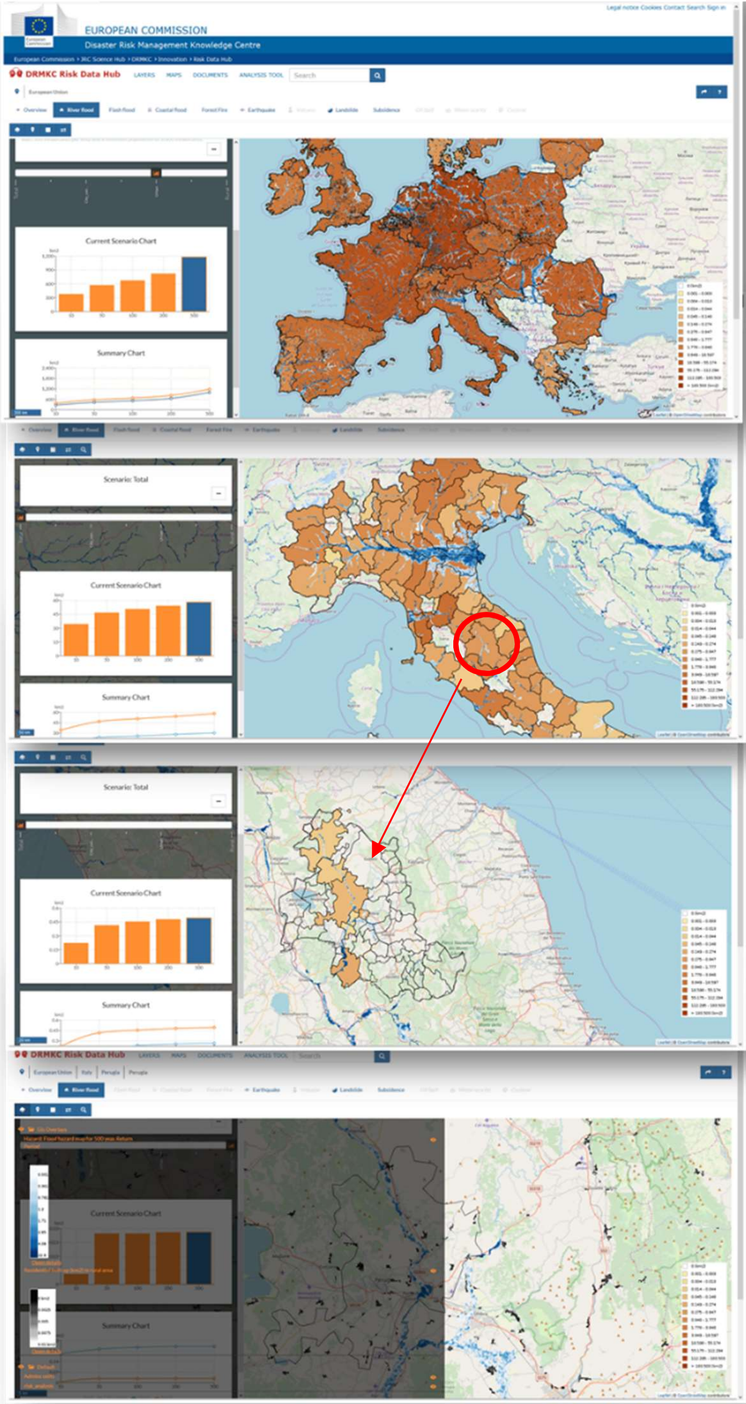
4.1.2.3.1 River floods

The impact estimation from flood inundation is considered in various studies, mainly, through hydraulic floodplain models and by quantifying the socio-economic damages (Feyen et al. 2012; Rojas et al., 2013; Alfieri et al., 2016; Jongman et al. 2014).

In order to provide an estimation of potential impact from floods, both on population and residential built-up, we use the European inundation maps derived from high-resolution 2-D hydraulic model LISFLOOD (Bates et al., 2010; Alfieri et al., 2014) as a measure of the areal extent of the flood-prone areas (Fig. 13). The extreme events simulated in the reference period 1990–2013 for different return period T=(10, 50, 100, 200,500) years are considered. To flood prone areas we intersect built-up and residential population layers in order to determine the flood potential impact.

The management of floods is based on prior assessments of flood events and their impacts and it became the dominant approach of flood control policies throughout Europe. An approximation of the impacts, as suggested by our approach, gives insights into what can be expected and supports decision-making on possible measures that can be taken, prioritising areas where action is required.

Figure 13 Across scale analysis of the impact from river flood in the Risk Data Hub



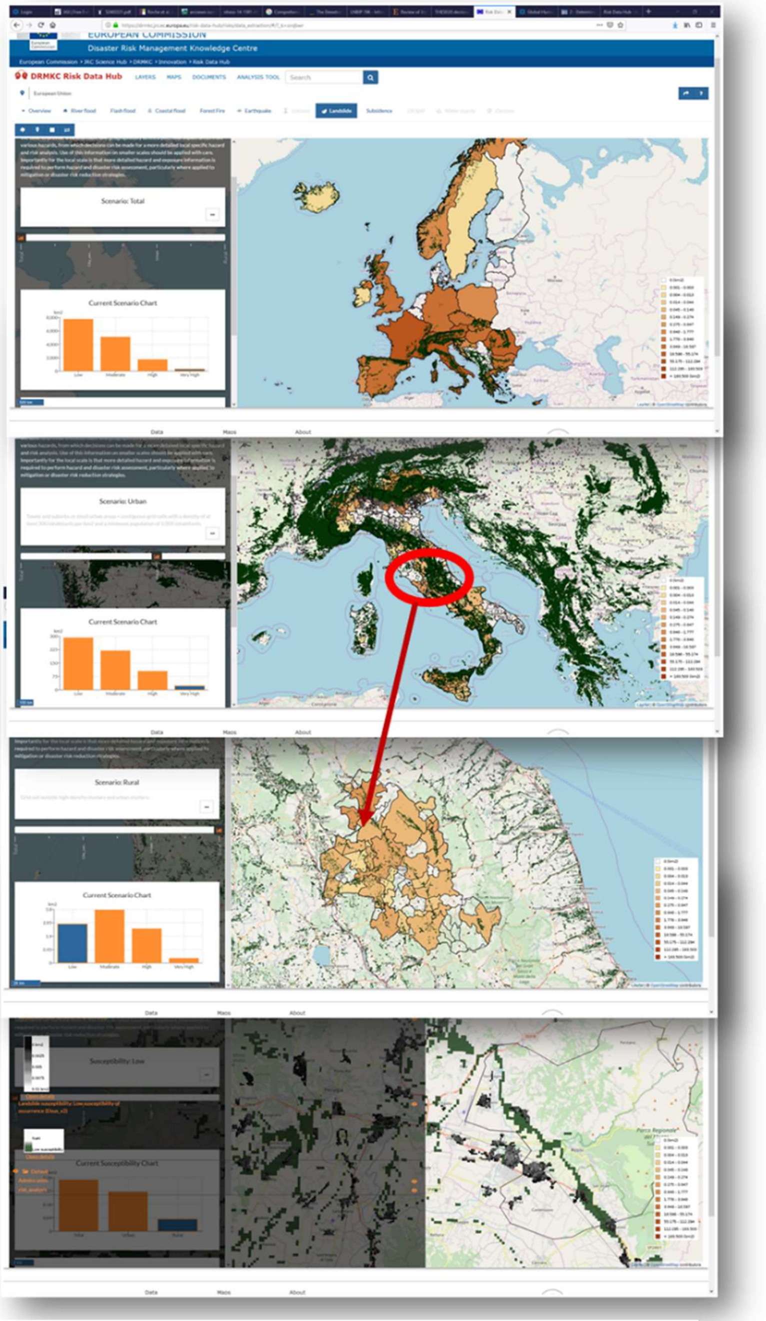
Source: Risk Data Hub

4.1.2.3.2 Landslides

Impacts from landslides on both built-up space (Zêzere et al. 2008, Papathoma-Köhle et al. 2011, Pomper et al., 2015) or human lives (Guzzetti, 2000, Papathoma-Köhle et al. 2007, Garcia et. al., 2016) are frequently considered and mainly in respect to physical vulnerability (relationships between process intensity and the expected degree of loss). The landslide, as a geohazard capable of causing damages, has been related in literature to either a landslide hazard or a susceptibility map (Promper et al., 2016). Within the Risk Data Hub, we consider the susceptibility map (Günther A, et al, 2013; Wilde M., et al., 2018) in order to approximate the potentially hazardous areas. The suggested approach is not trying to reflect the site conditions; it rather serves as a mean of providing general information on areas with potential impact from landslides. This practice is common (Glade et al. 2012, Kappes et al. 2012, Pellicani et al. 2013) and it achieves the scope for regional assessment as a first step towards identification of locations where in-depth analysis is required (Kappes et al. 2012).

