INSPIRE
Infrastructure for Spatial Information in Europe

D2.8.III.12 Data Specification on Natural Risk Zones – Draft Guidelines

Title	D2.8.III.12 INSPIRE Data Specification on *Natural* Risk Zones – Draft Guidelines
Creator	INSPIRE Thematic Working Group *Natural* Risk Zones
Date	2011-06-15
Subject	INSPIRE Data Specification for the spatial data theme *Natural* Risk Zones
Publisher	INSPIRE Thematic Working Group *Natural* Risk Zones
Type	Text
Description	This document describes the INSPIRE Data Specification for the spatial data theme *Natural* Risk Zones
Contributor	Members of the INSPIRE Thematic Working Group *Natural* Risk Zones
Format	Portable Document Format (pdf)
Source	
Rights	Public
Identifier	D2.8.III.12_v2.0
Language	En
Relation	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)
Coverage	Project duration

Foreword
How to read the document?

This document describes the *"INSPIRE data specification on Natural Risk Zones – Guidelines"* version 2.0 as developed by the Thematic Working Group (TWG) *Natural Risk Zones* using both natural and a conceptual schema language. This version is now available for the public consultation. Based on the results of the consultation (received comments and the testing reports), the final version 3.0 will be prepared by the TWGs.

The data specification is based on a common template used for all data specifications and has been harmonised using the experience from the development of the Annex I data specifications.

This document provides guidelines for the implementation of the provisions laid down in the draft Implementing Rule for spatial data sets and services of the INSPIRE Directive.

This document includes two executive summaries that provide a quick overview of the INSPIRE data specification process in general, and the content of the data specification on *Natural Risk Zones* in particular. We highly recommend that managers, decision makers, and all those new to the INSPIRE process and/or information modelling should read these executive summaries first.

The UML diagrams (in Chapter 5) offer a rapid way to see the main elements of the specifications and their relationships. The definition of the spatial object types, attributes, and relationships are included in the Feature Catalogue (also in Chapter 5). People having thematic expertise but not familiar with UML can fully understand the content of the data model focusing on the Feature Catalogue. Users might also find the Feature Catalogue especially useful to check if it contains the data necessary for the applications that they run. The technical details are expected to be of prime interest to those organisations that are/will be responsible for implementing INSPIRE within the field of *Natural Risk Zones.*

The technical provisions and the underlying concepts are often illustrated by examples. Smaller examples are within the text of the specification, while longer explanatory examples and descriptions of selected use cases are attached in the annexes.

In order to distinguish the INSPIRE spatial data themes from the spatial object types, the INSPIRE spatial data themes are written in *italics.*

The document will be publicly available as a 'non-paper'. It does not represent an official position of the European Commission, and as such cannot be invoked in the context of legal procedures.

Legal Notice

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

Interoperability of Spatial Data Sets and Services – General Executive Summary

The challenges regarding the lack of availability, quality, organisation, accessibility, and sharing of spatial information are common to a large number of policies and activities and are experienced across the various levels of public authority in Europe. In order to solve these problems it is necessary to take measures of coordination between the users and providers of spatial information. The Directive 2007/2/EC of the European Parliament and of the Council adopted on 14 March 2007 aims at establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) for environmental policies, or policies and activities that have an impact on the environment.

INSPIRE will be based on the infrastructures for spatial information that are created and maintained by the Member States. To support the establishment of a European infrastructure, Implementing Rules addressing the following components of the infrastructure are being specified: metadata, interoperability of spatial data themes (as described in Annexes I, II, III of the Directive) and spatial data services, network services and technologies, data and service sharing, and monitoring and reporting procedures.

INSPIRE does not require collection of new data. However, after the period specified in the Directive[1] Member States have to make their data available according to the Implementing Rules.

Interoperability in INSPIRE means the possibility to combine spatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or machines. It is important to note that "interoperability" is understood as providing access to spatial data sets through network services, typically via Internet. Interoperability may be achieved by either changing (harmonising) and storing existing data sets or transforming them via services for publication in the INSPIRE infrastructure. It is expected that users will spend less time and efforts on understanding and integrating data when they build their applications based on data delivered within INSPIRE.

In order to benefit from the endeavours of international standardisation bodies and organisations established under international law their standards and technical means have been utilised and referenced, whenever possible.

To facilitate the implementation of INSPIRE, it is important that all stakeholders have the opportunity to participate in specification and development. For this reason, the Commission has put in place a consensus building process involving data users, and providers together with representatives of industry, research and government. These stakeholders, organised through Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO)[2], have provided reference materials, participated in the user requirement and technical[3] surveys, proposed experts for the Data Specification Drafting Team[4] and Thematic Working Groups[5].

