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Mapping of risk web-platforms and risk data: collection of good practices

Improving the access and share of curated EU-wide risk data for fostering DRM

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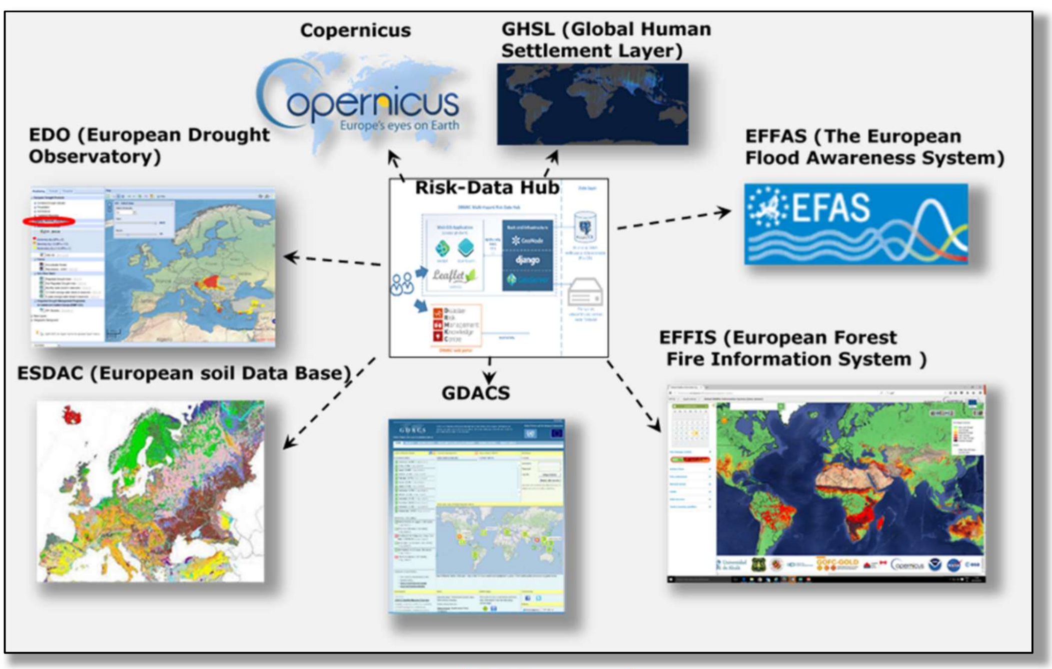

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Contents

Foreword

Successful Disaster Risk Reduction (DRR) results from the combination of top-down strategies with bottom-up methodological approaches.

The top–down approach flows from the formulation and implementation of policy through administrative directives, responsible organizations and operational practice linked with the management of the risk.

The bottom-up approach is linked to the analysis of the causal factors of disasters, including exposure to hazards, vulnerability, and coping capacity. It is more focused on practitioners. In the context of disaster science, policy and practice are often disconnected. 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 knowledge on the other.

The gap between practice and policy can be bridged using a spatial data infrastructure based on risk mapping. In this way, data can be linked to decision support systems (DSS) on common ground that becomes a "battlefield of knowledge and actions".

This report presents the results of an overview of the risk web-platforms and related risk data used in risk assessment at European level - member states of the European Union, EFTA (European Free Trade Association) and IPA (Instrument for Pre-Accession Assistance) countries. It assesses the current state of advancement of risk web-infrastructures and capabilities in order to establish a pool of good practice as well as identifying needs and gaps.

The outcome of the overview illustrates the needs in risk web-platform development and recommends capacities whose development should be prioritized in order to strengthen the link between risk data information and decision support systems (DSS).

The assessment is based on information extracted from the overview of the National Risk Assessment reports, the outcomes of diverse disaster risk workshops and conferences as well as web searches.

Abstract

This report presents the results of an overview of the risk web-platforms and related risk data used in risk assessment at assessment at European level including member states of the European Union, EFTA (European Free Trade Association) and IPA (Instrument for Pre-Accession Assistance) countries. It provides the current state of advancement for risk web infrastructures and capabilities in order to establish a pool of good practices leading to the identification of needs.

The outcome of the overview shows the need for risk web platform development and tries to recommend capacities that should be prioritized in order to strengthen the link between risk data information and decision support systems (DSS).

The assessment is based on information extracted from the overview of the National Risk Assessment reports, the outcomes of diverse disaster risk workshops and conferences as well as web searches.

1 Introduction

The main objective of this report is to have an overview of risk web-platforms and in particular on platforms with geospatial data technologies that support DRM activities through the development and sharing of information such as disaster risk mapping, data and methodologies.

The report aims to inform EU member states, developers, research institutions and DRM actors, of the presence of disaster risk platforms at national and transnational levels in Europe. It presents an opportunity to share good practices, learn from and be inspired by existing experiences.

The purpose of the report is to support the development of disaster risk web platforms across Europe and to create a knowledge base, which eventually will be used for the development of DRMKC's Risk Data Hub.

The effectiveness of disaster risk management depends greatly on the efficiency of managing relevant information. Over the past decades, technology has been developed in order to help decision-makers apply Disaster Risk Management (DRM) data and information in their policy formulation and implementation. Disaster risk web-platforms in general, and geospatial data technologies such as WebGIS in particular, have acquired an important role in DRM through sharing information and data required for decision-making. Their importance is evident when there is a need to bridge the gap between data and decision support systems (DSS). The risk-web platforms become, in this sense, platforms of exchange and sharing of geospatial data, tools and methodologies with great importance for DRM.

The need to connect and 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, recognized the critical role of geospatial technologies in disaster risk related actions in support of its Priorities 1 and 4. This recognition resulted in initiatives to use spatial information at all the stages of DRM covering all geographical scales (local, sub-national, national, regional).

This report is based on internally researched information including the overview of the National Risk Assessment reports, on expert meetings and workshops (e.g. first RiskData Hub workshop) and on various online sources published in the field of disaster risk (reports, peer reviewed articles, online web platforms).

The overview of risk web platforms will be based on a series of key elements for DRR related actions:

- the discovery of datasets relevant for disaster risk assessment
- the discovery of robust, scientifically founded methodologies with the intention of establishing a common and accepted scientific approach for disaster risk assessment.
- disaster risk mapping developed as an essential component of risk management
- the communication of disaster risk information that links hazards with exposed economic, social or environmental data.

After the brief introductory section, the report makes a short presentation of the available frameworks and policies that guided the development of risk-web applications.

The following section is dedicated to a basic overview of scientific approaches for disaster risk assessment methodologies and datasets relevant for disaster risk assessment and a listing of the web platforms built to support Disaster Risk Management (DRM).

Thereafter the report proposes a description of the conceptual model of the DataRisk Hub, and the way it could contribute to the development of a disaster management framework.

The last section of the report is dedicated to conclusions.

2 Disaster Risk Management Framework

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. The implementation of this approach is currently taking place at both international and national level.

The increasing incidence of disaster risks from hazards, demanded an improved dynamic approach on data sharing in order to increase the efficiency of risk management. Open data has become a precondition for risk understanding, identification and management and has required an Open Data Policy Development. In 2011, Global Facility for Disaster Reduction and Recovery (GFDRR) launched the Open Data for Resilience Initiative (OpenDRI) which challenges this limitation.

Decision-makers require technological support for complex forms of decision making as they face challenges in linking data information and decision support systems (DSS) without a form of spatial data infrastructure. Directive 2007/2/EC of the European Parliament, offers means to address these challenges.

In accordance with this context, the disaster risk web platforms adopted the policies and guidelines frameworks, data sharing initiatives and spatial data infrastructures with the purpose of setting the bases for knowledge for DRM at local, national, regional and EU-wide level.

2.1 Policies and guidelines

In this subsection, a brief presentation of the framework, which guided the development of the disaster risk web platforms, is presented following the global, Eu-wide and national legislative frameworks.

Global

Three global agreements enforced in the last years, provided important context for the development of services and products for DRM:

- First, the Sendai Framework for Disaster Risk Reduction (14-18 March 2015) set global targets to reduce economic and human losses from disasters by 2030.
- Second, a new focus on resilience to natural, man-made, and other hazards was incorporated into the Sustainable Development Goals (SDGs – 25 September 2015).
- Third, the UN Framework on Climate Change 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.

EU-wide

The EU has developed a legislative framework in order to address various aspects of DRM prevention, preparedness, response and recovery:

- The Floods Directive (EC, 2007a) aims at reducing and managing the risks that floods pose to human health, the environment, cultural heritage and economic activity.
- The Communication on Water Scarcity and Droughts (EC, 2007b) aims at preventing and mitigating water scarcity and drought situations
- The Green Paper on Forest Protection and Information in the EU: Preparing forests for climate change (EC, 2010), acknowledges the efforts made by the EU and Member States to address the issue of forest fire prevention.

- The Seveso II Directive on the prevention and mitigation of major industrial accidents (EC, 1996) and the correspondent amendment (EC, 2003b)

National

At a national level, one major activity has been the establishment of national strategies and national platforms for disaster risk reduction. In 2015 the Regional Office for Europe of the United Nations Office for Disaster Risk Reduction (UNISDR) reported that at European level 27 National Platforms have been established.

2.2 Community of Users

Various communities covering research, policy and operational actors, which have their own specificities but also present a common goal of overall risk management, will form the community of users for disaster risk web platforms. The diversity and cross-discipline disseminated data and results, render the community users as both data providers and also end-users. Therefore, disaster risk web platforms intend to create conditions to enhance a network for information transfer among various involved communities.

The data providers are mainly the research groups from the national and local level, different ministries (mainly Ministries of Environment), NGOs and also the EU-funded research project developed through programmes such as Horizon 2020 and the Framework Programme for Research and Technological Development (FP7).

Complementary to data providers the end-users represent a complex and ambitious challenge as they involve a wide variety of stakeholders. The user community of the DRMKC are multinational, cross-discipline scientists, policy-makers and practitioners. They are dispersed into different disciplines and sectors and often they are working independently on overlapping crisis situations. They can be divided in five main categories of users:

Policy Makers

At EU level, the main policy DGs concerned with Disaster Risk Management are DGs, ECHO, ENTR, ENV, ENER, MOVE etc.

At Member State's 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

3 Disaster Risk Management Framework

The scope of this overview is to establish an existing conceptual basis for the datasets, which the disaster risk web platforms hosts. An overview of existing datasets for exposure, vulnerability, hazards and disaster risk is presented as follow. Also, an inventory of the disaster risk management platforms will be presented in order to complete the image of resources used in risk assessment. Being a barely comprehensive effort due to the complexity of the research field and the scope of this report, the overview will only focus on presenting existing datasets used for the considered components of risk (exposure, vulnerability, hazards, risk).

3.1 Exposure

Exposure modelling techniques have been developed at various scales, from global (top-down approach, with work being carried out by governments or large institutions), to regional/national (approach based on statistical offices, state agencies, remote sensing, census data) and to local scale (the bottom-up approach by methods such as crowdsourcing and in situ surveys) (GFDRR, 2014).

3.1.1 Exposure conceptual framework

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

As an overview, the basic information needed to model the exposure *of a structure* to a hazard event are: location, occupancy, construction type, length or density (roads and railways) and replacement value (estimate of the direct loos). Other additional structural information: square footage, shape, height (height above ground of the first occupied floor – for hydrology), age, roof type, irregularities, material and mechanical properties.

Most exposure data sets at the national scale or above use the spatial *distribution of population* as a proxy for developing demographic exposure estimate. Incorporating the temporal variation in human exposure (movement of population through the course of a day) can be a key factor in determining the impact of rapid hazards events (earthquakes, landslides, or tsunami) (Coburn and Spence 2002;).

3.1.2 Exposure Datasets

In this section we present a few examples of online available datasets that refers to the elements at risk. For an easier overview of the available datasets we have structured the summary on categories.

Geographical data

SRTM Digital Elevation Model - NASA provides the Shuttle Radar Topographic Mission (SRTM) digital elevation model (DEM) version 4.1 freely to the public in efforts to increase the use of geospatial science for sustainable development and analysis in developing countries. For a good overview of the data please visit the webpage: http://srtm.csi.cgiar.org/index.asp.

Land Cover

Corine Land Cover is a compilation of national land cover inventories, which are integrated into a seamless land cover map of Europe. For a good overview of the data please visit the webpage:http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-2

Human exposure

Gridded Population of the World (GPWv3), a gridded data set that provides a spatially disaggregated population layer constructed from national or subnational input units of varying resolutions. For a good overview of the data please visit the webpage: http://sedac.ciesin.columbia.edu/data/collection/gpw-v3

Characterisation of population densities (GHS)

The Global Human Settlement Layer (GHSL) is developed and maintained by the Joint Research Centre of the European Commission. GHSL integrates several available sources about human settlements with information extracted from multispectral satellite images. The GHS resident population grids depicts the distribution and density of residential population, expressed as the number of people per cell. Resident population from censuses for year 2011 provided by Eurostat were disaggregated from source zones to grid cells, informed by land use and land cover from Corine Land Cover Refined 2006 and by the distribution and density of built-up as mapped in the European Settlement Map 2016 layer: http://data.jrc.ec.europa.eu/dataset/jrc-ghsl-ghs_pop_eurostat_europe_r2016a

Characterisation of built-up area (ESM)

The European Settlement Map is a spatial raster dataset that is mapping human settlements in Europe based on SPOT5 and SPOT6 satellite imagery. It is published with two associated data layers. It has been produced with GHSL technology 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 'EUGHSL2016') represents the percentage of built-up area coverage per spatial unit. Available at: http://ghsl.jrc.ec.europa.eu/datasets.php#2016public

Structural data

The Prompt Assessment of Global Earthquakes for Response (PAGER 10) (Wald et al. 2008), the Global Exposure Database for GAR 2013 (GED-13) and the Global Exposure Database for GEM (GED4GEM) are examples of global exposure databases that specifically include physical exposure information. For a good overview of the data please visit the webpage: PAGER - http://earthquake.usgs.gov/earthquakes/pager/ , for GED4GEM, see http://www.nexus.globalquakemodel.org/ged4gem/.