In order to provide a first-step estimate of the areas were landslide are most likely to threaten assets and population we selected the European Landslide Susceptibility Map version 2 (ELSUS v2) (Wilde M., et al., 2018). The resulting landslide susceptibility layer it is a measure of physical characteristics of various terrain factors that provides high predisposition to landslide occurrence. Finally, in order to quantify the extent of the potential impact from landslides we overlapped the susceptibility layer with population and residential built-up layers. With this approach we draw views of regions hazardousness at comparable scale and approximate locations with potential hazards impact as in Fig. 14.

Figure 14 Across scale analysis of the impact from landslide susceptibility in the Risk Data Hub



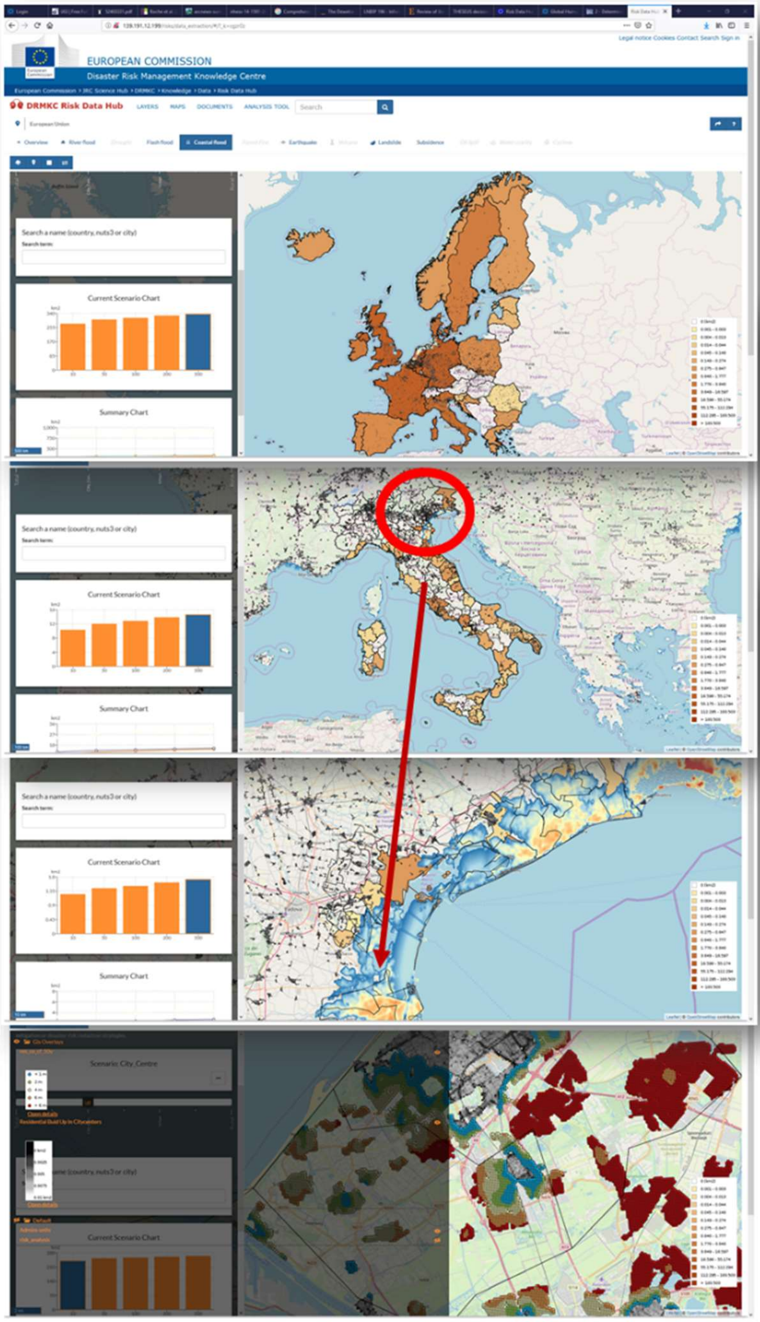
Source: Risk Data Hub

4.1.2.3.3 Storm surge

Storm surge (or coastal flooding) is generally defined as the sea water level that can exceed the height of natural (e.g., dunes, cliffs) or anthropic barriers (e.g., sea walls, dykes) (Vousdoukas, et al., 2016) producing catastrophic consequences in the coastal zones.

The inundations impact on coastal zones has been considered either by quantifying the flooded area (Hinkel et al., 2014; Losada et al., 2013; Weisse et al., 2014) or by estimating the people affected as a direct or indirect proxy of coastal impacts (Brown et al., 2013; Hinkel et al., 2010; Lloyd et al., 2015). When combined with socioeconomic exposure maps the coastal inundation estimation offers information with major implications for coastal management and adaptation.

Figure 15 Across scale analysis of the impact from storm surge in the Risk Data Hub



Source: Risk Data Hub

As to present the Risk Data Hub, hosts estimated storm surge data (fig. 5) for different return period T=(10, 50, 100, 200, 500) developed by Vousdoukas, et al., 2016 in order to provide measureable and geographically defined areas with damage potential from coastal flooding. The estimated inundation map represents the extreme total water level (TWL), and it is the result of the contributions from the mean sea level (MSL), the tide and the combined effect of waves and storm surge.

Mapping the exposure from Storm surge (coastal inundation) has been prepared considering either the EXTENT of the inundation maps or the WATER LEVELS. The water levels considered are: < 1m, <2m, <4m, <6m and < Maximum height level. The analysis is done using the coastal flood inundation maps (100m resolution) for the entire European domain, considering Baseline climatology and RCP 4.5, RCP 8.5 for the above mentioned return periods. As presented in Fig. 15 with this approach we assess regions hazardousness at comparable scale and for different RP and climate change scenarios and approximate locations with potential hazards impact.

4.1.2.3.4 Earthquake

For the Risk Data Hub we identify the areal extend (Fig 16) of the seismic hazard using the European probabilistic seismic hazard data produced in the context of the SHARE project (Woessner et al. 2015). More specifically we use the exceedance probabilities of peak ground acceleration (PGA) for a corresponding to 10 % exceedance probability in 50 years (i.e. equivalent to an average recurrence of such ground motions every 475 years).

In order to provide a measureable and geographically defined potential impact from seismic hazard, we delineate in our study, areas from high intensity distribution with damage potential. The potential damage zones considered are: "Light" potential damage zones = Intensity scale VI, "Moderate" potential damage zones = Intensity scale VII and "High" potential damage zones = Intensity scale VIII. We established these areas from an analogue approach that relates the physical ground motion parameters (such as PGA) with actual levels of damage derived from Instrumental Intensity scale developed by United States Geological Survey (USGS) (Worden, C. B., et. al., 2016). The relation established among the intensity classes considered are shown in table 1 (highlighted in grey):

Table 2. Instrumental Intensity scale developed by United States Geological Survey (USGS)

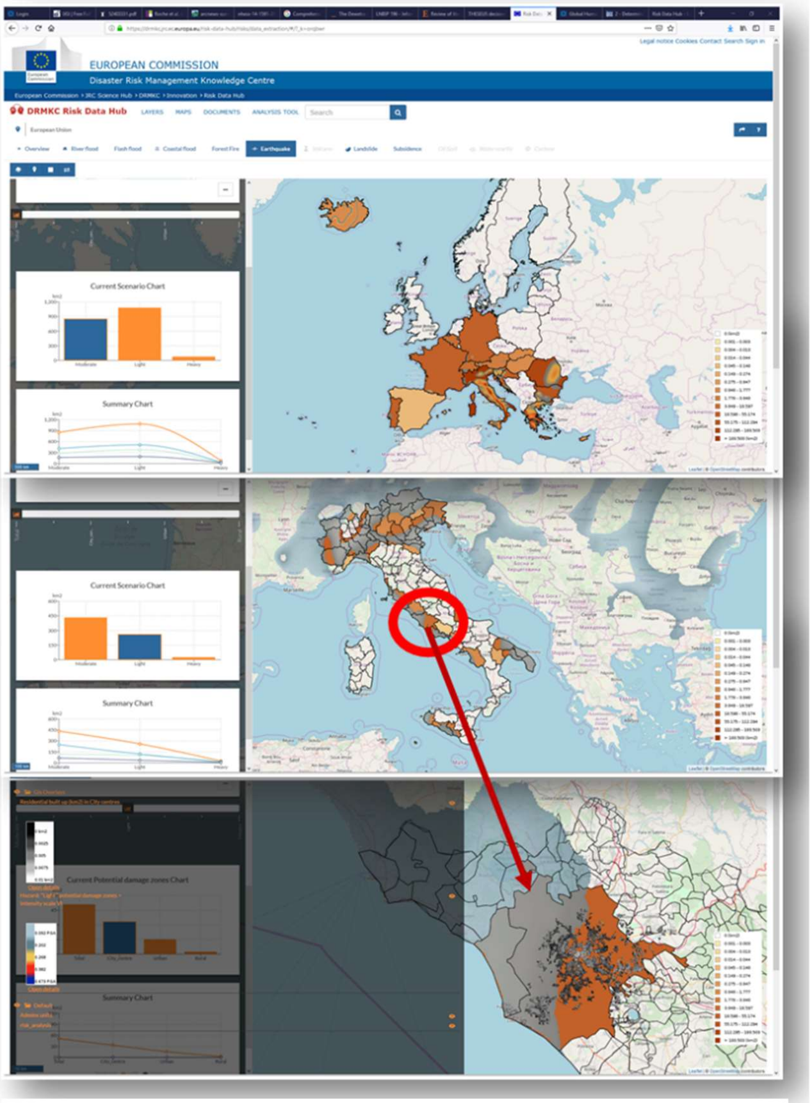
Instrumental Intensity	Acceleration (g)	Perceived shaking	Potential damage
I	< 0.0017	Not felt	None
II–III	0.0017 – 0.014	Weak	None
IV	0.014 – 0.039	Light	None
V	0.039 – 0.092	Moderate	Very light
VI	0.092 – 0.18	Strong	Light
VII	0.18 – 0.34	Very strong	Moderate
VIII	0.34 – 0.65	Severe	Moderate to heavy
IX	0.65 – 1.24	Violent	Heavy
X+	> 1.24	Extreme	Very heavy