Infrastructure

Open Street Map (OSM), is an open source effort to map the World's streets, roads, railway, waterways, place locations and natural environment. Complete street maps can be used to weight population distribution within a given spatial unit- such as a postal code. For a good overview of the data please visit the webpage: http://www.openstreetmap.org/

Socio economic indicator

The goal of using socio economic indicators is to create an open homogenized database of the building stock and population distribution, with spatial, structural, and occupancy-related information at different scales.

UN Statistical Division (UNSD) provides a global centre for data on international trade, national accounts, energy, industry, environment and demographic and social statistics gathered from national and international sources. For a good overview of the data please visit the webpage: http://unstats.un.org/unsd/environment/qindicators.htm

Other comprehensive sources:

The World Housing Encyclopedia (WHE),: http://www.world-housing.net

Eurostat : http://ec.europa.eu/eurostat

UN WPP 2011: World Population Prospects, the 2010 Revision

http://esa.un.org/wpp/Excel-Data/population.htm

WDI: World Bank. World Development Indicators

http://databank.worldbank.org/data/databases.aspx

ILO: International Labor Organisation, LABORSTA. http://laborsta.ilo.org/

UNESCO: Institute for Statistics:

http://stats.uis.unesco.org/unesco/tableviewer/document.aspx?ReportId=143

CIA Factbook: https://www.cia.gov/library/publications/the-world-factbook/

3.2 Vulnerability

There are multiple definitions, concepts and methods to systematize vulnerability. However, two perspectives in which vulnerability can be viewed (Brookes N, 2003) are established: first, *the amount of damage caused to a system by a particular hazard* and second *a state that exists within a system before it encounters a hazard.*

Vulnerability is commonly defined as:

- Multi-dimensional (e.g. physical, social, economic, environmental, institutional, and human factors define vulnerability);

- Dynamic (vulnerability changes over time);

- Scale-dependent (with regard to the unit of analysis e.g. individual, local, regional, national etc.)

- Site-specific (each location might need its own approach).

When referring to the multi-dimensional characteristic of the vulnerability, generally five components (or dimensions) need to be investigated in vulnerability assessment (Vogel and O'Brien, 2004):

- the physical/functional dimension (relates to the predisposition of a structure, infrastructure or service to be damaged due to the occurrence a hazard);
- the economic dimension (relates to the economic stability of a region endangered due to the occurrence of a hazard);
- the 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);
- the environmental dimension (refers to the interrelation between different ecosystems and their ability to cope with and recover from impacts of hazards);

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

3.2.1 Vulnerability Datasets

In this section, we present a few examples of online available datasets that refers to the vulnerability. The terms "loss" and "damage" are often used in reference to the adverse impacts of disasters on society, economies, and the environment (GFDDR, 2014). In this aspect the databases listed below are typically described in terms of damage and/or loss.

EM-DAT -provides disaster-related economic damage estimates and disaster-specific international aid contributions http://www.emdat.be/database

NatCatSERVICE - https://www.munichre.com/touch/portal/en/service/login.aspx?cookiequery=firstcall

GLIDE - This database is able to provide information on the date, duration, location, magnitude, source and a description of disastrous events:

http://www.glidenumber.net/glide/public/search/search.jsp?&lang=EN

Disaster Inventory System (DesInventar) -is promoting a global initiative to build national disaster databases with a well-defined methodology:

http://www.desinventar.net/index_www.html

3.3 Hazards

The classification schemes for hazards vary across different research institutions and governments, including two major classes: natural and technological or man-made hazards. The natural can be divided into (UNISDR 2009a):

- Geological or geophysical (e.g. earthquakes volcanic activity and tsunamis and related landslides, mudslides, avalanches etc.)

- Hydrometeorlogical (e.g. floods, tropical cyclones, storms, landslides triggered by rainfall wildfires, etc.)

-Biological (e.g. outbreaks of epidemic diseases, plant or animal contagion, insect or other animal plagues and infestations)

The technological hazards are mainly related to (UN/ISDR2009): industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, and chemical spills.

Various natural or human driven events become hazards once they threaten to affect society and/or the environment. A hazardous event that causes fatalities and/or overwhelming assets damage is considered a natural or man-made activity disaster.

The hazardous events are assessed according to their most important characteristics such as the probability of occurrence or frequency of hazard events, the intensity and the affected area (ISDR, 2004).

Probability of occurrence is an estimate of how often a hazard event can occur, the likelihood that something may happen in the future and it is restricted to a specified period of time.

Frequency is a temporal characteristic of a hazardous event. Most hazard events are defined by the relationship established between magnitude of the event and the frequency of the occurrence.

The intensity is used to refer to the damage caused by the event. It is normally indicated by scales, consisting of classes, with arbitrarily defined thresholds, depending on the amount of damage observed.

Affected area

This refers to the pattern of distribution of a hazard over the geographic area in which the hazard can occur.

3.3.1 Hazard datasets and methodologies – good practices

"A hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. This event has a probability of occurrence within a specified period of time and within a given area, and has a given intensity." (UN-ISDR, 2004).

Hazards include (as mentioned in the Sendai Framework for Disaster Risk Reduction 2015-2030, and listed in alphabetical order) biological, environmental, geological, hydrometeorological and technological processes and phenomena.

The term hazard include a wide variety of phenomena, ranging from local events like tornadoes to events at continental scale like climate change, or from very fast phenomena like lightening to very slow events as desertification. In order to describe the different hazard types, six main characteristics can be defined (C.J. van Westen e al.2011): •Triggering factors, •Spatial occurrence, •Duration of the event, •Time of onset, •Frequency, •Magnitude, •Secondary events.

One of the main targets of hazard assessment activities is to identify which areas are more prone to hazard events. Being difficult to cover the aspects of dynamic nature of the hazards (triggering factors, magnitude, frequency or duration), the adopted approach for this subchapter is to present information that will support in spatial identification of regions susceptible to hazard impact.

The datasets presented as follow are provided by the research groups from the EU's Joint Research Centre in Ispra which are also component centres of DRMKC - European Flood Awareness System (EFAS), European Forest Fires Information System(EFIS), Disaster Risk Management – Climate Risk Management and Land Management Groups. Next, we present a brief description of the available datasets acknowledging the authors and crediting the results to the aforementioned research groups.

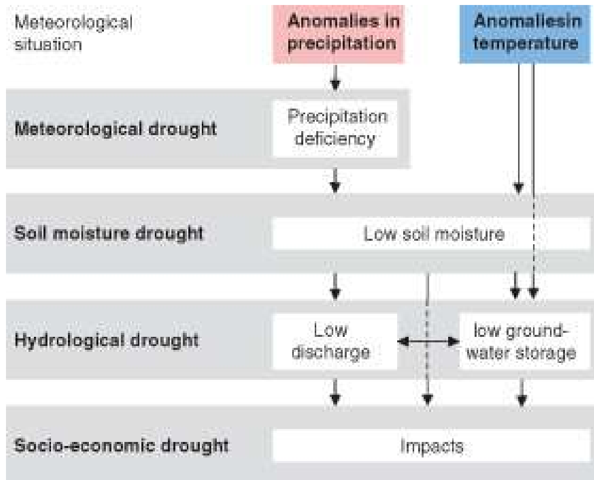
3.3.1.1 Drought

The definition of drought is dependent on the objective of a study. In drought research, generally the focus is on the atmospheric and terrestrial components of the water cycle and the linkages between them, i.e. precipitation, evapotranspiration, snow accumulation, soil moisture, groundwater, lakes and wetlands, and streamflow [Sheffield and Wood, 2011]. Droughts are generally classified into four categories as in Fig. 1.

For studies relating physical characteristics of the natural hazard of drought events to their various impacts the classification presented above could be considered as a good approach in defining the necesary link to evaluate which drought metric sould be considered in order to predict impact.

In drought analysis, availability of long time series of undisturbed, observational data is essential. Often, observational records are not long enough, some variables are not monitored at all, data quality is too low, or observations are influenced by human activities. To overcome these problems models can be used. As follow, we present some resources of meteorological and hydrological data that are available and can be used for the drought hazard analysis.

Figure 1. Different categories of drought and their development



Source: adapted from Stahl, et al, 2011

E-OBS- An available source of meteorological datasets (and drought indicators) that can be found at European level is represented by the E-OBS gridded dataset (Haylock et al, 2011) from the EU-FP6 project ENSEMBLES (http://ensembles-eu.metoffice.com) and the data providers in the ECA&D project (http://www.ecad.eu)" Available at: http://www.ecad.eu/download/ensembles/ensembles.php

Global Precipitation Climatology Centre (GPCC) - (Global Unified Gauge-Based Analysis of Daily Precipitation) - GPCC Global Precipitation Climatology Centre monthly precipitation dataset from 1901-present is calculated from global station data. Avialble at: https://www.esrl.noaa.gov/psd/data/gridded/data.gpcc.html

The CRU TS series of data sets (CRU TS = Climatic Research Unit Timeseries) contain monthly timeseries of precipitation, daily maximum and minimum temperatures, cloud cover, and other variables covering Earth's land areas for 1901-2015 (CRU TS4.0 is a recent release). Available at: https://www.esrl.noaa.gov/psd/data/gridded/data.crutem4.html

Soil moisture. Satellite soil moisture products from ASCAT, AMSR-E and MIRAS (SMOS) sensors are freely available. Data have spatial resolution of 25 km and daily coverage.

ASCAT: http://www.eumetsat.int/Home/Main/News/Features/708786
AMSRE: http://nsidc.org/data/docs/daac/ae_land3_l3_soil_moisture.gd.html
MIRAS (SMOS): http://www.esa.int/esaMI/smos/

Other:
NASA GMAO office's MERRA model - http://gmao.gsfc.nasa.gov/pubs/docs/Yi437.pdf
Global Land Data assimilation System (GLDAS) soil moisture: http://ldas.gsfc.nasa.gov/gldas/

Moreover, also in situ observations of soil moisture are freely available via the International Soil Moisture Network (ISMN). ISMN is an international cooperation to establish and maintain a global in-situ soil moisture database. This database is an essential means of the geoscientific community for validating and improving global satellite observations and land surface models (http://www.ipf.tuwien.ac.at/insitu/).

The meteorological, hydrological but also soil moisture or vegetation data data have been used to derive gridded drought indices such as the CDI (Combined Drought Inidcator), PDSI (Palmer Drought Severity index), SPEI (Standardised Precipitation-Evapotranspiration Index) or the SPI (Standardised Precipitation Index).

Resources:

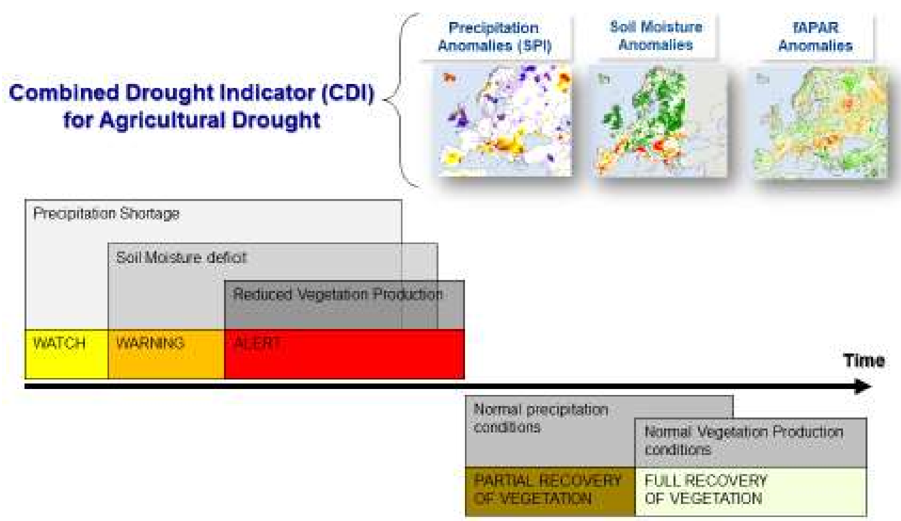
PDSI. The data consist of the monthly PDSI over global land areas computed using osberved or model monthly surface air temperature and precipitation, plus other surface forcing data. Available at: http://www.cgd.ucar.edu/cas/catalog/climind/pdsi.html

SPEI. The SPEI is a multiscalar drought index based on climatic data based on precipitation and potential evapotranspiration. It can be used for determining the onset, duration and magnitude of drought conditions with respect to normal conditions in a variety of natural and managed systems such as crops, ecosystems, rivers, water resources, etc. Available at: http://spei.csic.es/

CDI and SPI. The CDI of the EDO (The European Drought Observatory) is based on three main indices: Standardized Precipitation Index (SPI-1 and SPI-3), soil moisture anomaly and fAPAR anomaly (fig. 2). The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. On short timescales, the SPI is closely related to soil moisture, while at longer timescales, the SPI can be related to groundwater and reservoir storage

The European Drought Observatory (EDO) developed by the Joint Research Centre (JRC) to monitor, assess and forecast drought events across the entire European continent host a suite of drought indicators. Available drought products include a monthly updated Standardized Precipitation Index (SPI), daily updated modelled soil moisture anomalies, and remote sensing observations on the state of the vegetation cover (i.e. anomaly of the fraction of Absorbed Photosynthetically Active Radiation (fAPAR), Standardized SnowPack Index (SSPI), Normalized Difference Water Index (NDWI)) and Combined Drought Inidcator (CDI). Available at: http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000

Figure 2. CDI classification scheme based on three drought impact levels and two vegetation recovery stages (Sepulcre-Canto, et. al., 2012)



Source: EDO, 2017

3.3.1.2 River Flood

Mapping the flood hazard at continental and global scale is a challenging task. Especially in major world rivers, this requires a modelling framework designed to simulate flow routing along the river network over lengths of hundreds of kilometres. At the same time, simulations should account for multiple flooding processes, potentially involving floodplains with a width of hundreds of kilometres, including complex channel-floodplain flow interactions and the presence of dyke systems, dams and reservoirs. The procedure proposed by [Alfieri et al. (2014)](), provided a feasible and effective solution to the mentioned issues. The European and Global Flood Awareness System (EFAS and GloFAS) produced the resulting flood hazard mapping methodology based on the hydrological information and using two-dimensional hydrodynamic models. The mapping procedure mentioned above derived discharge maps for 10, 25, 50, 100, 250, 500 and 1000 year floods. Thy are available at : http://data.jrc.ec.europa.eu/collection/FLOODS

3.3.1.3 Landslide

The landslide datasets and the methodological details describing the creation of the dataset presented as follow should be credit to the Disaster

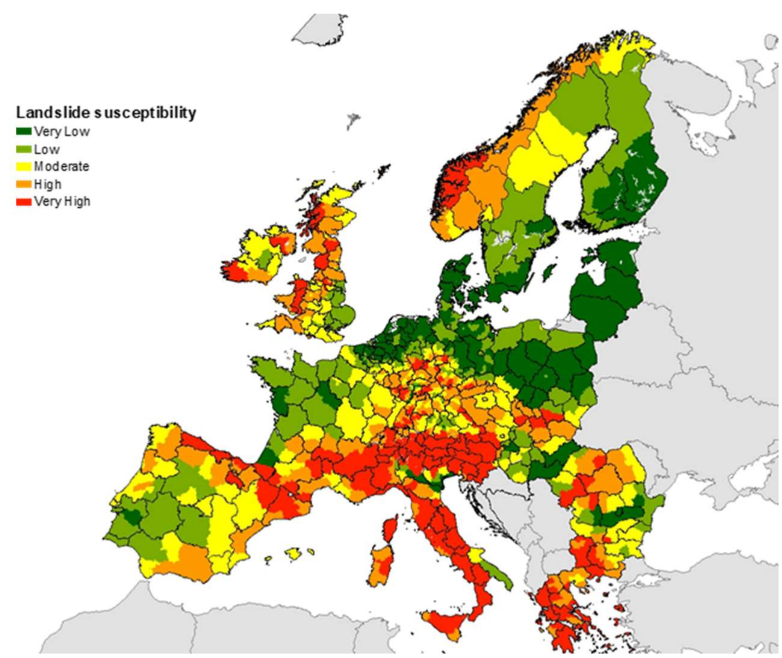
Risk Management Group (Land Management Group) - JRC, and to the research published by Günther A, et al, 2013.

The Europe-wide spatial landslide susceptibility assessment is actually a synoptic-scale analysis of:

- terrain slope, obtained from the global GTOPO 30 terrain elevation dataset.
- lithological complexes in Europe, obtained from the "dominant soil parent material" information of the Soil Geographical Database of Eurasia.
- land cover information in five classes, obtained from the PELCOM dataset.

The NUTS 3-aggregated map (Fig. 3) of the Classified European Landslide Susceptibility map covers 27 EU and presents susceptibility levels assessed by calculating the mean value of the classified susceptibility grid. The mean values were then classified through quantile slicing to obtain five susceptibility classes: very low, low, moderate, high and very high susceptibility.

Figure 3. Landslide susceptibility assessment at the NUTS 3 aggregation level



Source: Günther A, et al, 2013

Available layer of landslide susceptibility can be found in the ESDAC database: https://esdac.jrc.ec.europa.eu/

3.3.1.4 Forest Fire

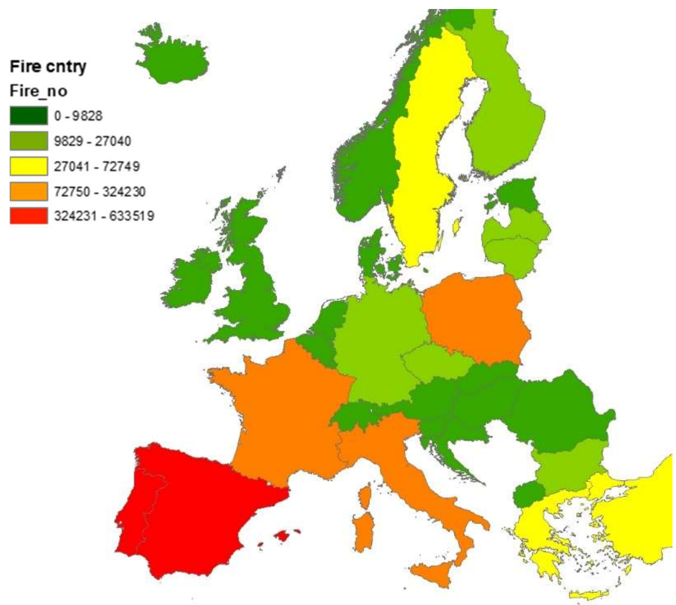
The forest fire datasets and the methodological details describing the creation of the dataset presented as follow should be credit to the European Forest Fires Information System - EFIS, and to the research published by San-Miguel-Ayanz, J., et al, 2012.

The Forest fire data presented on the DataRisk Hub database prototype version is aggregated at EU country members' administration level (Fig. 4) and it is a sum of the number of forest fires recorded between 1985 and 2009. Information on individual fire events was recorded every year by individual countries and was provided to the JRC, which maintains the database.

Datasets of the vulnerability, elements exposed to fire and even a risk assessment for the forest fire are not presented in the prototype version of the RiskData Hub. For the future development of the DataRisk hub new datasets will be presented as EFFIS database on burnt area is based on data provided by the Moderate Resolution Imaging Spectroradiometer (MODIS).

Available datasets on fire datasets (inventory of fire occurrence and burned areas) can be found in the EFFIS database: http://effis.jrc.ec.europa.eu/

Figure 4. Forest fire –number of fires - at the country administrative level



Source: San-Miguel-Ayanz, J., et al, 2012

3.3.1.5 Earthquake

At the European level, several initiatives have focussed on different components of earthquakes characteristics and assessment .

-**The SHARE project** (2009-2013) delivered a European wide probabilistic seismic hazard assessment producing more than sixty time-independent European Seismic Hazard Maps (ESHMs). Link: http://www.share-eu.org/ . Most used recommended is the European Seismic Hazard Maps illustrating the probability to exceed a level of ground shaking in terms of the peak ground acceleration (PGA) with a 10 % probability in 50 years (corresponding to a return period of 475-year). Source: http://www.share-eu.org/node/90 . (Last accessed: 05/02/2018)

- **The SYNER-G project** (2009–2013) developed an innovative methodological framework for the systemic assessment of physical as well as socio-economic seismic vulnerability at urban and regional level (Pitilakis et al. 2013). Link: http://www.vce.at/SYNER-G/files/project/proj-overview.html (Last accessed: 05/02/2018)

-**The NERA project (2010–2014**) aimed at integration seismic and engineering infrastructures to establish an effective network of European research infrastructures for earthquake risk assessment and mitigation. Building on pastachievements, the project identified key players in European building inventory collection and summarized the state-of-the-art knowledge of building inventory data in Europe. Link: http://www.nera-eu.org/ (Last accessed: 05/02/2018)

- **Sesimic portal -** Access to the Seismic Event, BroadBand and Strong Motion Data of the European Seismologic Station.
Thanks to a unique joint initiative by observatories, research institutes in and around Europe, a broad set of seismological data is becoming available. Within NERIES, the seismic portal has been developed as a single point of access to diverse, distributed European datasets.
The portal provides tools to explore and download earthquake information, broadband and accelerometric waveforms, as well as providing access to other NERIES project datasets as they become available.
Extension: Europe
Available at: http://www.seismicportal.eu/ (last accessed: 29/11/2017)

- **Waveform Explorer .** The Waveform Explorer portlet allows the users to search and request broadband seismic data from the whole EIDA (European Integrated Data Archive) network, which offers continuous data coming from c.a. 1000 stations, which are stored in several Data Centres In EU.
Extension: Europe
Available at: http://145.23.252.222/eida/webdc3/ (last accessed: 29/11/2017)

- **AHEAD –** the European Archive of Historical Earthquake Data 1000-1899, is a distributed archive aiming at preserving, inventorying and making available, to investigators and other users, data sources on the earthquake history of Europe, such as papers, reports, Macroseismic Data Points (MDPs), parametric catalogues, and so on.
Available at: https://www.emidius.eu/AHEAD/index.php
Extension: Europe

- **RESORCE (Reference database for Seismic ground-motion Prediction in Europe)** is a freely accessible platform for accessing and retrieving reliable ground-motion data from pan-European earthquakes and associated seismological and geotechnical parameters. The use of RESORCE is granted for non-commercial purposes only.
Available at: http://www.resorce-portal.eu/
Extension: Europe

3.4 Disaster Risk

Risk assessment is used here as a synonym for risk analysis. However, many authors and documents distinguish between them. Where this is done, risk assessment is taken as including: risk identification, risk analysis, and risk evaluation (EC, 2010a).

Even if very briefly, the risk assessment in this report intends to present the methods of determining and representing the quantitative or qualitative degree of risk.

3.4.1 Risk conceptual framework

There are two approaches to defining risk: deterministic (meaning single values or scenario-like means or percentiles used to describe model variables) and probabilistic (meaning that probability distributions are used to describe model variables).

3.4.1.1 Probabilistic Risk Assessment (PRA)

The probabilistic Risk Assessment is characterized by two quantities:

- the magnitude (severity) of the potential loss or damage;

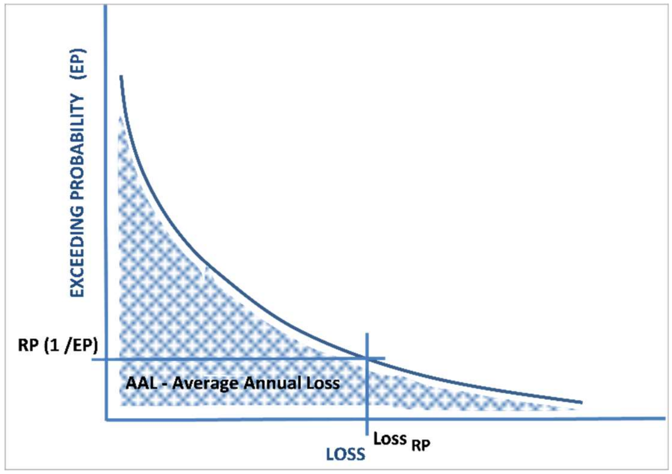
- the likelihood (probability) that the loss or damage will occur.

By considering the likelihood (probability) of occurrence of each event and 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. In probabilistic risk assessment the following statistical concepts are encountered: Uncertainty, Return Period, Exceedance Probability, Loss-Frequency Curve, AAL.

Uncertainty is a function of the amount of information available (a state of having limited knowledge) as well as the imperfect measurement methods or complexity of the system. There may be a tendency to ignore uncertainty when producing a probability model, but uncertainty should not be excluded unless an analysis shows its exclusion to have minimal impact (Duncan et al., 2014). Uncertainty can be described by distribution functions, and it is determined by the confidence levels.

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). It is a standard statistical concept allowing calculation of events and its consequences in a probabilistic manner. 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. Applied to the assessment of the disaster risk the afore mentioned statistical concept is represented by the **Exceedance Probability (loss-frequency) curve** which is a graphical representation of the probability that a certain level of loss will be exceeded in a given time period (Fig. 5).

Figure 5. 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

For example, the 100-year hazardous event, which is an event with an annual exceeding probability of 1%, is estimated to lead to damages that will have 1% chances of being exceeded. Another important property of loss frequency curves is the area under the curve. This area represents the expected annual value of damages, and is known as the **Average Annual Loss (AAL)** which can be obtained as the sum of all losses weighted by probability of all events that create a loss.

3.4.1.2 Deterministic risk assessment

Deterministic risk assessment or the scenario assessment is the process of analysing the consequences (damages, losses or impacts) from a single postulated hazard event (scenario). Therefore, it does not provide information about variability and uncertainty that may be associated with a risk. Nevertheless, scenario assessment is used to develop action plans for risk management and risk reduction strategies. The choice between a probabilistic risk and scenario assessment depends on the aims of the study.

3.4.2 Risk assessment methods

Most definitions, concepts and methods quantify the disaster risk as the product of probability and expected losses or damages.

3.4.2.1 The qualitative method

The qualitative method incorporates the multi-dimensional aspects of vulnerability, and coping capacity:

RISK = Hazard X Vulnerability/Coping Capacity

In this approach indicators are developed in order to characterize vulnerability of people and places by their capacity to withstand a potential hazardous event. The result of the equations will show risk only as relative qualitative classes, and allows to compare risk levels between different administrative areas (cities, regions, counties, and countries).

3.4.2.2 The quantitative method

The quantitative method recognizes the disaster risk as the consequence of the interaction between a hazard and the characteristics that make people and places vulnerable and exposed:

RISK = Hazard X Vulnerability X Amount of elements at risk

In this approach the way disaster risk is presented is in function of the way the amount of elements-at-risk are characterized (e.g. number of buildings or the economic value or the area). The hazard component in the equation actually refers to the probability of occurrence of a hazardous phenomenon with a given intensity within a specified period of time (e.g. annual probability). (C.J. van Westen e al.2011) and the vulnerability is limited to physical vulnerability of the elements-at-risk considered.

3.4.3 Risk models and mapping

Consequences are expressed in a risk assessment as:

- ***qualitatively*** (e.g., high, medium or low) when severity/impact of the consequences and their likelihood (probability/frequency) of occurrence are both expressed qualitatively. Risk matrix analysis is a qualitative technique suited for relative comparisons (between regions, locations etc.) using a visual two-dimensional display of the "ranking" of the risk

The risk matrix approach (Fig 6) is often the most practical approach as basis for spatial planning, where the effect of risk reduction methods can be seen as changes in the classes within the risk matrix.