Source: USGS

We have assessed the build-up and population potential impact, and its spatial variation using the geographical scale of the analysis and the magnitude of the aggregation method as a proxy. Seismic hazard has a different geography of exposure, it is not necessarily hazard related. We acknowledge the fact that within seismic hazardous areas, there are other characteristics, not only the geographical location that will have a significant impact on whether or not exposed elements are likely to experience harm. In this context, most important are the attributes of exposure (frame structure, material used, building codes, year of construction, economic values etc.). Nevertheless, by delineating the potential damage zones we assumed that it achieves the scope for general assessment. The potential impact and its spatial variability is depicted from the sum of residential and population among the statistical areas (administrative levels LAU and NUTS) situated in the areas prone to seismic hazard.

In order to account for the exposure not only as a coincidence of the geographical location of hazard and assets, a greater level of information that includes attributes of the assets is needed. For the seismic hazard the exposure assessment is explicitly linked with the attributes/metrics of assets (build up space, land use, infrastructure, demography, environment etc.). This information is often available only at local scale, part of cadastral plans, critical infrastructure engineering, census, etc., and administrated by different institutions at national level making difficult to be accessed. Therefore, within the development of the Risk Data Hub we anticipate the integration of a centralized exposure datasets at pan European level. We foresee this development with the integration of the Open Street Map vector layers.

Figure 16 Across scale analysis of the exposure from earthquake in the Risk Data Hub



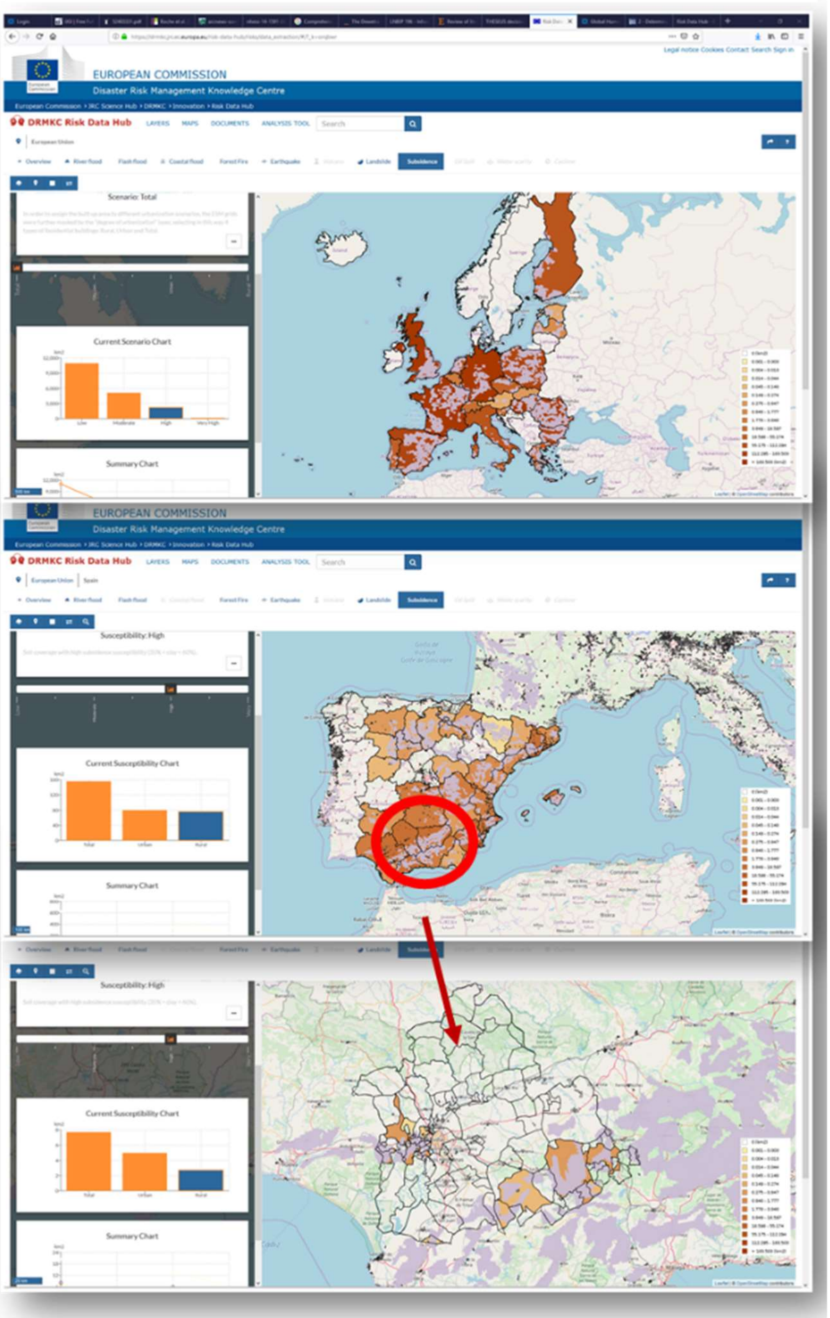
Source: Risk Data Hub 2018

4.1.2.3.5 Subsidence

We consider subsidence as a clay-related geo-hazard capable of causing harm to both life and the built environment. It is a result of soils shrinking and swelling according to wetting and drying conditions respectively (Corti et al. 2011) which causes vertical and horizontal ground movement (due to volumetric changes in soil mass) causing significant damage to buildings and infrastructure (Pritchard, et. al., 2015). Ground movement, incorporating clay-related subsidence, is a recognised geo-hazard being studied by Corti et al., (2011) in France, Sudjianto, et al. (2011), Steinberg, (2008) in the United States, and Pritchard, et. al. (2015) in Great Britain (GB). It is also the base information for the National Observatory for Natural Hazards (ONRN) in France for the evaluation and review of asset exposure and loss records at different scales, from municipal to national level.

Within the Risk Data Hub (Fig 17) we aimed to provide a measureable and geographically defined potential impact areas from clay-related subsidence. Our approach does not quantify the shrink–swell behaviour of a soil by modelling meteorological, soil hydrology or soil mechanics data. Instead, we indicate the potential for such a hazard to be present, with regard to the amount of clay content of the soils on which the high activity and plasticity index of the soils is based on. The subsidence susceptibility is given by the clay (<0.002mm) proportions of the soils texture. We define subsidence as a clay-related geo-hazard capable of causing harm to build environment and life as consequence, which is a result of soils shrinking and swelling according to wetting and drying conditions. We used Dominant surface textural class of the Soil Typological Units (STUs) from the European Soil Data Centre (ESDAC) ([Panagos, et.al, 2011](#)), for the entire Europe, at 1000 m resolution in order to assess the subsidence susceptibility for different classes: very high (clay > 60 %), high (35% < clay < 60%), medium (18% < clay < 35% and >= 15% sand, or 18% < clay and 15% < sand < 65%) and low (18% < clay and > 65% sand).

Figure 17 Across scale analysis of the exposure from subsidence in the Risk Data Hub



Source: Risk Data Hub 2018

4.1.2.3.6 Forest (Wild) Fire (under development)

Forest Fire has been treated within the Risk Data Hub considering Wildland–Urban Interface area (WUI) (FAO, 2002), as areas where wildfires are most likely to threaten assets and population and present fire danger conditions.

Identification of WUI areas that are more likely to be affected by fires is essential for fire management. Researchers and policymakers have requested for a better accountability of impact potential from fire hazard especially within the WUI areas communities (Lee, et al., 1991; Jakes, et al., 2007). Accordingly, population (Gaither, et. al. 2015; Ojerio et. al., 2011; WFEC, 2014) or artificial areas (Atkinson, et al., 2012; Chuvieco et al., 2010; Keane, et. al., 2010; Stockmann, et. al., 2010) has been largely used for characterising potential exposure or sensitivity to forest fire within the WUI community. Conducted at relevant spatial scales, fire hazard potential in the WUI area can provide important information about the potential magnitude and extent of impact.