Figure 6. Example of the risk matrix approach

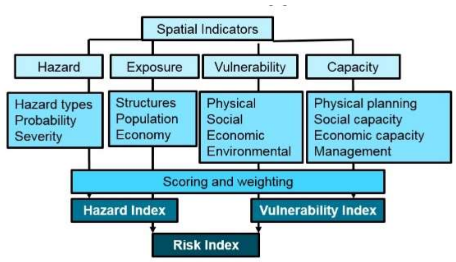
Likelihood \ Impact	Negligible	Minor	Moderate	Significant	Severe
Very Likely	Low Med	Medium	Med Hi	High	High
Likely	Low	Low Med	Medium	Med Hi	High
Possible	Low	Low Med	Medium	Med Hi	Med Hi
Unlikely	Low	Low Med	Low Med	Medium	Med Hi
Very Unlikely	Low	Low	Low Med	Medium	Medium

Source: C.J. van Westen e al.2011

- ***semi-quantitatively***: expressing risk in terms of risk indices. These are numerical values, often ranging between 0 and 1. It does not have a direct meaning of expected losses, but only a relative indications of risk. The risk is estimated using qualitative risk assessment methods and it is expressed in a relative sense. The process of disaster risk assessment is divided into a number of components, such as hazard, exposure, vulnerability and capacity (Fig 7), through a so-called criteria tree, which list the subdivision into objectives, sub-objectives and indicators. Data for each of these indicators are collected at a particular spatial level, for instance by administrative units.

There are many methods in which such risk indices have been used: Disaster Risk Index (DRI)(http://www.grid.unep.ch/), Spatial Multi-Criteria Evaluation (Castellanos and Van Westen, 2007), Seismic Risk Index (SRI), Drought Index (Carrao, H., 2016) etc.

Figure 7. Risk Indicator based approach

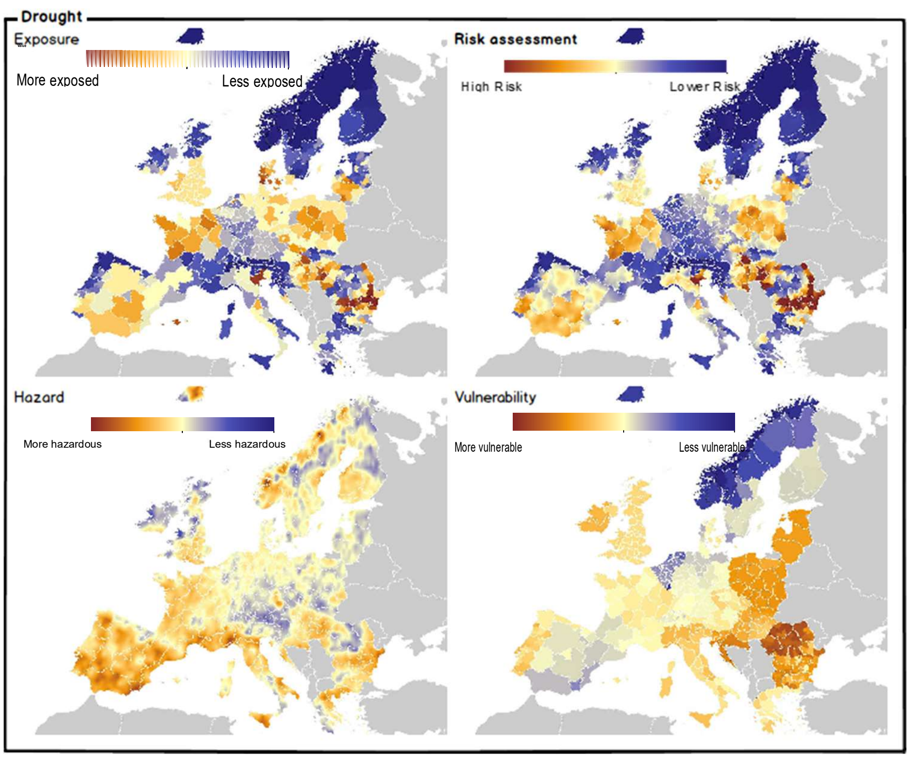


Source: C.J. van Westen e al.2011

Please find below an example of risk assessment based on a semi-quantitatively approach.

The methodological details describing the creation of the dataset presented here underlines two methodologies: *indicator based approach* and *an impact based approach.*

Figure 8. Drought Exposure, Risk, Vulnerability and Hazard at the NUTS 2 aggregation level



Source: Carrão et al, 2016.

The drought risk data presented in Fig. 8 is computed at global level and adopts an _indicator-based approach._

The maps represent the input of the scores of hazard, exposure and vulnerability, at the sub-national administrative level (NUTS 2). The scores range on a scale of 0–1, where 0 represents the lowest risk, hazard, exposure and vulnerability and 1 is associated with the highest risk, hazard, exposure and vulnerability. The components of the risk assessment and the sources are presented in Table 1.

Table 1. Drought risk assessment resources

	Component	Factor	Indicator	Scale	Year	Source
Drought	Hazard		WASP Index	Gridded	1901-2010	GPCC
	Vulnerability	Economic	Energy consumption per capita	Country	2014	U.S. EIA
			Agriculture (% of GCP)	Country	2000-2014	World Bank
			GDP per capita	Country	2000-2014	World Bank
			Poverty headcount ratio (%of total pop.)	Country	2000-2014	World Bank
		Social	Rural population (% of total pop.)	Country	2000-2014	World Bank
			Literacy rate (% of > ages 15)	Country	2000-2014	World Bank
			Improved water source (% rural pop.)	Country	2000-2014	World Bank
			Life expectancy at birth (years)	Country	2000-2014	World Bank
			Population ages 15-64 (% of total pop.)	Country	2000-2014	World Bank
			Refugee population (% of total pop.)	Country	2000-2014	World Bank
			Government Effectiveness	Country	2013	WGI
			Disaster Prevention & Preparedness	Country	2014	OECD
		Infrastructural	Irrigated land (% of total agric. land)	Gridded	2008	FAO
			% of retained renewable water	Catchment	2010	Aqueduct
			Road density (km/100sq. km)	Vector	2010	gROADSV1
	Exposure	Economic	Global agricultural land use	Gridded	2000	MODIS –SPOT VEGETATION
			Livestock of the world	Gridded	2005	FAO
			Baseline water stress	Catchment	2010	GDBD
		Social	World population	Gridded	2010	SEDAC

Source: Carrão et al, 2016.

Data source links:

World Bank: http://data.worldbank.org/products/wdi

U.S. Energy Information Administration (EIA): http://www.eia.gov/

Worldwide Governance Indicators (WGI): http://info.worldbank.org/governance/wgi/index.aspx#home

Organisation for Economic Co-operation and Development (OECD): http://stats.oecd.org/

Food and Agriculture Organization (FAO): http://www.fao.org/nr/water/aquastat/main/index.stm

Aqueduct: http://www.wri.org/our-work/project/aqueduct

Global Roads Open Access Dataset (gROADSv1): http://sedac.ciesin.columbia.edu/data/set/groads-global-roads-open-access-v1

Socioeconomic Data and Applications Center (SEDAC): http://sedac.ciesin.columbia.edu/data/collection/gpw-v4

Global Drainage Basin Database (GDBD), http://www.cger.nies.go.jp/db/gdbd/gdbd_index_e.html

An informal description of the methodologies used to compute the drought risk and the risk determinants are presented as follows. For a more comprehensive description, please refer to Carrão et al, 2016.

Drought risk – is computed as the product of Exposure, Vulnerability and Hazard. In order to include the determinants of risk in the model, they were normalized on the range between 0 and 1, scores that were associated, respectively, with the lowest and highest hazard, exposure and vulnerability conditions.

Drought hazard data is computed at global level (and masked at EU 28 level for the RiskData Hub) using WASP index subtracted from GPCC data set (0.5° latitude/longitude grid spacing). The computation of drought hazard is performed with monthly precipitation totals from the Full Data Reanalysis Monthly Product Version 6.0 of the Global Precipitation Climatology Centre (GPCC) (Becker et al., 2013) and it covers the time interval from January 1901 to December 2010. The drought hazard for the is estimated as the probability of exceedance the median of global severe precipitation deficits for an historical reference period of *N* years. The severity of each precipitation deficit is computed by means of the weighted anomaly of standardized precipitation (WASP) index (Lyon and Barnston, 2005).

Drought exposure – is computed at global level (and masked at EU 28 level for the RiskData Hub) at the subnational level (NUTS 2). The drought exposure is computed and validated on the basis of four spatially explicit geographic layers*:* Global agricultural lands in the year 2000 (MODIS and SPOT-VEGETATION combined), *T*Gridded population of the world, version 4 (GPWv4 - SEDAC), Gridded livestock of the world (GLW - FAO), v2.0*.* Baseline water stress (BWS - GDBD).

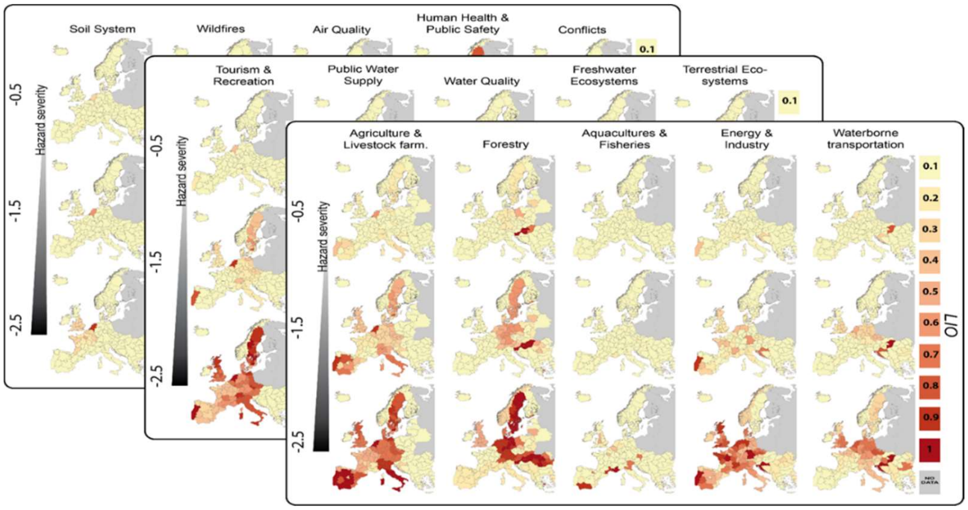
Drought Vulnerability – is derived from an arithmetic composite model combining (a) social, (b) economic and (c) infrastructural factors computed data computed at the subnational level (NUTS 2).

*Drought – impact approach***.** For Europe, a standardised and categorised collection of textual drought impact reports from the European Drought Impact Report Inventory (Stahl et al. 2016) (www.geo.uio.no/edc/droughtdb) facilitates sector specific analysis for the entire facet of impacts caused by drought.

Vulnerability information stem from a comprehensive pan-European investigation (De Stefano et al. 2015) and pan-European databases; the hazard component is described by a set of operationally monitored drought indices.

The multivariable logistic regression framework applied enables to determine the predictive skill of these commonly used hazard indices and vulnerability factors in order to predict drought impacts, and applies a combination of best performing predictors for sector specific risk analysis. Finally, drought risk is mapped for fifteen specific impact sectors at different hazard severities (Fig. 9)

Figure 9. Mapping drought risk, likelihood of impact occurrence (for fifteen specific impact sectors)



Source: Blauhut , V., et al., 2015

The hybrid approach is: a simple and transparent method, applicable for a variety of very different impact, hazard and vulnerability information, transferable to all hazards, and independent of its scale of application.

Drought – Subsidence. One of the most difficult aspects in risk assessment is to link the hazard, more specifically metrics of hazard, with exposed elements in order to predict impact. In the case of drought, a way of linking drought related metric with exposure of the type of build up space or infrastructure is trough soil subsidence (soil shrinking and swelling). Droughts can induce important building damages due to shrinking and swelling of soils, leading to costs as large as for floods in some region. Subsidence is Great Britain's (GB) most damaging soil-related geohazard, costing the economy up to £500 million per annum (Pritchard, O.G., 2015). Corti et al. (2009) have suggested that in recent years the impact of soil subsidence in France has been equivalent, financially, to flooding and in Within the United States, the financial cost of swelling soils has exceeded other natural disasters (i.e. tornadoes, earthquakes and hurricanes) (Sudjiantoet al.2011). An ongoing work (Antofie et. al 2018 to be published) will use a subsidence susceptibility map by extracting from Dominant surface textural class of the STU (European Soil Data Centre: https://esdac.jrc.ec.europa.eu/), the values of the fine and very fine soil texture with clay content > 35%.

- ***quantitatively*** (e.g., the number of people potentially hurt or killed) when consequences are expressed numerically (e.g., the number of people potentially hurt or killed) and their likelihoods of occurrence are expressed as probabilities or frequencies.

For calculating risk quantitatively (as presented in 3.4.2.2), the vulnerability is limited to physical vulnerability of the elements-at-risk considered, determined by the intensity of the hazard event and the characteristics of the elements-at-risk (e.g. building type).

However, when the hazardous event vary spatially as well as temporally the equation should include (C.J. van Westen e al.2011):

- the temporal probability of a certain hazard scenario (a hazard scenario is a hazard event of a certain type with a certain magnitude/frequency/return period);

- the spatial probability that a particular location is affected given a certain hazard scenario;

- the quantification of the amount of exposed elements-at-risk, given a certain hazard scenario (e.g. number of people, number of buildings, monetary values, hectares of land)

- the vulnerability of elements at risk given the hazard intensity under the specific hazard scenario.

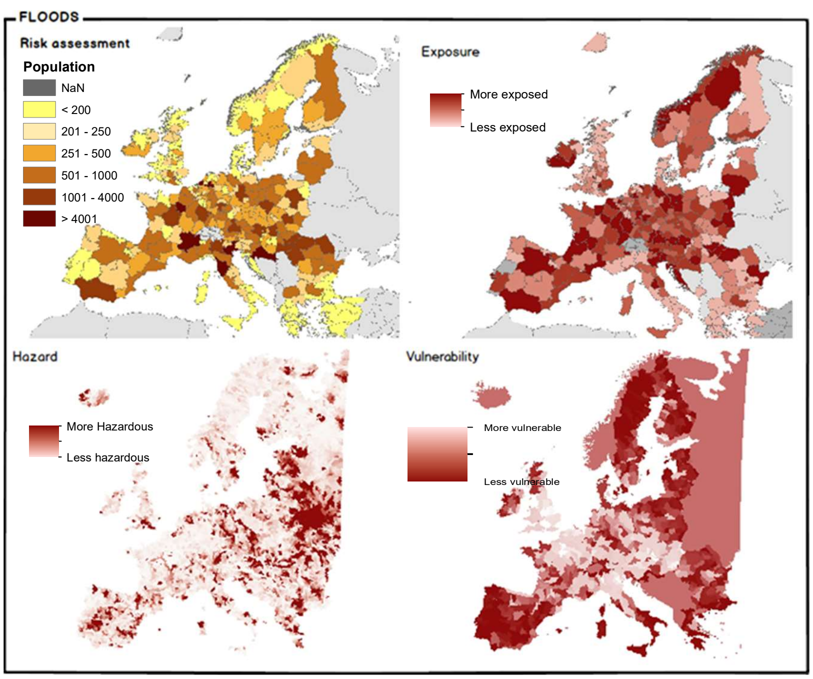
The Quantitative Risk Assessment method is the best for evaluating several alternatives for risk reduction, through a comparative analysis of the risk before and after the implementation followed by a cost-benefit analysis.

Please find below an example of risk assessment based on a quantitative approach.

The methodological details describing the risk assessment presented as follow should be credit to the Disaster Risk Management Group (EFAS) - JRC, and to the research published by Alfieri., L. et al, 2015.

The flood risk data presented on the RiskData Hub prototype version is aggregated at EU 28 level for the RiskData Hub (Fig. 10) and it is a result of the combination of the impact of events and their frequency of occurrence on social and economic components. The modelled factors contributing to the overall flood risk are: the maximum simulated flood return period (T) within 1990–2013, the potential population affected by a flood with a 100-year return period, the return period of flood protection levels.

Figure 10. Flood Exposure, Risk, Vulnerability and Hazard at the NUTS 2 aggregation level



Source: Alfieri, L. et al., 2015

For the RiskData Hub prototype only the social (population affected) component is presented. The economic component of the risk will be made available for a future development of the platform.
An informal description of the methodologies used to compute the flood risk and the risk determinants are presented as follows. For a more comprehensive description please refer to Alfieri., L. et al, 2015.

Flood risk is assessed by modelling the factors contributing to the overall flood risk: maximum simulated flood return period (T) within 1990–2013 (hazard), potential population affected by a flood with a 100-year return period (exposure) and the return period of flood protection levels (vulnerability). The flood risk presented in the RiskData Hub prototype defines the annual population affected by floods at the NUTS 2 aggregation level.

Flood hazard - flood hazard map defines the maximum flood depth and extent caused by the corresponding flood return period T= {10, 20, 50, 100, 200, 500 years}. Therefore, the hazard component gives information on the most extreme events simulated in the reference period 1990–2013.

Flood Vulnerability - is based on a selection of all discharge peaks over threshold (POT) exceeding the *Flood Protection Level* (by Jongman et al., 2014) at any location.

Flood Exposure - is focused on estimating the population affected due to river floods. *The potential population affected (PPA)* by floods of a specific return period is estimated by overlaying the corresponding flood hazard map with the 100 m resolution map of European population density. Available datasets on river floods can be found at: http://data.jrc.ec.europa.eu/collection/floods

3.5 Risk Management Web Platform

Integrating information on risk assessment on easily accessible, publically available datasets is a clear request addressed by Hyogo or Sendai Frameworks for the disaster risk management. The implementation of these frameworks created a growing number of web-based platforms operating at EU levels providing data and information that support the DRM. Next we present a brief inventory of the existing Disaster Risk Assessment platforms, divided by divers geographical levels: global, European/regional and national/subnational.

3.5.1 Global platforms

- **Index for risk management (INFORM)**

  INFORM is a global platform, open-source risk assessment for humanitarian crises and disasters. It is set as a model that builds up a score of risk by bringing together different indicators that measures the Hazard and Exposure, Vulnerability and Lack of Coping Capacity. INFORM does not look at economic assets but instead at the population at risk. The exposure asset that is focused at in INFORM is thus population. The vulnerability of population is not hazard dependent as the exposed population is defined as the expected number of people located within the hazard zone for each type of hazard at country level.

Available at: http://www.inform-index.org/ (last accessed:24/11/2017)
Extension: Global

- **The Global Disaster Alert and Coordination System (GDACS)**

  GDACS offers automatic links to map products such as baseline maps, situation specific maps, damage assessments and web-maps. It offers in-situ sensor data, model output data, priority areas, baseline data, satellite image derived data (examples: flood extent, earthquake damage assessment, landslide extent). GDASC offers the following disaster information systems and online coordination tools: Disaster Alerts, the Virtual OSOCC (online platform for real-time information exchange and cooperation among all actors in the first phase of the disaster) a Science Portal dedicated to several scientific communities

Available at: http://portal.gdacs.org/data/ (last accessed:24/11/2017)

Extension: Global

- **Global Assessment Report on Disaster Risk Reduction (GAR**). It provides an instant guide to disaster, risk and economic background of countries and territories. Data on past hazardous events, population, capital stock, economic indicators distribution and risk from natural hazards can be visualized and downloaded. Probabilistic hazard and risk models have been developed for earthquake, tropical cyclone wind and storm surge, tsunami and river flooding worldwide, for volcanic ash in the Asia-Pacific region and for agricultural drought in parts of Africa. The impact of climate change on wind hazard and risk in the Caribbean and on agricultural drought in Africa has also been modelled

Available at:
http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php
Extension: Global

- **The Rapid Analysis and Spatialisation Of Risk (RASOR).** RASOR is developing a platform to perform multi-hazard risk analysis for the full cycle of disaster management, including targeted support to critical infrastructure monitoring. A scenario-driven query system simulates future scenarios based on existing or assumed conditions and compares them with historical scenarios. Initially available over five case study areas, RASOR will ultimately offer global services to support in-depth risk assessment and full-cycle risk management.

Available at: http://www.rasor-project.eu/rasor-platform/(last accessed:24/11/2017)
Extension: Global

- **The Global Drought Observatory (GDO). GDO is an information system developed by Joint Research Centre (JRC)** for the European Commission's humanitarian services, providing up-to-date information on droughts world-wide and their potential impacts. Drought monitoring is achieved by a combination of meteorological and biophysical indicators, while the societal vulnerability to droughts is assessed through the targeted analysis of a series of social, economic and infrastructural indicators. The combination of the information on the occurrence and severity of a drought, on the assets at risk and on the societal vulnerability in the drought affected areas results in a likelihood of impact, which is expressed by a Likelihood of Drought Impact (LDI) indicator. The location, extent and magnitude of the LDI is then further analysed against the number of people and land use/land cover types affected in order to provide the decision bodies with information on the potential humanitarian and economic bearings in the affected countries or regions. All information is presented through web-mapping interfaces based on OGC standards and customized reports that can be drawn by the user.

Available at: http://edo.jrc.ec.europa.eu/ (last accessed:24/11/2017)
Extension: Global

- **OpenQuake Platform,** by the GEM Foundation, it is web-based platform that offers an interactive environment in which users can access, manipulate, share and add data, and explore models and tools for integrated assessment of earthquake risk.

Available at: https://platform.openquake.org/
Extension: Global

3.5.2 European and Regional Web platforms

3.5.2.1 Floods

- **FLOODRISK.** Projects covering the Danube basin under the EU Strategy for the Danube River and ICPDR (International Commission for the of Danube River) provided means of formalized cooperation for Serbia, Bosnia and Herzegovina, Montenegro, Moldova and Ukraine.
  As example the FLOODRISK project developed for a joint mapping exercise for flood hazard and flood risk and data harmonization in the transnational Danube river floodplains.

Available at: http://www.danube-floodrisk.eu/ (last accessed: 29/11/2017)
Extension: Regional (Danube River Basin)

- **IPA FLOODS.** The European Commission developed dedicated projects within the Instrument for Pre-accession (IPA) framework. Beneficiaries: Albania, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Kosovo ([1]), Montenegro, Serbia and Turkey. IPA FLOODS - has been developed in order to support the approximation to the EU Floods directive in Western Balkans counties and Turkey. It is a Programme for Prevention, Preparedness and Response to Floods

Available at: http://ipafloods.ipacivilprotection.eu/ (last accessed: 29/11/2017)
Extension: Regional (IPA countries)

3.5.2.2 Earthquake

- **EFEHR** is a non-profit network of organisations and community resources aimed at advancing earthquake hazard and risk assessment in the European-Mediterranean area. EFEHR is not replacing national or local efforts, it is supporting and enriching them. EFEHR constitutes one of the three service domains in the Thematic Core Service (TCS) Seismology within the European Plate Observatory System (EPOS). The two others are ORFEUS (waveform services) and CSEM-EMSC (seismological products services).

Available at: http://www.efehr.org/en/home/
Extension: European-Mediterranean area

3.5.2.3 Infectious diseases

- **ECDC - Surveillance Atlas of infectious Diseases**

  European Centre for Diseases Prevention and Control (ECDC) mission is to identify, assess and communicate current and emerging threats to human health posed by infectious diseases. ECDC collects, analyses and disseminates surveillance data on 52 communicable diseases and related special health issues from all 28 European Union (EU) Member States and two of the three remaining European Economic Area (EEA) countries (Iceland and Norway). The Surveillance Atlas for Infectious Diseases enable interactive exploration of EU/EEA surveillance data for a growing subset of diseases and special health topics.

Available at: http://atlas.ecdc.europa.eu/public/index.aspx?Instance=GeneralAtlas (last accessed:24/11/2017)
Extension: Europe

[1] This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ opinion on the Kosovo Declaration of Independence.

3.5.2.4 Multiple single hazards

- **The World Health Organisation (WHO) e-atlas of disaster risk for the European Region**

  The platform presents hazards as Seismic, Flood, Landslide, Wind speed and Heat Wave. It is addressed to ministries of health in EU member states with the goal of improving the disaster management capacities. The platform is a pure visualization tool where a user can choose to view maps by country, region (Europe) or by hazard. The user is presented with a list of links to access documents and it offers few possibilities for interaction when a map is displayed.

Available at: http://data.euro.who.int/e-atlas/europe/ (last accessed: 29/11/2017)
Extension: Europe

- **PPRD East, Electronic Regional Risk Atlas (ERRA)**

  PPRD2 Programme supports international cooperation for the reinforcement of Civil Protection capacities between the European Union, the Mediterranean (PPRD South2) and Eastern Partnership Countries (PPRD East2) under the umbrella of the European Neighbourhood Policy (ENP).
  Further developments and results of these programmes are presented on Electronic Regional Risk Atlas (ERRA) for PPRD East and respectively PPRD South Risk Atlas.

  ERRA displays is a web portal that maps the level of hazard, exposure and vulnerability related to earthquakes, floods, forest fires, landslides and industrial hazards. Available maps also show where key infrastructures (roads, railways, dams, airports) and important public buildings are located

Available at: http://erra.pprd-east.eu/ (last accessed: 29/11/2017)
Extension: Regional (Eastern EU neighbour countries)

- **IPA DRAM.** In the Instrument for Pre-accession (IPA) framework, the Programme for Disaster Risk Assessment and Mapping (IPA DRAM) contributes to enhance the capabilities of the partner countries (Albania, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Kosovo ([2]), Montenegro, Serbia and Turkey.) to strengthen disaster risk management.

Available at: http://www.ipadram.eu/about-the-programme/ (last accessed: 29/11/2017)
Extension: Regional (IPA countries)

3.5.2.5 Drought

- **DriDanube. Drought Risk** in the Danube Region project aims to increase the capacity of the region to adapt to climatic variability, to manage drought related risks by enhancing resilience to drought with recently developed tools and data sets. The project is set to develop: a new drought monitoring service prepared for operational use, an unified drought risk protocol based on the Civil Protection Mechanism and an improved drought emergency response in the Danube region.

Available at: http://www.interreg-danube.eu/dridanube (last accessed: 24/11/2017)
Extension: Regional (Danube River Basin)

[2] This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ opinion on the Kosovo Declaration of Independence.

- **Drought Management Centre for South-eastern Europe - DMCSEE –** coordinate and facilitate the development, assessment and application of drought risk management tools and policies in South-Eastern Europe with the goal of improving drought preparedness and reducing drought impacts.

Available: http://dmcsee.org/(last accessed:24/11/2017)
Extension: Regional (South East Europe)

- **The European Drought Reference (EDR) database and the European Drought Impact Report Inventory (EDII)** were both compiled as part of the EU funded DROUGHT R&SPI Project.

  Developed within the EU-FP-7 project DROUGHT-R&SPI the EDII aims to evaluate the availability and use of drought impact information and to provide a new view on drought impacts across Europe. It intends to establish a link between drought indices and the directly observable impacts across a wide range of sectors. In this sense, the EDII becomes a capable source for spatial and temporal information on impacts and their cause, which is essential for drought policy planning at national and pan-European levels. The source of drought impact inventory is variate, differ by region and change over time and includes scientific and governmental sources, private sector reports, theses, scientific articles, newspapers, NGO reports, books and divers online sources. In addition, through a website interface, users can submit drought impact data, which will become a part of the database.

Available: http://www.geo.uio.no/edc/droughtdb/ (last accessed:24/11/2017)
Extension: Europe

- **CARPATCLIM.** The main aim of the project is to improve the basis of climate data in the Carpathian Region for applied regional climatological studies such as a Climate Atlas and/or drought monitoring, to investigate the fine temporal and spatial structure of the climate in the Carpathian Mountains and the Carpathian basin with unified methods. Therefore, a freely available, high resolution daily gridded database has been produced for the Larger Carpathian Region (LCR).