A threefold steps approach were set in our study for characterising potential exposure and sensitivity to forest fire. First, we identified the WUI areas at European level, than we delimited the WUI area with potential fire activity and lastly we quantified the residential built-up area and population exposed to fire within the identified WUI area.

The WUI areas are mapped according to the methodology described by Modugno., S. et. al, 2016: as the space where artificial surface (urban area) and forest fuel mass come into contact. These two surfaces were created as the selection from level 1 and 3 land cover classes from CLC 2006 shown in table 1.

Table 3. CLC 2006 nomenclature used to select classes that represent the residential areas and fuel areas

Residential areas	Code	Fuel areas	Code
Continuous urban fabric	1.11	Broad-leaved forest	3.11
		Coniferous forest	3.12
Discontinuous urban fabric	1.12	Mixed forest	3.13
		Sclerophyllous vegetation	3.23
		Transitional woodland-shrub	3.24

In order to account for the area exposed to fire we have assigned maximum buffer distances (according with the Mediterranean Countries forest fire management plans) around the considered fuel (400m) and artificial surfaces (200m). In order to identify the potential of fire activity we further established a spatial relationship of WUI areas with historical events (burned areas). The historical events of burned areas used cover 2006-2017 time period and were accessed from the Joint Research Centre European (San-Miguel-Ayanz et al., 2013), supplied by the Forest Fires Information system (EFFIS, 2014). A Euclidean distance of 10 km was applied and considered as independent explanatory variable for the potential fire activity. By applying this distance range, we have selected the WUI areas with high potential of fire activity at European level.

4.2 The Vulnerability Assessment module (under development)

The Risk Data Hub foresees the inclusion of a vulnerability assessment module. We anticipate that the vulnerability assessment module will offer a collection of layers that will either present vulnerability as hazard related or associated with quantitative or qualitative aspects or factors within a system (social, economic, environment). Anticipated methodological approaches are presented below in subchapter 4.2.1.

4.2.1 Methodological aspects

When referring to the multi-dimensional characteristic of the vulnerability, generally five components (or dimensions) need to be investigated in vulnerability assessment (Vogel, C., et al. 2014):

- Physical/functional dimension (relates to the predisposition of a structure, infrastructure or service to be damaged due to the occurrence a hazard);

- Economic dimension (relates to the economic stability of a region endangered due to the occurrence of a hazard);

- Social dimension (relates with the presence of human beings, individuals or communities, and their capacities to cope with, resist and recover from impacts of hazards);

- Environmental dimension (refers to the interrelation between different ecosystems and their ability to cope with and recover from impacts of hazards);

- Political/institutional dimension (refers to those political or institutional actions that determine differential coping capacities and exposure to hazards and associated impacts).

In order to find a common ground regarding the assessment methods within the Risk Data Hub we will be concentrated on what is exposed and sensitive to change and namely methods used for measuring systems and physical vulnerability.

4.2.1.1 System vulnerability assessment.

The systems vulnerability assessment focusses on determining the indicators of societies' coping capacities to any natural hazard and identifying the vulnerable groups or individuals, economic and environmental sectors based on indicators (Ciurean et al., 2013).

One significant manner in expressing the system's vulnerability is attributed to indicator based methods. These indicators assess the vulnerability of a characteristic or quality of a system to an impact of a pressure event linked with a hazard of natural origin (composite indicator of human wellbeing, gender, age, disparity and poverty etc.). More on this methodology can be found in Birkmann, 2006.

4.2.1.2 Physical vulnerability assessment

In physical vulnerability assessment, the role of hazard and their impacts is emphasized, while the human systems in mediating the outcomes are minimized (Ciurean, et al. 2013).

Physical vulnerability for different types of hazards (landslides, floods, earthquakes etc.) can be expressed as (Kappes, M.,2012):

- Vulnerability curves (relative for percentage, absolute curve for amount of damage) constructed on the relation between hazard intensities and damage data;

- Fragility curves, provide the probability for a particular group of element at risk to be in

- Damage matrices describe the relationship between hazards' parameters and the relative damage or damage factor of the element at risk.

4.3 The Historical Events module

The systematic collection of disaster related data has rapidly become a crucial concern, loss data accounting is now in demand at all levels from national, to European and international. EU Member States and associated countries are called, in the frame of the Decision No.1313/2013/EU of the European Parliament and of the Council on a Union Civil Protection Mechanism (UCPM), to prepare regular National Risk Assessments (NRA). The preparation of evidence-based NRA requires a sound collection of disasters damage and loss data for a wide range of events of different nature.

Records of damage and losses occurred due to past disastrous events are not always available. Rarely countries have procedures and databases to collect and store post-event damage data; in many countries there are no organizations in charge of collecting data and open global datasets have different quality and structure for loss and damage data (Petrucci at al., 2018). Nevertheless the goal of loss and damage is best addressed at national and subnational level by the governmental departments or institutions addressing crisis management.

However, there is no authoritative loss database that can provide a trend at European level (De Groeve, 2015). At European level the loss and damage data are available through global multi-hazards databases such as NatCat SERVICE (Munich Re), Sigma (Swiss Re) and EM-DAT (Centre for Research on the Epidemiology of Disasters) (Wirtz, K., et al., 2014). The Risk Data Hub proposes to become the reference point for data collection, developing a centralised pan European platform for collection of loss and damages data.

Through the Historical Events module the Risk Data Hub offers an overview of currently available collection of extreme events and related losses and damages. This module makes use of inventoried data which eventually is spatially represented as maps of impacted areas or further structured into types of analysis (e.g. Sendai targets or EU Solidarity Funds).

An important focus within the Risk Data Hub is to gather a collection of records of real amount of loss and damage. As decision making is based on "robust statistics" and records on loss and damage data are not always available, various sources of "modelled" impacts is used in parallel to compare or fill in the gaps in real data. Most of the sources considered in this aspect are scientific partners of DRMKC: European Forest Fire Information System (EFFIS), EFAS (European Flood Awareness System), Emergency Management Service Rapid Mapping (EMS Copernicus), European Drought Observatory (EDO) etc.

Having a European-wide coverage and with a reduced access to national records, the identified sources for information are various: online media (e.g. Europe Media Monitor), online encyclopaedia (Wikipedia), existing multi-hazards databases (e.g. Munich Re, Swiss Re, EM-DAT, GLC), EU services (e.g. EMS Copernicus, ERCC), EU financed projects (e.g. Share) or academic research. A more detailed presentation of these sources is presented in the subchapter 4.3.2.1.

These sources serve for different purpose: some identify the event, others offer records about the event's losses and damages while others provide the location and the extension of the disastrous event. The Risk Data Hub provides a good methodological example in bringing together all these information. It could be essential not only for the understanding the impacts mechanism but also it could be fundamental for disaster risk management. Post-event damage and loss data have an intrinsic key role in all the phases of the DRM.

4.3.1 Methodological aspects

The methodology can be essentially described as a process starting firstly with gathering hazard-related information on occurred impacts from events using several global and European datasets, secondly with mapping the obtained records by using GIS techniques. Like so, available records on the impacts associated with the events have been collected from several sources and merged in a unique European multi-hazard wide catalogue.

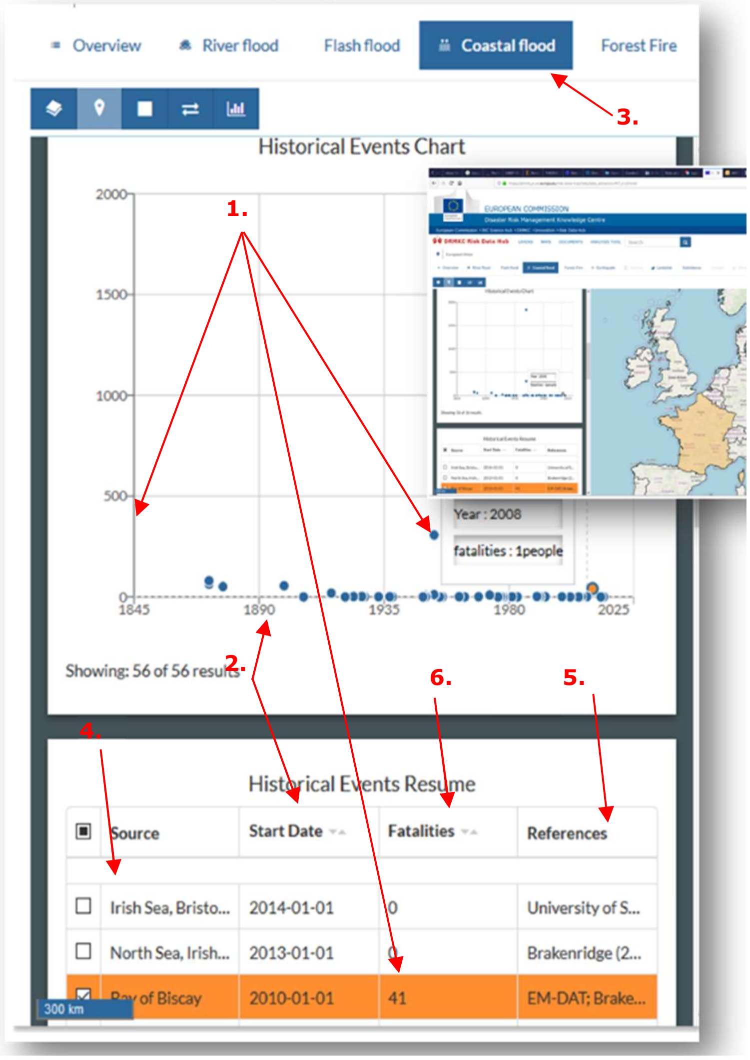
Being a WebGis, the Risk Data Hub approach on loss and damage data includes recording data from past event (historical events) and offering a spatial representation of the event's impact area. The approach is a characteristic of the Risk Data Hub which is a decision support system that integrates spatial data along with statistical analysis. The statistical records are further structured to integrate the Sendai Targets for DRR and also to provide valuable information to authorities interested in accessing financial aid (e.g. Solidarity Fund) in post-event. The methodology used to connect spatial and statistical data and the practical use of the result from single input is presented as follow.