Extension: Regional (Carpathian Basin)
Available: http://www.carpatclim-eu.org/ (last accessed:24/11/2017)

- **The European Drought Observatory (EDO**) is developed by the Joint Research Centre (JRC) to monitor, assess and forecast drought events across the entire European continent. At the core of the European Drought Observatory (EDO) are a web portal and map server presenting up-to-date drought relevant information to the public and to decision makers in policy and water resources management. As droughts can affect the entire water cycle (e.g., precipitation, soil moisture, stream flow and groundwater) and have direct impacts on the vegetation cover, all these components need careful monitoring. Therefore, a suite of indicators is calculated from different data sources in order to capture various aspects of a drought event and to forecast its probable evolution. Available drought products include a monthly updated Standardized Precipitation Index (SPI), daily updated modelled soil moisture anomalies, and remote sensing observations on the state of the vegetation cover (i.e. anomaly of the fraction of Absorbed Photosynthetically Active Radiation (fAPAR), Standardized SnowPack Index (SSPI), Normalized Difference Water Index (NDWI)) and Combined Drought Inidcator (CDI).

Extension: Europe
Available at: http://edo.jrc.ec.europa.eu/ (last accessed:24/11/2017)

3.5.2.6 Forest fire

- **The ALP FFIRS** project aims to improve forest fire prevention under a changing climate in the Alpine Space, by creating a shared warning system based on weather conditions. The fire regime at any given location is the result of complex interactions between fuels, social issues, topography, ignitions and weather conditions. The analysis of fires frequency and distribution will allow to model forest fire danger in the alpine region. The definition of a univocal Alpine Forest Fire Danger Scale will support the interpretation of danger thresholds as enhancement of emergency plans and operational procedures. Due to the climate change, forest fires as potential disturbance have become an issue in the Alpine region over the last decade. An Alpine network on forest fire impact mitigation will be assembled reflecting common policies in risk prevention management, by fostering mutual aid in prevention, preparedness and suppression procedures.

  The ALP FFIRS project is part of the European Territorial Cooperation and co-funded by the European Regional Development Fund (ERDF) in the scope of the Alpine Space Programme.

Available at: www.alpine-space.eu (last accessed:24/11/2017)
Extension: Regional (Alpine region)

3.5.2.7 Water scarcity

- **Enviro Grids.** With 30 partners distributed in 15 countries, the enviroGRIDS project is contributing to the Global Earth Observation System of Systems (GEOSS) by promoting the use of web-based services to share and process large amounts of key environmental information in the Black Sea catchment (2.2 mio. km^2, 24 countries, 160 million inhabitants). The main aim of the project is to assess water resource in the past, the present and the future, according to different development scenarios. The objective is also to develop datasets that are compatible with the European INSPIRE Directive on spatial data sharing across Europe. The data and metadata gathered and produced on the Black Sea catchment is distributed through the enviroGRIDS geoportal. The challenge is to convince and help regional data holders to make available their data and metadata to a larger audience in order to improve our capacity to assess the sustainability and vulnerability of the environment.

Available at: http://blacksea.grid.unep.ch/maps/232/view (last accessed:24/11/2017)
Extension: Regional (Black Sea catchment)

3.5.2.8 Landslides

- **The Society Adaptation for coping with Mountain risks in a global change Context (SAMCO)** project (under construction) aims to develop tools on a GIS-based platform to characterize and measure ecosystem and societal resilience from an operative perspective (three mountain cases initially) in the mountain area. It will consider the potential impact of landslide, rockfalls and flood hazard on land-use, socio-economic system, analyse the consequences in terms of vulnerability and map indicators of mountain slope vulnerability exposed to several hazards type. It will have a multi-risk approach.
  Extension: Regional (Alpine region)
  Available at: http://anr-samco.com(last accessed: 24/11/2017)

- **Other initiatives:**

a) a web-based toolbox for landslides will continue and improve the work done in the SafeLand project. The new improved toolbox will be developed within the project **Klima 2050** funded by Norwegian Research Council.
b). The Federal Ministry of Transport and Digital Infrastructure (BMVI) in Germany aims to developing a GIS web platform that will address the future landslide hazard potential for the federal transport system under the influence of climate change. This new research program currently funds three research fields consisting of several individual projects each (http://www.bmvi-expertennetzwerk.de).
c). the success of Google Alert's service on developing a landslide database (10947 notification in 3 years from 2012-2015) in Italy has created the need of integrating the web source with more technical information.

3.5.3 National and sub-national Web platforms

A common approach to communicate disaster risk information such as hazards or risk is by modelling various physical processes in order to create hazard zones and then overlaying the hazard zones on exposed economic, social or environmental layers. These approaches provide some insight on potential impacts from hazards. Nevertheless, combining hazard-modelling results with socioeconomic or environmental data has to be complemented with metrics of the exposure indicators on one side and probabilistic approach on the side of the hazards. This is especially important for predicting impacts and respectively risk assessments. Scientific or community web platforms that use similar approach provide visibility and relevance of the underlying disaster risk information.

We reviewed disaster web platforms created with national or subnational coverage that have provided links between hazard modelling, societal, and environmental impacts. Focusing mainly on the map portals hosted by the disaster risk web platforms or other types of platforms (e.g. national geoportals) we have assessed the presence or absence of these elements in relation with data, methodology and map content. The characteristics looked for were: presence of an inventory of impacts or hazard events, quantitative against simple visual areal representation of risk and mapping of multiple single hazards. Some of the web portals reviewed are listed in Table 2.

Table 2. Web platforms for risk management considered

CRT	CNTR_ID	Link
1	AT	http://www.hora.gv.at/
2	BE	http://geoapps.wallonie.be/inondations and http://gdiviewer.agiv.be/
3	BG	
4	CH	http://www.planat.ch/en/home/
5	CZ	http://hydro.chmi.cz/cds
6	DE	https://www.cedim.de/english/riskexplorer.php
7	DK	http://miljoegis.mim.dk/cbkort?profile=miljoegis_oversvoemmelsesdirektiv
8	EE	http://geoportaal.maaamet.ee/eng/
9	EL	http://floods.ypeka.gr/index.php
10	ES	http://sig.magrama.es/snczi/visor.html?herramienta=DPHZI
11	FI	http://paikkatieto.ymparisto.fi/tulvakartat/Html5Viewer_2_7/Index.html?configBase=http://paikkatieto.ymparisto.fi/Geocortex/Essentials/REST/sites/TulvakarttapalveluEN/viewers/HTML5270/virtualdirectory/Resources/Config/Default

12	FR	http://www.onrn.fr/site/rubriques/indicateurs/cartographie.html
13	HR	http://korp.voda.hr/
14	HU	http://www.vizugy.hu/index.php?module=content&programelemid=62
15	IE	http://www.floodmaps.ie/View/Default.aspx
16	IT	http://www.geoservices.isprambiente.it/arcgis/rest/services/RischioIdraulico/Superficie_aree_pericolosita_idraulica/MapServer
17	LT	http://gis.gamta.lt/potvyniai/
18	LV	http://ozols.daba.gov.lv/pub/
19	NL	http://www.risicokaart.nl/en/
20	NO	https://gis3.nve.no/link/?link=flomsone
21	PL	http://mapy.isok.gov.pl/imap/
22	PT	https://www.apseguradores.pt/cirac_V2/
23	RO	http://gis2.rowater.ro:8989/flood/
24	SE	http://vattenwebb.smhi.se/
25	SI	http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@ARSO&culture=en-US
26	SK	http://mpomprsr.svp.sk/
27	UK	http://apps.environment-agency.gov.uk/wiyby/37837.aspx
28	UK_Scotland	http://map.sepa.org.uk/floodmap/map.htm
29	UK_N_Irland	http://riversagency.maps.arcgis.com/apps/webappviewer/index.html?id=fd6c0a01b07840269a50a2f596b3daf6
30	UK_Wales	https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Defa

Being a barely comprehensive effort due to the complexity and the easiness of accessing information (most platforms are developed in the national language), the outcome overview was limited on presenting observations on disaster risk assessment, considering components such as: mapping, data availability, methods for different administrative scales and considered hazards. It is an incomplete and constrained overview of the methods and approaches but it aims to provide a general landscape of the web platforms at European level.

- The review of the map portals showed that some included maps of exposure and others provided areal extension of the hazards, but only a few related the hazards with the socioeconomic and environmental layer in a fully integrated visual representation.
- Additionally, most reviewed application lacked the methodological development in disaster risk representation (e.g. a statistical description of the risk), most of them showing a simple visual areal representation of risk due to the hazard occurrence. Only a few applications portrayed the spatial extent of a hazard or its related risk with a graphical depiction/statistical description (e.g. ONRN-France).
- As immediately noticed most of the web applications are centred or build on the platforms mainly dedicated for flood disaster risk management. The information focused on flood hazards, risk assessment and exposure have the highest level of detail compared with other hazards.
- The information presented on risk web platforms must take into account the diversity of information related with disaster risk. As noticed during the overview, there are different approaches for presenting the information. The relevance and usability of the platform is critical to the successful uptake of the information presented.

Several platforms offered a complete and easy to access information that used the following characteristics:

- the geospatial information presented on the web platform included the relation exposure – hazard. This approach provides a more complete insight to practitioners and policy makers regarding disaster risk assessments in general.
- the across-scale view in disaster risk assessment was included considering administrative units as aggregation stages for risk information. The management of the risk reflects more the policy component and they are linked with administrative directives, organizations and operational skills coordinated at level of administrative entities.
- the disaster risk information is linked across scale to individual assets/exposure data that can be easily integrated with preparedness, resilience and financing schemes (top-down actions) that are linked at property/asset level.
- the hazard assessment included information based on scenarios (return period). This approach support the probabilistic approach (risk is the probability of the impact/damage) in disaster risk assessment.
- the geospatial information includes mapping on hazard, vulnerability, risk and resilience at local level.
- the cross-discipline approach includes a Multi-Hazard approach. This implies an alignment of methodological approaches and data used for disaster risk assessment across different hazards.
- the geospatial data on hazards and exposure was backed up by loss records of historical events and lessons learnt.
- the level of disaster risk reduction are presented as analysis of the progress made in the implementation of prevention measures (e.g. ONRN platform).

3.5.3.1 Czech Republic

- **Drought**

InterSucho project - aimed to understand drought as multifaceted extreme events at a regional scale with a focus on the Czech Republic, Slovakia and Central Europe, and across various time scales. It presents information on Drought intensity, Soil moisture deficit, Vegetaion condition, Impact on yields and drought duration (days).

Extension: Country/Regional
Slovakia: http://www.intersucho.cz/sk/ (last accessed:24/11/2017)
Czech Republic: http://www.intersucho.cz/cz/ (last accessed:24/11/2017)

- **Landslide**

RUPOK application is an online landslide risk tool for road networks, which hosts information on road links that can be blocked due to landslides. It allows for visualisation of the cause, place and time of road link blockage. It is used for the estimation of the indirect costs due to blockages, it helps road administrators and it is an adaptable tool that can be transferred to any other region.
Available: www.rupok.cz

3.5.3.2 Greece

- **Forest fire**

FLIRE: Floods and Fire risk assessment and management. FLIRE is a demonstration project aiming to the development of an integrated Decision Support System (DSS) for both flash floods and forest fires risk assessment and management.

The FLIRE’s area of implementation is the peri-urban environment of the Eastern Attica region, more specifically the Rafina river basin (Greece), a typical Mediterranean area extends over approx. 130 km2 with rapid and uncontrolled urbanization. This pilot area is quite prone both to flash floods and forest fires resulting in its gradual ecological degradation, with significant consequences for the almost 5 million inhabitants of Athens.
Extension: local (Eastern Attica- Greece)
Available: http://www.flire.eu/en/

3.5.3.3 France

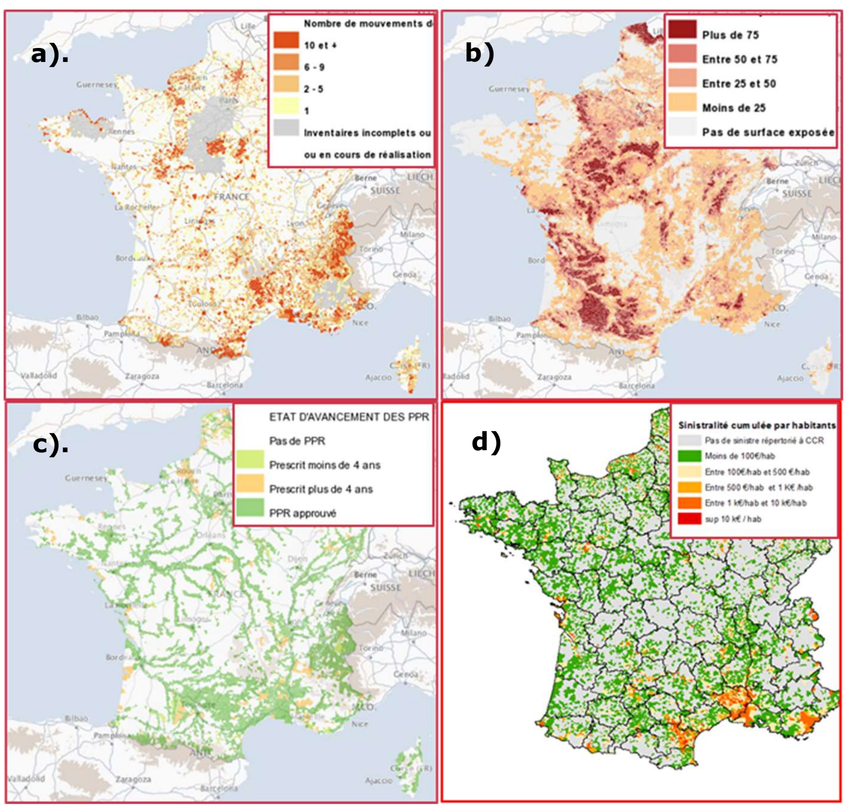
- **Multiple single hazards**

National Observatory for Natural Hazards (ONRN)

As a result of lessons learnt from recent disasters in France, major public and private stakeholders have decided to join forces in launching a National Observatory for Natural Hazards (ONRN) in 2012 .