4.3.1.1 Presenting impact records

Within the Risk Data Hub an historical event is defined by a temporal and spatial extension, magnitude of impact, hazard type, source of impact, damage type and reference of the event (source and original ID) as in Fig. 18.

The records of the events are divided considering the type of the damage. Currently the types of damages are: affected area, economic losses, population (with subtype people affected and fatalities). They follow the compound Sendai targets structure and are direct losses. When available the structure reflects the subtype of the Sendai Targets.

Figure 18 Historical events represented by: 1.Magnitude of damage; 2.Temporal extent; 3. Hazard type; 4. Impact source; 5. References; 6. Damage type.



Source: Risk Data Hub 2018

River flood, flash flood and storm surge (coastal flood), loss and damage records come from various sources and are a part of the same dataset: Hanze dataset (Paprotny,D., et al., 2018). As main rule at least one of the four damage types (area flooded, persons killed, person affected and economic losses) considered for this dataset had to be available (Paprotny,D., et al., 2018) for the event to be registered. Not all events have all 4 records, therefore RDH uses a graphical description along with a table for a more complete characterisation of the event. The data source for the flood, flash flood and coastal flood is presented in the subchapter 4.3.2.

The same structure is applied for other historical events types (earthquake, landslides and forest fire) as shown in Fig. 18. As a particularity for the forest (wild) fires the datasets on past events and associated records come from spatial data inventories on burned areas provided by EFFIS. Different from floods the burned areas are not linked with real, inventoried records on damage type as economic losses, or people affected and fatalities. They only present the amount of burned area. For the forest fire records we use the aid of fire news from the European media (EMM)[21] which is foreseen to be systematically collected. As these records are most of the time seasonal or linked with climatology (heat waves, drought) the inventory of burned areas is

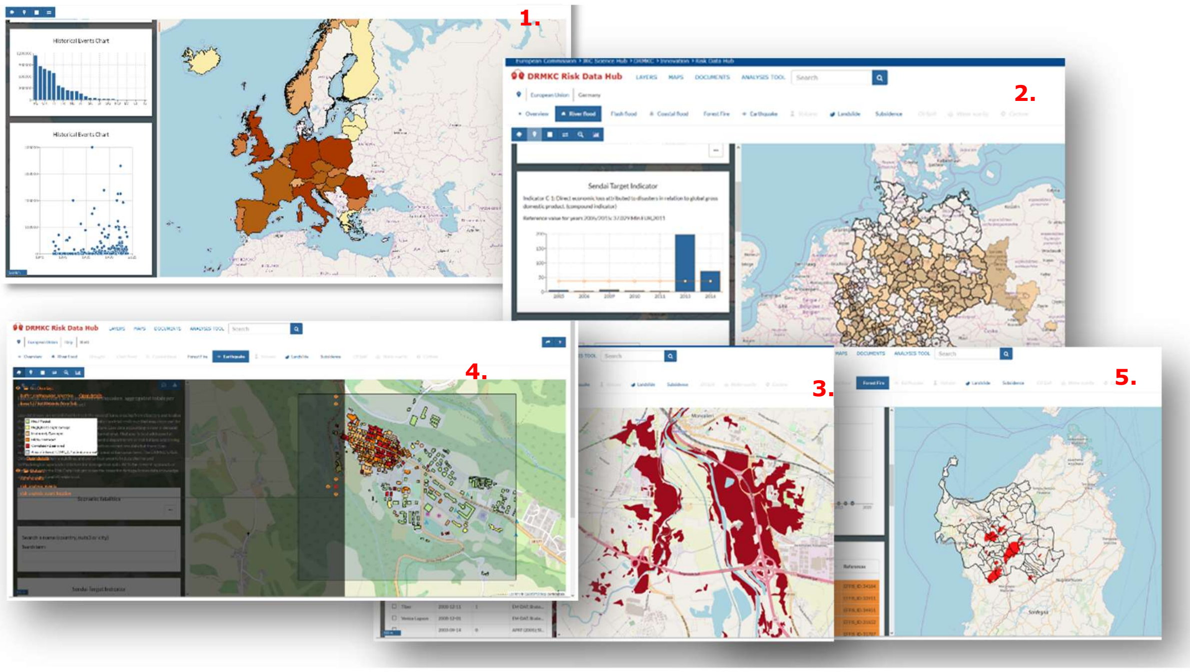
[21] http://emm.newsbrief.eu/NewsBrief/clusteredition/en/latest.html

aggregated according to the season or time period the records refers to. A description of the outcome records and completeness of the data is presented in subchapter 4.3.2.

4.3.1.2 Identification of the impact areas

Impact areas refers to the spatial data associated with the impact events. Hosting a multi-hazard database, an alignment of methodological approaches is required when mapping the impact areas. As in the case of exposure this is done by aggregating values up to administrative unit level. In the case of loss data the impacts from hazardous events are aggregated at the level of NUTS3 and country level. When a finer level of detail is available (e.g. burned areas for forest fire) the impact records information is linked at the area of extension of the hazardous event. Currently the Risk Data Hub host impact areas for earthquakes, forest areas and floods (Fig. 19).

Figure 19 Impact areas: 1. Country aggregation, 2. Impact area as administrative units 3. Flood spatial extension, 4. Seismic impact on buildings, 5. Burned areas.



Source: Risk Data Hub 2018

For floods (river, flash and coastal floods) the impact records are aggregated within the Hanze dataset at the level of NUTS3. For the Risk Data Hub this information is further linked to the finer level of spatial extension using various sources. Most common is the Copernicus Rapid Mapping Service and for future developing we assess the use of other sources as the MODIS Water Vectors and Maps from Dartmouth Flood Observatory.

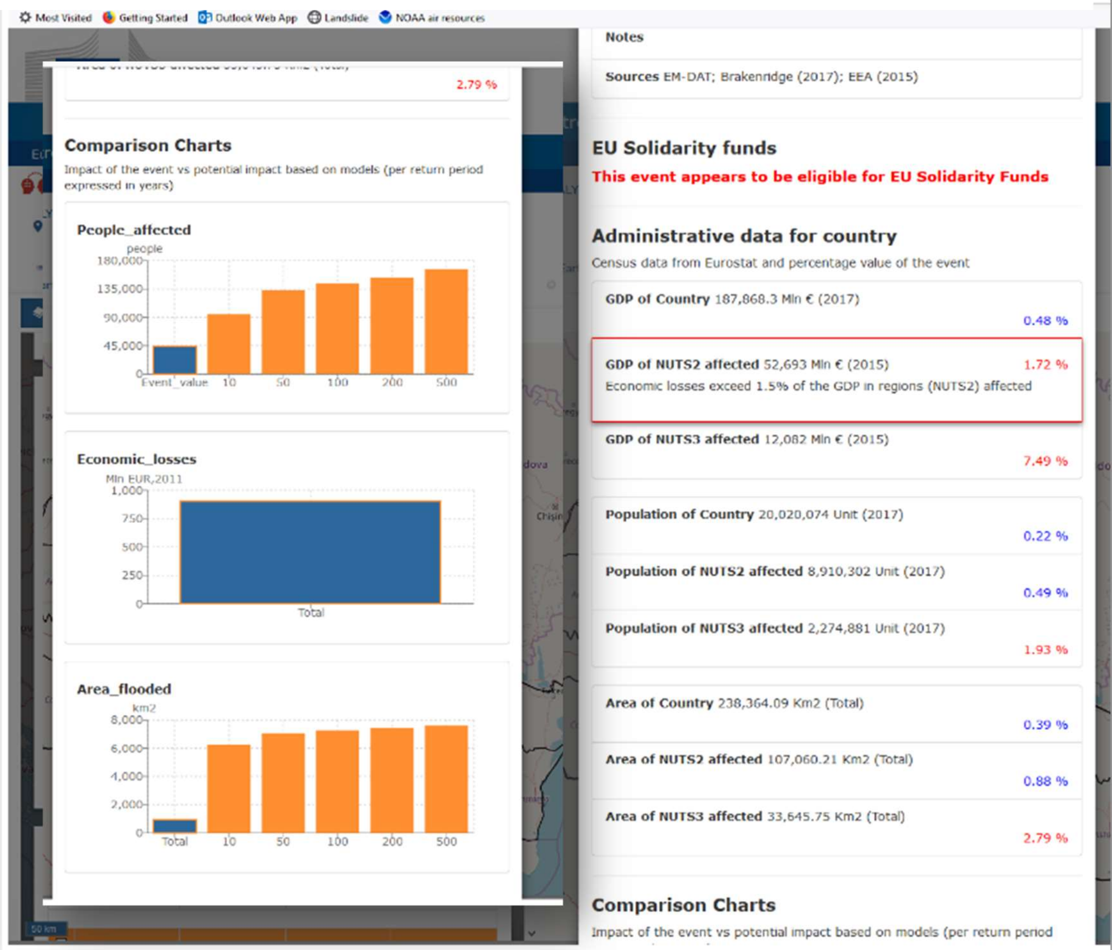
As in the case of floods the seismic impacts at finer resolution (affected buildings, infrastructure networks) are provided by the Copernicus Rapid Mapping Service. Moreover, the seismic data is represented, as extra information, on map portal also as point data denoting the epicentre and aftershocks.

For forest fire the area of the burned scars is represent as detected from MODIS satellite imagery. No distinction is made between wildland fires, environmental burnings or prescribed fires. More information on the methodology of inventorying the burned areas can be found on http://effis.jrc.ec.europa.eu.

4.3.1.3 Analysis for the European Union Solidarity funds request

This post-event analysis uses recorded data into a type of analysis that is supporting national authorities to report and eventually request monetary aid. There is no standard methodology to assess the magnitudes of impacts that leads to requesting financial support. As a minimum requirement Directorate General for Regional Policy (DG REGIO) established a set of reference thresholds for major and regional disasters. Within the Risk Data Hub we provide a first assessment based on indicating these thresholds for the considered events. We compare the recorded impacts - at NUTS2 and country level - either against census data (using Eurostat as source) or against assessment of impact. Based on the availability of impact records the comparison is done for: affected people, fatalities, area affected and economical damages (Fig. 20). We provide more data sources for further analysis and we indicate the events that overpassed the referenced thresholds. Apart the census data from Eurostat, the impacts are also related to damage assessment models. As example the Rapid Damage Assessment (RDA) module of EFFIS, Copernicus emergency rapid mapping service (EMS) or the Risk Data Hub exposure data could support the reporting of damages. Apart statistical analysis, spatial data such as areal extent of the event and assets affected could be systematically linked with the

Figure 20 Supporting the Solidarity Funds requests through analysis of the impacts events (left – against modelled data, right – against census data)



Source: Risk Data Hub 2018

event for extra information. The support provided by the Risk Data Hub could speed up the application and assessment process of the request making it usable both for national authorities and policy directorate. Also it could provide an extra measure of transparency and equity for damage monetary coverage.

Please see https://ec.europa.eu/regional_policy/EN/funding/solidarity-fund/#1 for more information on the EUSF.

4.3.1.4 Analysis for Sendai Reporting

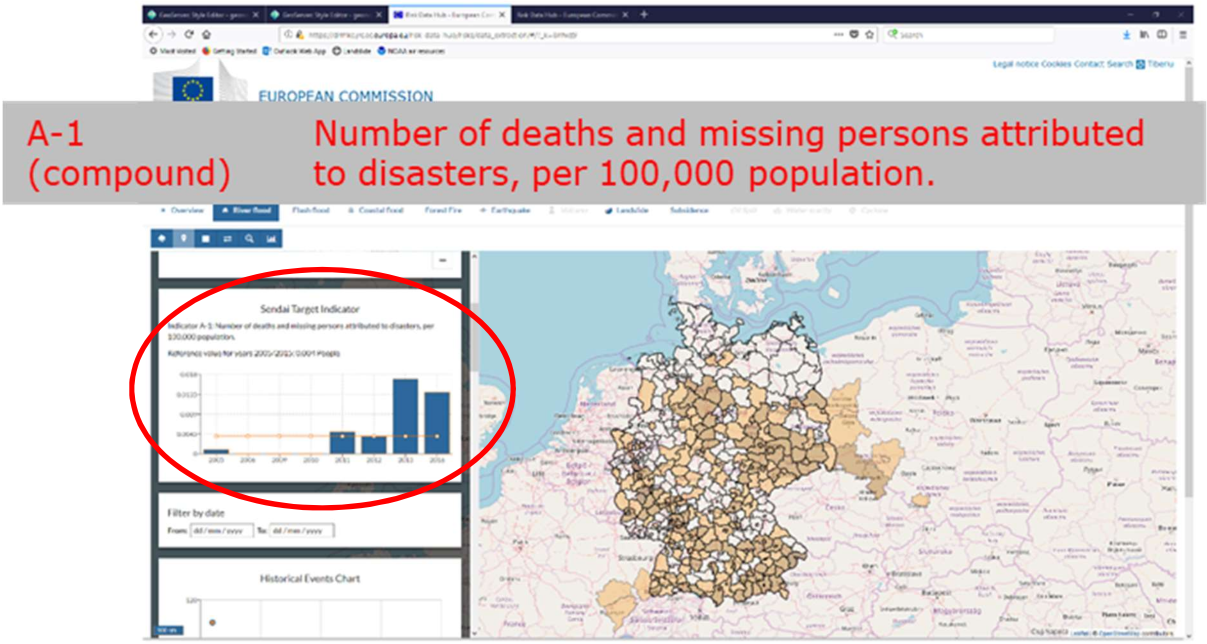
The purpose of this analysis is to support local/national authorities to finalize and implement the reporting of Sendai indicators. In order to achieve this purpose the collected data on loss and damages had to be structured accordingly on RDH. Currently 3 indicators are already integrated (Fig. 21):

- A-1 (Number of deaths and missing persons attributed to disasters, per 100,000 population)

- B-1 (Number of directly affected people attributed to disasters, per 100,000 population)

- C-1 (Direct economic loss attributed to disasters in relation to global gross domestic

Figure 21 Example of Sendai indicator integration and analysis



Source: Risk Data Hub 2018

product (compound indicator)

Eventually the indicators are used to monitor the progress and achievements against the global Targets of Sendai Framework for DRR. For further details please consult the technical guidelines found here: https://www.unisdr.org/we/inform/publications/54970.

The limitation in the extent of indicators implemented on RDH up to date, lays in the availability of the records from existing sources. Datasets with more detailed records have been the object of several initiatives and they are mostly considering fatalities by gender, age and circumstances and refer mostly to floods and landslides. A comprehensive overview on the datasets produced is provided by Salvati et al., 2018. Existing practices of regional or local loss and damage datasets could be found here: Pereira et al., 2016 (DISASTER dataset), Petrucci et al., 2018 (MEFF datasets) Napolitano et al., 2017 (LAND-deFeND), San-Martin et al., 2018 (DamaGIS). At national level existing databases are: HOWAS21 database (Kreibich et al., 2017) in Germany, Swiss Flood and Landslide Damage Database (Kron et al., 2012) in Switzerland and FloodCat database (Molinari et al., 2013) in Italy. Based on these existing practices the Risk Data Hub will develop its applications in order to include a comprehensive extent of Sendai indicators and their analysis.

4.3.2 Data

The analysis of loss and damage data requires data that are not always available as part of a single database. As it is the case of the Risk Data Hub, the loss and damage database is a collection of sources that become complementary. These sources focused on different aspects of the impact events but our purpose was to define the event, gather data on loss and damage records and present the spatial extent of the damages.

As expected the resulting database presents constrains. The data collected is not an amount of official national datasets. This may be considered a pitfall when presenting the dataset as a "reference dataset" at pan European level. Partially this aspect can be discharged as currently the Risk Data Hub loss and damage datasets is a collection of existing practises used and recognised at scientific and policy level. The Risk Data Hub is not playing the role of reporting platform for Sendai indicators or presenting standard methodological approach for EUSFR. Instead it supports local authorities to implement policies using methodologies and offering access to existing practices and solution that can be adopted at local level. Being the result of partnerships which includes also local authorities (e.g. Support Services offered to local authorities through DRMKC), the Risk Data Hub becomes a collaborative development considering the needs and realities expressed at local level. When these needs are expressed the policy formulation becomes evidence based, an accomplishment that DRM frameworks are asking for.