This unique national public-private-civil as well as societal-academic partnership agreement between State authorities, the insurance market trade associations represented by Mission Risques Naturels (MRN), Caisse Centrale de Réassurance (CCR) the state reinsurer of NatCat insurance system, and involving the Mayors Association, has already linked up with regional observatories to develop “bottom up” projects regarding risk data sharing and dissemination. The observatory leads a network of regional and local observatories for natural risks and coordinate working groups.

Figure 11. Map view of the ONRN indicators. As example: a). Number of landslides, b). Proportion of municipal surface area with high subsidence in 2014 (%), c).Progress of flood prevention plans, d). Mean cost €/ inhabitant in 2013 due to flood damage.



Source: ONRN, 2017.

The observatory provides a tool for monitoring, evaluation and review of asset exposure, loss records and national and regional risk reduction policies, at different scales, from municipal to national level. It contributes to a shift towards a general culture of disaster risk prevention and mitigation. The ONRN web portal provides access and share key information useful to the activities and decision-making processes of stakeholders involved in risk prevention in the following fields (Fig. 11):

- hazards and associated zoning maps: landslides, earthquakes, floods, subsidence - swelling and shrinking of soil rich in clay, storm, hail and snow effects).
- assets at risk, vulnerability and resilience at local level.
- loss records and lessons learnt.
- stakeholders and their projects,
- progress made in the implementation of prevention measures.

This platform supports decision making for DRR participative governance and reflects an example of good practice towards integrated disaster risk information management.

Available at: http://www.onrn.fr/site/rubriques/indicateurs/cartographie.html

3.5.3.4 Austria

- **Multiple single hazards**

Hora – Natural hazards overview and risk assessment. "HORA – Flood Risk Zoning Austria" is an Austria-wide risk zoning system for natural disasters, presently with the priorities of floods, earthquakes and hail (www.hochwasserrisiko.at). This project is unique in Europe and, in the course of four years, has been jointly implemented by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and the Austrian Insurance Association (VVO) on more than 25.000 river kilometres. The beneficiaries of this cooperation are to be the citizens of this country when it comes to provide important information for example on the risk of flooding of one's home or of an industrial enterprise or an infrastructure facility. So, in addition to obtaining easy and quick information about any risk of flood via a digital internet hazard map, which serves as a first risk assessment as well, this tool can also be used to optimise and set priorities in the required flood control at the municipal, provincial and federal levels.

Available: http://www.hora.gv.at/

3.5.3.5 Serbia

- **Landslides**

BEWARE project proposes a standardized post-event landslide database, developed for Serbia. It includes a Web GIS application that allows a search and preview of landslides data. It includes components for landslides location and editing. It aims to help on developing a landslide prediction model. A BEWARE mobile GIS application is available too .

Available at: http://geoliss.mre.gov.rs/beware/?p=276

4 The Risk Data hub - Web platform for DRM

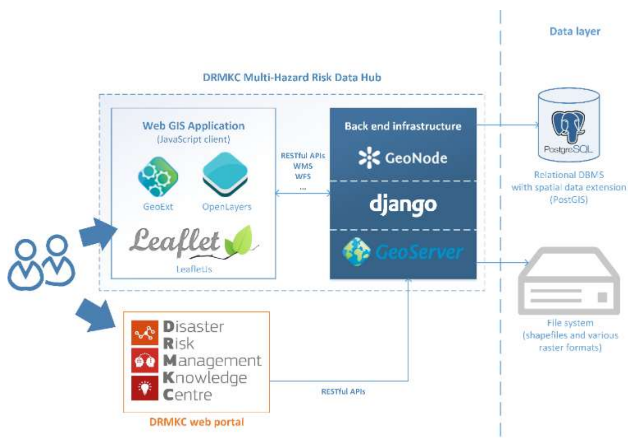
The DRMKC RiskData Hub will host various geospatial data, technologies and methodologies coming from different sources (projects, organisations and scientists). In order to share all these resources, the platform will promote data sharing on the concept of open data and open technologies. Moreover, a set of standards it will be adopted as a strategy for rendering the spatial data and associated technologies easily accessible and to support a seamless interaction between users and the resources hosted on the platform. Furthermore, DRMKC RiskData Hub will provide technology and users will not only be able to access the database but also will become the main participants for producing and updating the required data.

4.1 System architecture

DRMKC RiskData Hub is a web-based application that aims to offer a technological solution for freely visualize access, download and link to geospatial data on disaster risk and determinants of risk at EU-wide scale.

Risk Data hub database is currently implemented following the software architecture as shown in the figure 12. GeoNode is a geographic Content Management System (CMS), mainly aimed at collaborative sharing and editing of geographic layers and maps and it is composed by:
- A Database Management System and its spatial extension: PostgreSQL and PostGIS
- A server-side software which can provide standard Web Map Services: GeoServer;
- A CSM framework: Django;
- Client-side libraries for building WebGIS applications: OpenLayers, GeoExt and LeafletJs.

Figure 12. Schema of the Multi-Hazard Risk Data Hub architecture, based on the Geonode technology stack. The hub will be also integrated with the DRMKC web portal (e.g. for displaying the latest published layers) through the RESTul web services made available by GeoNode.



Source: Risk Data Hub, 2017.

RiskData Hub supports the identification, implementation and evaluation of prevention and preparedness 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 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. This approach is set to identify not only the geographically located causal factors of disaster but also to link to individual sectors or assets exposed to hazards. This approach can be easily integrated with preparedness, resilience and financing schemes (top-down actions) that are linked at this level of property or asset.

It is important to consider administrative units as aggregation stages when considering potential impacts. This is because the management of the risk reflects more the policy component and they are linked with administrative directives, organizations and operational skills coordinated at level of administrative entities.

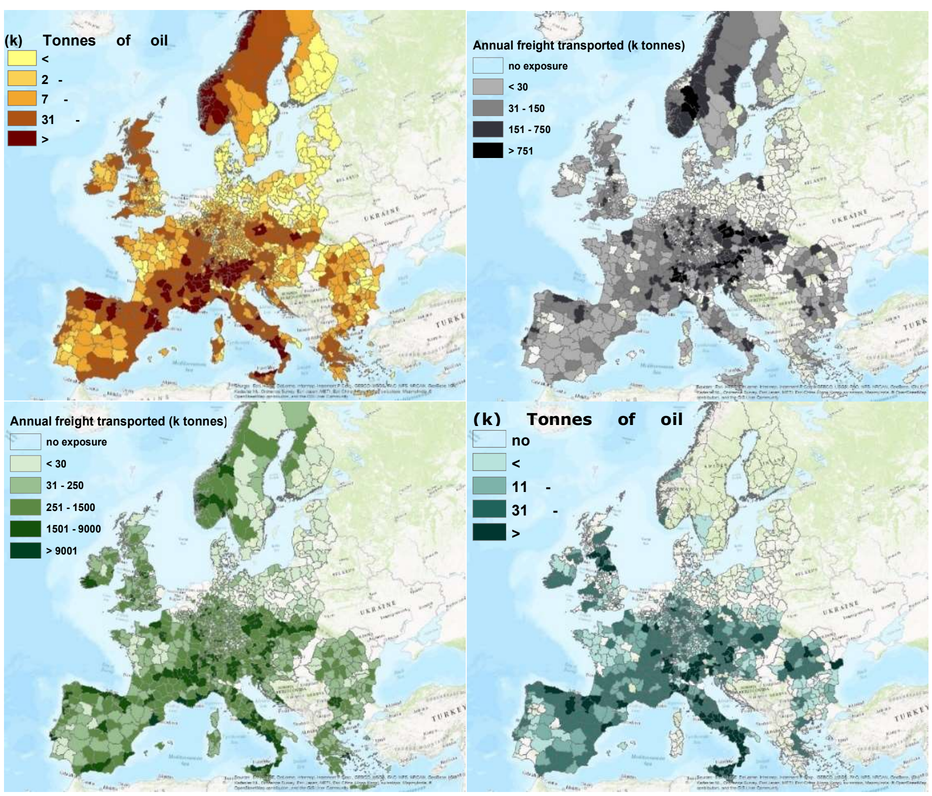
To meet the demand for statistics at administrative aggregation level, the GISCO NUTS 2013 (NUTS, 2016) and LAU (Local Administrative Units) data is used in the Risk Data hub.

Please find below some implemented example of potential impact quantified from their spatial coincidence with hazards such as landslide or floods.

<u>Landslide potential impact on infrastructure</u>

The potential impact of landslide on critical infrastructure (Fig. 13) it is an important information for DRM being essential for the maintenance of vital lifelines functions or social well-being of people. To allow a consistent impact framework, infrastructure types belonging to the same sector required a data transformation process to bring them to a level of comparability.

Figure 13. Infrastructure potential impact (equivalent to tonnes of oil) from landslide susceptibility



Source: Risk Data Hub, 2017.

The infrastructure layers (e.g. energy, transport, industry etc.) were converted in "harmonized" information: from categorical information to continuous indicator of intensity. The advantage of this procedure is that the impact from various hazards can be combined with hazard data to derive an impact measured. For the example presented, the electricity and gas pipeline network is harmonized and consequently measured in k (1000) tons of oil equivalent/year, and the railways and motorways networks in annual freight transported in k (1000) tons, respectively. The data sources, the original data structure, and the reference dates can be consulted in the JRC technical report (Forzieri, G. et. al., 2015) available at: https://ec.europa.eu/jrc/en/publications-list .

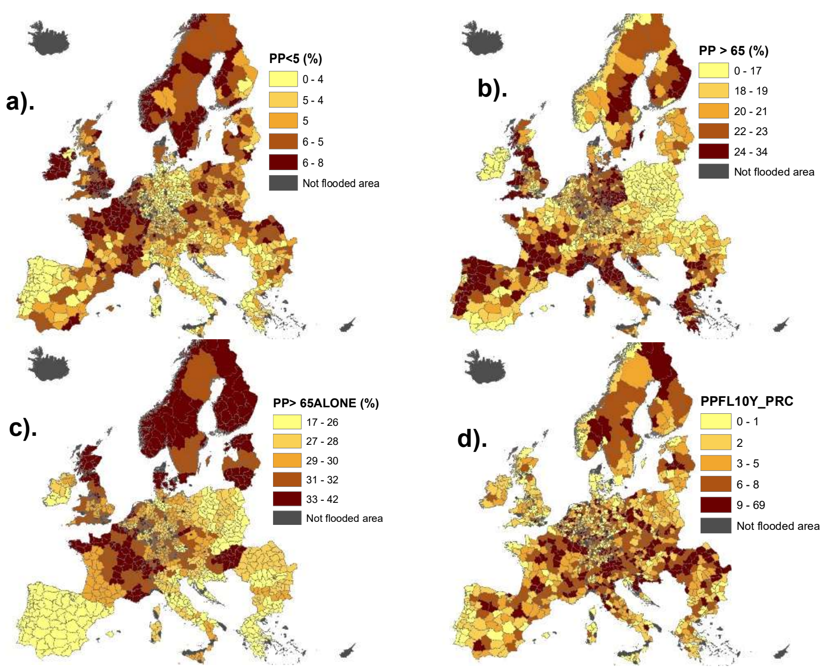
The data used for this approach is also linked to the GHSL - Global Human Settlement Layer framework. The GHSL datasets available for open and freely download can be found either on the JRC Open Data portal or through Copernicus Land service portal:

- European settlement map (ESM_100m_2016)(Pesaresi M., et al 2016) available at: http://ghsl.jrc.ec.europa.eu/datasets.php . It includes dataset that is mapping human settlements in Europe based on the GHSL methodology applied to SPOT5 and SPOT6 satellite imagery.
- PGHS_POP_GPW42015_GLOBE_R2015A_54009_250m (Freire S., et al. 2016). Available at: http://ghsl.jrc.ec.europa.eu/datasets.php. The dataset depicts the distribution and density of population, expressed as the number of people per cell.

Flood potential impact on demography

For the potential impact of the hazards on demographical metrics, Eurostat demographic data is used: (http://ec.europa.eu/eurostat). Assuming that the population is equally distributed the disaggregation of the population by gender, age, social status it is applied in order to make assumption of the demography characteristics in the footprint of a hazard (Fig. 14).

Figure 14. Flood (RP 10yr) potential impact on demography; a) – population age < 5 years old; b) population age > 65 years old: c) population age >65 leaving alone; d) population potentially affected by flood



Source: Risk Data Hub, 2017

4.2 Access to methodologies in support of Disaster Risk Assessment

Various information (e.g. country reports on risk assessment, risk data from local to regional/national level, good practices in risk assessment) will be contained as stand-alone web pages on Risk Data Hub.
Apart from providing access to geospatial, data the RiskData Hub also ease the access to various methodological approaches in disaster risk assessment. This approach will be a benefit for the Hub, as the information will be linked across sectors and scales contributing to a complete view on disaster risk. Below we present a few examples of methodological approaches for drought risk assessment that were collected during the first Risk Data hub workshop:

- Within the DROUGHT-R&SPI project, it was developed an approach for drought risk assessment combining hazard information and vulnerability factors to predict the likelihood of impact occurrence (LIO) in an empirical model framework (*Blauhut et al. 2015*). The method is applied at Pan-European scale and it establish a link between drought indices (in this case SPEI) and the directly observable impacts across a wide range of sectors. The multivariable logistic regression framework applied enables to determine the predictive skill of these commonly used hazard indices and vulnerability factors in order to predict drought impacts. Availability and accessibility of impact information appears in this aspect essential, such as it may provide the necessary link to evaluate whether drought metrics can predict impacts. For further information, please see:

• Blauhut V., Gudmundsson, L., and Stahl, K.: Towards pan- European drought risk maps: quantifying the link between drought indices and reported drought impacts, Environ. Res. Lett., 10, 014008, doi:10.1088/1748-9326/10/1/014008, 2015a.