4.3.2.1 Data sources

The sources of information consulted to be integrated on the Risk Data Hub are listed below:

- **Hanze**, known as 'Historical Analysis of Natural Hazards in Europe' is a database of the Delft University of Technology which provides a compilation of past damaging floods for 37 European countries. Information on date, location, extent and economic losses of past damaging floods from 1870 to 2016 is provided.

- The **Dartmouth Flood Observatory** (DFO) at the University of Dartmouth in USA is a global data depository for spatially referenced floods, which covers the period from 1985 to the present. It provides information on the date and location of the occurrence of the event, number of fatalities and displaced.

- The ***SHARE*** European Earthquake Catalogue (SHEEC) is a set of seismic events occurred in Europe, with the exception of Greece and surrounding areas, from 1900 to 2006. Mainly the information contained in the catalogue regards: date, time, magnitude, latitude and longitude.

- The Greek seismological catalogue of the **University of Athens** was consulted, basically hazard related information was retrieved.

- The Significant Earthquake Database of the National Geophysical Data Center (NOAA) contains information on destructive earthquakes around the globe. Information concerning past events and their impact were collected in order to populate the RDH Historical Event Catalogue.

- Information concerning the date, location and geographical extent of forest fires was provided by the **European Forest Fire Information System** (EFFIS). The time coverage of the forest fires ranges from 2000-onwards. Moreover, information on fatalities and injured was retrieved from annual reports of EFFIS, though the information is given for fire-season and not per event.

- The **Global Landslide Catalog** (GLC) accessible from the NASA's open data portal contains information on mass movements triggered by rainfall around the world. Number of injured and fatalities and qualitative description of the event are the details collected from the open dataset.

- The **Emergency Events Database** (EM-DAT) of the Centre of Research on Epidemiology of Disasters in Brussels and United States Office for Foreign Disaster

Assistance, one of the main public global databases for natural disasters has been consulted. Information on significant indicators such as casualties, people affected and economic losses, from 1900 onwards was collected.

- **Copernicus Emergency Management Service** (Copernicus EMS) provides information for emergency response in relation to different types of disasters. Satellite imagery is the main data source; the produced maps from the list of activations of rapid mapping were connected to the RDH Historical Event records.

- The free online encyclopaedia **Wikipedia** was also used as a source of information to delineate the impact of past events especially quantitative information such as fatalities, injured and economic losses was collected.

- The **Emergency Response Coordination Centre** (ERCC) Daily Maps service of the European Commission has been consulted. The ERCC publishes maps, available to the public, regarding the most important events which contain summarizing information regarding the impact and the extension of events.

- **FloodList**, founded by Copernicus, which brings news and information on floods, occurred worldwide, is another source consulted.

- **Europe Media Monitor** (EMM) natural hazards dataset is a source of information considered for RDH Historical Event Catalogue. Data from this source are not yet implemented; however in the near-future EMM data will be included in the catalogue.

The damage and loss sources of information have been combined order to form a complete catalogue of historical impacts from disastrous events.

4.3.2.2 RDH Historical Event Catalogue

As a result of collecting data, a catalogue corresponding to the four hazards considered has been created. The RDH Historical Event Catalogue presents a total of 18951 records, stored in tabular and/or geospatial format. More information on the way the data are structured in the data base and methodologies regarding definition of the events can be consulted on the dedicated Technical report by Rios Diaz et.al, 2018.

Upon availability the impact events, corresponding to different hazards, present various records types and completeness level. As follow characteristics of the loss and damage datasets are presented structured by the type of event. It is not a presentation of the architecture of the database considering logical connections and structures as this is the scope of a different report. Instead we make a characterisation of the hazardous events considering the amount of events, records considered, time period coverage and the attributes of the events (presented as part of the Annexes). The amount of records is presented in the tables 4 and 5.

4.3.2.2.1 Floods

The module containing the Flood's records covers a period from 1870 to 2018. It is composed from three hazards subtypes with various amounts of inputs:

- River floods: 818 events
- Flash floods: 879 events
- Storm surge (coastal floods): 56 events

The impact types considered in the Floods module are: people fatalities, people affected, flooded area and economic losses (mln. euro in 2011 prices).

4.3.2.2.2 Earthquakes

The Earthquake records contains a total of 211 events occurred in in the period from 1901 –2018. Each event is characterized by the magnitude, time of occurrence, and epicentre location as latitude/longitude. The impact types considered fatalities, injured, affected and economic losses (mln euro in 2011 prices) is presented.

4.3.2.2.3 Landslides

The Landslide records cover the period 1993-2018 for a total of 580 events across Europe. Each event is qualitatively described in terms of spatial extent and information about injured and fatalities is reported.

4.3.2.2.4 Forest (wild) fires

The Wildfire records cover the period 2000-2018. The catalogue includes a total of 16407 burned areas across European countries. Matching records on various impacts with the burned areas was prepared considering aggregation to the season or time periods of climatological events such as drought or heatwaves. In this way records on fatalities and injured people per fire-seasons and total area burned were retrieved.

Table 4 Total sum of fatalities, injured and affected people per hazard type

HAZARD		Time Coverage	#EVENTS	#FATALITIES	#INJURED	#AFFECTED
FLOODS	RIVER FLOODS	1870-2018	818	5769	-	6037963
	FLASH FLOODS		879	10510	-	1118692
	COASTAL FLOODS		56	2225	-	352471
EARTHQUAKES		1901-2018	211	125399	54428	2526894
WILDFIRES		2000-2018	-	653	3187	-
LANDSLIDES		1993-2018	580	231	103	-

Table 5 Total sum of economic losses and affected area per hazard type

HAZARD		Time Coverage	#EVENTS	ECONOMIC LOSSES (Mln EUR 2011)	AFFECTED AREA (km^2)
FLOODS	RIVER FLOODS	1871-2018	818	144953	116513
	FLASH FLOODS		879	69371	2904
	COASTAL FLOODS		56	13483	3791
EARTHQUAKES		1901-2018	211	170915	-
WILDFIRES		2000-2018	-	-	56858
LANDSLIDES		1993-2018	580	-	-

The different sources of information analysed during the RDH Historical Event Catalogue compilation, reported different formats of the economic losses.

As a result of the compilation, information regarding economic losses occurred due to floods and earthquake was collected. Main sources of information were:

- HANZE
- EM-DAT
- WIKIPEDIA

HANZE database contains economic losses both in the original currency of the time of the event and in Euro in 2011 prices. Though, in EM-DAT, the value of estimated damage in monetary terms is given in Dollars (US $). For each disaster the amount of damage corresponds to the damage value at the moment of the event. Finally Wikipedia either reports the damage in dollars or in Euro.

Therefore in order to make a homogeneous and standardized collection the damage data in monetary terms needed to be converted. The conversion has been conducted following the same approach of the HANZE database.

The HANZE database consists in a comprehensive set of data and information, as matter of fact it provides a set of currency information, GDP data and deflator indexes for the area and time coverage considered in the study establishing the 2011 as the reference year. Thereafter, in order to make all the records homogeneous and comparable, the HANZE methodology has been adopted for economic losses deriving from other sources.

However, as aforementioned in EM-DAT and Wikipedia the estimated damage in monetary terms is given in dollars (US $) but HANZE does not provide a methodology for the exchange rates. Therefore, conversions have been carried out through a methodology accessible from the Portal for Historical Statistics of Stockholm University (Historical currency converter edited by Rodney Edvinsson).

Essentially, the economic losses measured in dollars at the time of the event have been converted in the currency of the country at the time of the event. After that, the currencies have been converted and normalized in Euro- 2011 prices- using the conversions factors between new and old currencies and the deflator indexes of HANZE database. Historical currency converter http://www.historicalstatistics.org/ .

4.3.2.3 Data Completeness

Not every record presents a value for the damage and losses categories and often it is not specified if the value was not recorded or it was null, which would have been beneficial to know for indicators such as fatalities, injured and affected. Not having available and clear indicators makes comparisons less reliable and statistics inconsistent and highlights the need for a more systematic and comprehensive damage and loss data collection. A comparison of the events and records is presented in table 6.

Table 6 Comparison between events and total records present in the catalogue

HAZARD		Time Coverage	#EVENTS	FATALITIES	INJURED	AFFECTED	ECONOMIC LOSSES (Mln EUR 2011)	AFFECTED AREA (km^2)
FLOODS	RIVER FLOODS	1870-2018	818	505	-	358	38	122
	FLASH FLOODS		879	720	-	306	236	23
	COASTA L FLOODS		56	34	-	21	10	14
EARTHQUAKES		1901-2018	211	153	106	82	57	-
WILDFIRES		2000-2018	-	-	-	-	-	ALL
LANDSLIDES		1993-2018	580	55	30	-	-	-

4.4 The Risk Assessment as good practices module (under development)

The Risk Assessment module is still ongoing work.

The process of disaster risk assessment is divided into a number of components, such as hazard, exposure, and vulnerability/coping capacity. Within the Risk Data Hub, even if the mentioned components are considered within its own dedicated module they are not related in a methodological background to produce results for the risk assessment module. The complexity and variety of the methodological approach given by the particular spatial level that is addressed as well as the multi-dimensional application, anticipated the need to gather within the risk assessment module outcomes of good/existing practices. The diversity of research done so far will be capitalized by offering on the Risk Data Hub a place where methodologies and outcomes will have visibility and be accessible. The Risk Data Hub will benefit from outcomes of EU-funded research project developed through programmes such as Horizon 2020 and the Framework Programme for Research and Technological Development (FP7), academic research activities (e.g. universities) or other research groups. From the EU's Joint Research Centres various groups which are also collaborating centres of DRMKC have provided over the years outcomes mainly directed towards supporting policies. The European Flood Awareness System (EFAS), European Forest Fires Information System(EFIS), Global Disasters Alerts and Coordination System (GDACS), Major Accident Reporting System (eMARS), Global Informal Tsunami Monitoring System (GTIMS-2), European Reference Network for Critical Infrastructure Protection (ERNCIP) are a few of the groups with which the DRMKC established scientific partnerships.

By using this approach the Risk Data Hub is not only enlarging the scientific partnership network but also uses curated and scientific comprehensive outcomes that eventually will be put to use for managing disaster risk. It offers the opportunity to compare methodologies and outcomes that are matching equal scopes of disaster risk management. In this way an overview of the research results in disaster risk will be made and gaps in scopes will be identified.

5 Conclusions

Disaster Risk Management Knowledge Centre (DRMKC) is currently developing a GIS web-based platform in order to foster the joint development of a shared knowledge for DRM at pan European level.

The Risk Data Hub provides easy access to knowledge, supports and monitors policy implementation and creates collaborative network taking advantage of a well-placed position. It benefits from the networked approach of the DRMKC across Commission, EU Member states and DRM communities.

The Risk Data Hub capitalise on the existing knowledge, networks, tools, methods and data and support their broad dissemination. This offers means to assess the progress made and to identify gaps in scope for DRM.

The Risk Data Hub proposes a way to facilitate the link between practice and policy by creating a collaborative network for discovering already existing data, actions, and practices for DRM.

The Risk Data Hub considers in its development the common interests of climate change adaptation (CCA) and disaster risk reduction (DRR) platforms: reducing vulnerability and building resilience. This is important when decision makers are expected to switch between different views of the same topic, such as the short-term risk management of extreme events versus long-term adaptation (CCA) to extreme events in a changing climate.

It facilitates the actions that Member States need to take in order to meet risk management related obligations such as Disaster Loss Databases, National Risk Assessment and finally Risk Management Plans. The preparation of evidence-based NRA requires a sound collection of disasters damage and loss data for a wide range of events of different nature. The Risk Data Hub creates a system that improves the access and sharing of data, tools and methodologies with the intention of establishing a sound scientific approach on disaster risk assessment pre- and post-events.

The platform offers means to evaluate and indicate events that leads to requesting financial support, as the EU Solidarity Funds. The support provided by the Risk Data Hub could speed up the application and assessment process of the request making it usable both for national authorities and policy directorates. In addition, it provides an extra measure of transparency and equity for damage monetary coverage.

In order to support local/national authorities to finalize and implement the reporting of Sendai indicators, RDH provides methodological and implementation example. The collected data on loss and damages is structured following the Sendai Indictors methodology. Eventually, decision makers can consider the indicators, to monitor the progress and achievements against the global Targets of Sendai Framework for DRR.

The Risk Data Hub provides support for the assessment of the economic efficiency of DRR measures. The disaster risk mapping within the Risk Data Hub suggests the probabilistic methodological approach (enabling analysis of acceptable risk levels) while the economic impact records form post-events and assessments from pre-events supports the development of decision facilitator tools such as Cost Benefit Analysis.

The Risk Data Hub is developed as a decision support system that integrates spatial data along with statistical analysis. This helps decision makers have an indication for time and spatial coverage of the economic damages and human losses across Europe from hazardous events, upon which consistent decisions can be taken.

The Risk Data Hub is giving the decision makers access to “robust statistics”, supporting evidence based policy formulation. The Risk Data Hub gathers records of real amount of loss and damage. In addition, various sources of “modelled” impacts is used in parallel to compare or complete the recorded data, offering a base for understanding not only the impacts mechanism but also the range of uncertainty.

The Risk Data Hub is set on identifying the geographically located causal factors of disasters, linking disaster risk information to local scale to individual assets, properties, environment and people. This approach challenges the scale disagreement concerning the global scale of policy and local scale of practice and implementation.

The Risk Data Hub offers a complete insight for practitioners and policy makers dealing with disaster risk management. The geospatial information hosted on the platform is built on the relation exposure – hazard. This approach provides the spatial identification of potential areas of impact and risk drivers, creating awareness and targeting adaptation measures.

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List of figures

List of tables

Annexes

Annex 1. Information contained in RDH Historical Event Catalogue – Flood module

FLOODS	
ATTRIBUTE	DESCRIPTION
ID Code	Unique identifier code automatically generated by the system
Hazard type code	Descriptive code for each type of hazard (FL - river flood; FLSH - flash flood; CF - coastal flood)
Country code	Iso2 country code
Region code	Affected regions listed through the NUTS3 code
Year	Year of the event
Country name	Country in which the event occurred
Start date	Date on which the event started (or ended if further information are not given)
End date	Date on which the event ended
Type	Type of flood event, which can be River, Coastal or Flash. The events were implemented according to the HANZE database delineations.
Flood source	Name of the river, lake or sea from which the flood originated (qualitative and non-complete list of attributes)
Area flooded	Inundated area in km^2
Fatalities	Number of deaths due to the flood, including missing persons
Person affected	Number of people whose houses were flooded. However, according to HANZE database the reported numbers of persons affected often only show the number of evacuees or persons rendered homeless by the event. If no other number was available, those ones were used. If only the number of houses flooded was reported, the number persons affected was estimated considering 4 people in each house.
Losses (nominal value)	Economic damage in the currency and price of the time of the event
Losses (mln EUR, 2011)	Economic damage in euro adjusted by inflation indexes
Cause	Descriptive attribute containing the meteorological causes of the event
Notes	Descriptive attribute containing relevant information concerning the event (i.e. triggering factors etc.)
Sources	List of datasets, publication and other forms of sources from which the information was retrieved

Annex 2. Information contained in RDH Historical Event Catalogue – Earthquake module

EARTHQUAKES	
ATTRIBUTE	DESCRIPTION
ID Code	Unique identifier code automatically generated by the system
Hazard type code	Descriptive code of the hazard (EQ - earthquake)
Country code	Iso2 country code
Region code	Affected regions listed through the NUTS3 code
Year	Year of the event
Country name	Country in which the event occurred
Start date	Date on which the event started (or ended if further information are not given)
End date	Date on which the event ended
Epicentre	Latitude and longitude
Magnitude	Measure of the seismic energy
Time of occurrence	Exact time of the occurrence of the event
Fatalities	Number of the deaths
Injured	Number of injured people
Person affected	Number of affected people (umber of evacuees or persons rendered homeless by the event)
Losses (nominal value)	Economic damage in the currency and price of the time of the event
Losses (mln EUR, 2011)	Economic damage in euro adjusted by inflation indexes
Notes	Descriptive attribute containing relevant information concerning the event (i.e. inconsistency between sources)
Sources	List of datasets, publication and other forms of sources from which the information was retrieved

Annex 3. Information contained in RDH Historical Event Catalogue – Forest Fire module

FOREST FIRE	
ATTRIBUTE	DESCRIPTION
ID Code	Unique identifier code automatically generated by the system
Hazard type code	Descriptive code of the hazard (FF - forest fire)
Country code	Iso2 country code
Region code	Affected regions listed through the NUTS3 code
Year	Year of the event
Country name	Country in which the event occurred
Start date	Date on which the event started (or ended if further information are not given)
End date	Date on which the event ended
Area burned	Area burned by the fire given in hectares
Fatalities	Number of fatalities per fire-season
Injured	Number of injured per fire-season
Notes	Descriptive attribute containing relevant information concerning the event
Sources	List of datasets, publication and other forms of sources from which the information was retrieved

Annex 4. Information contained in RDH Historical Event Catalogue – Landslides module

LANDSLIDES	
ATTRIBUTE	DESCRIPTION
ID Code	Unique identifier code automatically generated by the system
Hazard type code	Descriptive code for each type of hazard (FL - river flood; FLSH - flash flood; CF - coastal flood)
Country code	Iso2 country code
Region code	Affected regions listed through the NUTS3 code

Year	Year of the event
Country name	Country in which the event occurred
Start date	Date on which the event started (or ended if further information are not given)
End date	Date on which the event ended
Fatalities	Number of fatalities
Injured	Number of injured
Cause	Descriptive attribute, cause of the event (i.e. rain, earthquake etc.)
Notes	Descriptive attribute containing relevant information concerning the event (i.e. qualitative description of the extension of the phenomenon)
Sources	List of datasets, publication and other forms of sources from which the information was retrieved

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