- Within the French National Observatory for Natural Hazards (ONRN) a simple model is used to examine the damage drought can induce to buildings and infrastructure due to soil subsidence (soil subsidence is a process by which certain soils shrink and swell in response to dry and wet conditions). The model is capable of reproducing yearly drought-induced building damages suggesting a strong meteorological influence. In addition, due to relation increased damage - increase of temperature the method can be accounted for climate change. For further information, please see:

• Corti, T., Muccione, V., Köllner-Heck, P., Bresch, D., and Seneviratne, S. I.: Simulating past droughts and associated building damages in France, Hydrol. Earth Syst. Sci., 13, 1739-1747, https://doi.org/10.5194/hess-13-1739-2009, 2009.

• Corti, T., Wüest, M., Bresch, D., and Seneviratne, S. I.: Drought-induced building damages from simulations at regional scale, Nat. Hazards Earth Syst. Sci., 11, 3335-3342, https://doi.org/10.5194/nhess-11-3335-2011, 2011.

- Within European Drought Observatory, a methodological approach has been developed for drought risk assessment for national and subnational scales. The method is based on the product of three independent determinants: hazard, exposure and vulnerability. Drought hazard is derived from a non-parametric analysis of historical precipitation deficits; drought exposure is based on a non-parametric aggregation of gridded indicators of population and livestock densities, crop cover and water stress; and drought vulnerability is computed as the arithmetic composite of high level factors of social, economic and infrastructural indicators, collected at both the national and sub-national levels. For further information, please see:

• Hugo, C., Gustavo, N., Paulo, B.,: Mapping global patterns of drought risk: An empirical framework based on sub-national estimates of hazard, exposure and vulnerability, Global Environmental Change, Volume 39, 2016, Pages 108-124, ISSN 0959-3780, http://dx.doi.org/10.1016/j.gloenvcha.2016.04.012.

4.3 Relationship between Risk Data Hub and climate adaptation Web platforms

The European Commission recognises the need for an effective relationship between climate services adaptation and DRR. For example, at EU level, DG ECHO and DG Climate Action work together with complementary responsibilities (e.g. ECHO is responsible for the 'Mechanism for Civil Protection' including the EU Monitoring and Information Centre, and DG Climate Action is responsible for the EU Strategy on Adaptation).

At a practical level, there is emerging experience in Europe of integrating climate change adaptations with DRR services (EEA, 2015):

- at the national level (Austria, Denmark, Finland, France, Germany, Hungary, Ireland, the Netherlands, Norway, Poland, Spain, Sweden, Switzerland and the United Kingdom),
- at transnational level (the Alpine region - PLANALP, the Pyrenees platforms - http://www.opcc-ctp.org and the Baltic Sea Region- EUSBR (EU strategy for Baltic Region,),
- at European level: Climate-ADAPT. Available: http://climate-adapt.eea.europa.eu/

4.3.1 DRR and CCA general aspects

a. <u>Scope DRR and CCA</u>

- Climate adaptation focuses its efforts on supporting adaptation and building resilience. Building resilience is also an important task for DRR. There is thus a common need to address climatological extremes and to reduce vulnerability and enhance resilience.
- The common interests include the identification, implementation and evaluation of prevention and preparedness measures in the context of extreme events. These have led to an expressed need for a stronger relationship between the DRR and climate adaptation communities, including between their respective service platforms.

b. <u>DRR and CCA services - consideration of risk</u>

CCA : - Integration of climate, environment as well as socio-economic information and data. Interest in assessing and addressing climate-related risks.

DRR: - Integration of climate, environment as well as socio-economic information and data. Interest in assessing and addressing disaster related risks, (broader than just climate risks).

c. <u>Means of delivery</u>

- Available and accessed through a variety of mechanisms, including web-based platforms

d. <u>The nature and scope of the platforms</u>

Climate adaptation platforms:

- have different origins and do not yet have a general guiding framework (EEA, 2015)

- tend to focus on providing action-oriented and supportive policy data, information and knowledge (services)
- include socio-economic and other environmental data and information, and tools and resources to support adaptation decision-making.
- addresses changes in extreme climate events,
- focuses its efforts on supporting adaptation and building resilience

Platforms on DRR:

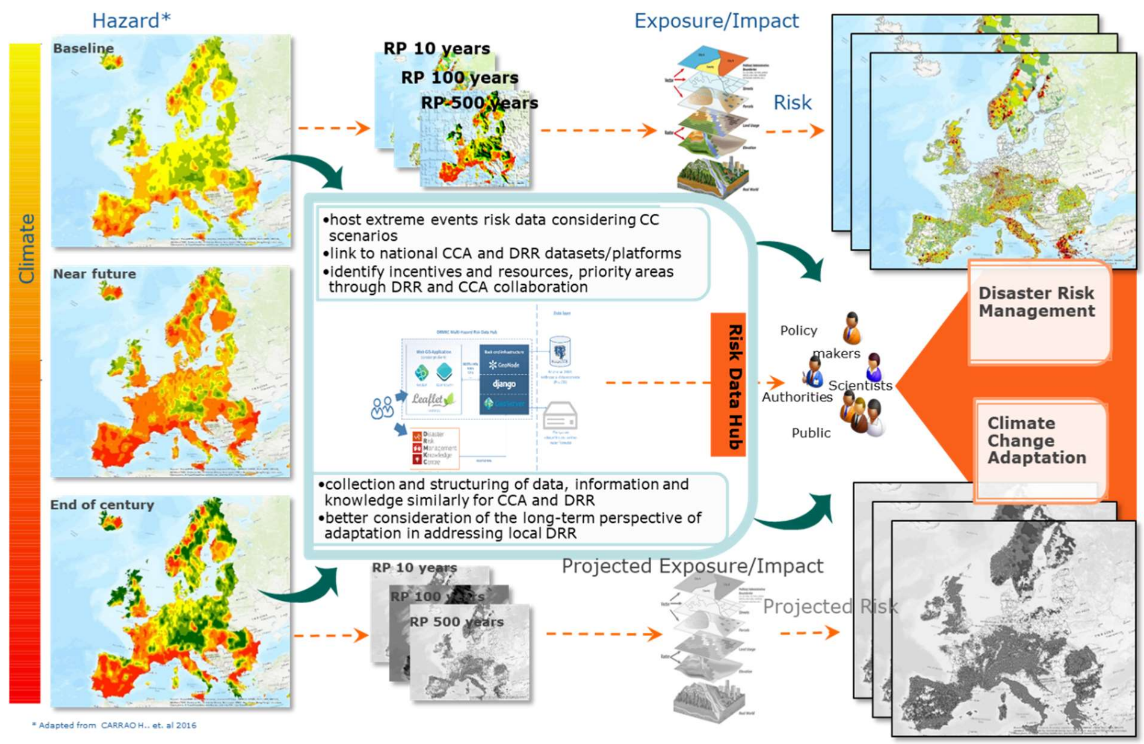
- cover the whole policy and implementation cycle of early warning, prevention, preparedness, response and recovery.
- provide opportunities for interested practitioners to share and develop knowledge and experiences on DRR-related issues
- include socio-economic and environmental data and information, and tools and resources to support risk management decision-making.
- focuses its efforts on supporting adaptation and building resilience

4.3.2 Risk Data hub linking DRR and CCA

The RiskData Hub enhance collaborations with climate adaptation platforms. The RiskData hub is focused on sharing data, information and knowledge, which support users on disaster risk management. Even though various DRR platforms have been operating for this purpose only, the common interests have required a stronger interaction at regional and national level with climate change adaptation platforms. RiskData Hub enhance collaboration within climate adaptation platforms by:

- Identifying incentives (e.g. provide loss and damage assessments as results of extreme events) and resources to enable the appropriate collaboration;

Figure 15. Conceptual approach of the relation DRR and CCA on Risk Data Hub platform



Source: Risk Data Hub, 2017.

- Improving the institutional linkages to better connect these platforms in areas of common interest (identification, implementation and evaluation of prevention and preparedness);

- Exchanging experiences on the collection and structuring of data, information and knowledge;
- Identifying priority areas and improve the links to support collaboration (e.g. integration of response policies, plans and action, and better consideration of the long-term perspective of adaptation in addressing local DRR)

An example: Risk Data Hub contributes to the harmonisation and standardisation of the risk data content, collection and structuring of data considering CCA. It supports the basis for estimating likelihood (from return periods) of extreme events. Socio-economic and environmental exposure and impacts to extreme events are structured based on return periods and are considering climate change scenarios (RCP2.6, RCP4.5, and RCP8.5)[3] for base period, near future and end of the century.

This is important when users are expected to switch between different views of the same topic such: as short-term risk management of extreme events versus long-term adaptation to extreme events in a changing climate (Fig. 15).

[3] 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).

5 Conclusions

Key messages on risk web-platforms good practices

There are several platforms (ONRN, PLANAT, HORA) that offered a complete and easy to access information that used the following characteristics:

- the geospatial information presented on the web platform included the relation exposure – hazard. This approach provides a more complete insight to practitioners and policy makers regarding disaster risk assessments in general.
- the across-scale view in disaster risk assessment was included considering administrative units as aggregation stages for risk information. The management of the risk reflects more the policy component and they are linked with administrative directives, organizations and operational skills coordinated at level of administrative entities.
- the disaster risk information is linked across scale to individual assets/exposure data that can be easily integrated with preparedness, resilience and financing schemes (top-down actions) that are linked at property/asset level.
- the hazard assessment included information based on scenarios (return period). This approach support the probabilistic approach (risk is the probability of the impact/damage) in disaster risk assessment.
- the geospatial information includes mapping on hazard, vulnerability, risk and resilience at local level.
- the cross-discipline approach includes a Multi-Hazard approach. This implies an alignment of methodological approaches and data used for disaster risk assessment across different hazards.
- the geospatial data on hazards and exposure was backed up by loss records of historical events and lessons learnt.
- the level of disaster risk reduction are presented as analysis of the progress made in the implementation of prevention measures (e.g. ONRN platform).

Key messages on risk web-platforms landscape in Europe

- The disaster risk web-platforms in Europe is varied, and the number and scope of such platforms are increasing. There are risk web-platforms that are providing disaster risk information at the national level and for multiple hazards (Austria-HORA, France-ONRN, Slovenia – Atlas Okolja etc.). They are part of governmental institutions, mostly the Environment Ministry.

- At sub-country level the presence of the disaster risk web platforms are linked either with project developments (ex. France – SAMCO project) or are means of assisting decision-makers in the different steps of the adaptation policy cycle. They are primarily linked to the preparation, implementation and evaluation of adaptation strategies and plans. For example the Implementation of flood directive:

- Catalonia Internal Hydrographic Basin, (GIS Viewer) http://aca-web.gencat.cat/recursos/sig/public/VisorPEF.html

- Miño-Sil Hydrographic Basin, (GIS Viewer) http://siams.chminosil.es/snczi/

- Jucar Hydrographic Basin, (GIS Viewer) http://aps.chj.es/idejucar/?f=RWEB_WEB_ARPSI_F&c=SNCZI_Estudio_cartografico_zonas_inundables

- Ebro Hydrographic Basin, (GIS Viewer)
http://iber.chebro.es/sitebro/sitebro.aspx?SNCZI

- Eastern Cantabrico Hydrographic Basin, (GIS Viewer)
http://www.uragentzia.euskadi.net/appcont/gisura/

- At transnational level, the web platforms, mainly developed during projects, are focusing on single hazards (e.g. DriDanube, The ALP FFIRS, Enviro Grids for water scarcity. These different platforms have varied histories and have been in place for different lengths of time. They have also policy contexts that are reflected in the scope of services provided. Most of the platforms are directly linked to the implementation of EU adaptation strategies and plans.

The EU research funds have served as an input for developing amongst platforms, for example the FP7 Framework or the Horizon 2020 Framework Programme for Research and Innovation call. A great number of projects have been developed at European level such as Drought Impact Report Inventory – EDII.

Key messages on needs in risk web platform developments

The geospatial representation of the relation exposure - hazard provides a more complete insight to practitioners and policy makers regarding risk assessments. Disaster risk assessment is set on identifying the geographically located causal factors of disasters, including exposure to hazards, vulnerability of people and property, land use and environment. This is important since an inventory based disaster risk assessment linked to individual assets/exposure, can be easily integrated with preparedness, resilience and financing schemes (top-down actions) that are linked at property/asset level. There is though limitations in terms of linking information to assets level where disaster risk reduction takes place and where financial schemes are applied that are inherited by the risk web platforms developed at European level. Some of these limitations are presented below:

- The assessments information on the web platform often present findings over large areas and data are often aggregated at statistic units (most of the time at administrative areas or hydrological basin). Therefore, the extraction of exposure data for an individual community or sub-set of communities can be challenging and time-consuming for a practitioner. This is important since an inventory based disaster risk assessment linked to individual assets/exposure, can be easily integrated with preparedness, resilience and financing schemes (top-down actions) that are linked at property/asset level.

- The geospatial representation of the relation exposure - hazard with aggregated totals rarely provide practitioners with the ability to focus on a particular topic of interest such as a demographic attribute (e.g., renter-occupied households), business sector (e.g., manufacturing or retail) or land cover type (e.g., wetlands). Availability and accessibility of attribute information for exposure provide the necessary link to evaluate whether the hazard metrics can predict impacts. This detailed datasets creates the basis for studies relating physical characteristics of the natural hazard events to their various impacts.

- In the case of climate driven hazards, most of the risk web-platforms does not offer hazard assessment information based on scenarios and it is limited to presenting aggregated totals (over an area and over historical period).

- Finally, the risk web-platforms that are based on the underlying hazards and socioeconomic relations (temporal, spatial coincidence etc.) are not designed to allow for regular updates as new hazard modelling is completed or new socioeconomic data are acquired.

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List of figures

List of tables

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