---

[1] For all 34 Annex I,II and III data themes: within two years of the adoption of the corresponding Implementing Rules for newly collected and extensively restructured data and within 5 years for other data in electronic format still in use

[2] Number of SDICs and LMOs on 8/6/2011 was 461 and 249 respectively

[3] Surveys on unique identifiers and usage of the elements of the spatial and temporal schema,

[4] The Data Specification Drafting Team has been composed of experts from Austria, Belgium, Czech Republic, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Switzerland, UK, and the European Environmental Agency

[5] The Thematic Working Groups of Annex II and III themes have been composed of experts from Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, Turkey, UK, the European Commission, and the European Environmental Agency

This open and participatory approach was successfully used during the development of the data specification on Annex I data themes as well as during the preparation of the Implementing Rule on Interoperability of Spatial Data Sets and Services[6] for Annex I spatial data themes.,

The development framework elaborated by the Data Specification Drafting Team aims at keeping the data specifications of the different themes coherent. It summarises the methodology to be used for the data specifications and provides a coherent set of requirements and recommendations to achieve interoperability. The pillars of the framework are four technical documents:

- The Definition of Annex Themes and Scope[7] describes in greater detail the spatial data themes defined in the Directive, and thus provides a sound starting point for the thematic aspects of the data specification development.

- The Generic Conceptual Model[8] defines the elements necessary for interoperability and data harmonisation including cross-theme issues. It specifies requirements and recommendations with regard to data specification elements of common use, like the spatial and temporal schema, unique identifier management, object referencing, a generic network model, some common code lists, etc. Those requirements of the Generic Conceptual Model that are directly implementable will be included in the Implementing Rule on Interoperability of Spatial Data Sets and Services.

- The Methodology for the Development of Data Specifications[9] defines a repeatable methodology. It describes how to arrive from user requirements to a data specification through a number of steps including use-case development, initial specification development and analysis of analogies and gaps for further specification refinement.

- The "Guidelines for the Encoding of Spatial Data"[10] defines how geographic information can be encoded to enable transfer processes between the systems of the data providers in the Member States. Even though it does not specify a mandatory encoding rule it sets GML (ISO 19136) as the default encoding for INSPIRE.

Based on these framework documents and following the successful development of the Annex I Data specifications (Technical Guidelines) and the Implementing Rules, the new Thematic Working Groups have created the INSPIRE data specification for each Annex II and III theme. These documents – at the version 2.0 – are now publicly available for INSPIRE stakeholders for consultation. The consultation phase covers expert review as well as feasibility and fitness-for-purpose testing of the data specifications.

The structure of the data specifications is based on the "ISO 19131 Geographic information - Data product specifications" standard. They include the technical documentation of the application schema, the spatial object types with their properties, and other specifics of the spatial data themes using natural language as well as a formal conceptual schema language[11].

A consolidated model repository, feature concept dictionary, and glossary are being maintained to support the consistent specification development and potential further reuse of specification elements. The consolidated model consists of the harmonised models of the relevant standards from the ISO 19100 series, the INSPIRE Generic Conceptual Model, and the application schemas[12] developed for

---

[6] Commission Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services, published in the Official Journal of the European Union on 8th of December 2010.

[7] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.3_Definition_of_Annex_Themes_and_scope_v3.0.pdf*

[8] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.5_v3.3.pdf*

[9] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.6_v3.0.pdf*

[10] *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.7_v3.2.pdf*

[11] UML – Unified Modelling Language

[12] Conceptual models related to specific areas (e.g. INSPIRE themes)

each spatial data theme. The multilingual INSPIRE Feature Concept Dictionary contains the definition and description of the INSPIRE themes together with the definition of the spatial object types present in the specification. The INSPIRE Glossary defines all the terms (beyond the spatial object types) necessary for understanding the INSPIRE documentation including the terminology of other components (metadata, network services, data sharing, and monitoring).

By listing a number of requirements and making the necessary recommendations, the data specifications enable full system interoperability across the Member States, within the scope of the application areas targeted by the Directive. They will be published (version 3.0) as technical guidelines and will provide the basis for the content of the Amendment of the Implementing Rule on Interoperability of Spatial Data Sets and Services for data themes included in Annex II and III of the Directive. The Implementing Rule Amendment will be extracted from the data specifications keeping in mind short and medium term feasibility as well as cost-benefit considerations. The Implementing Rule will be legally binding for the Member States.

In addition to providing a basis for the interoperability of spatial data in INSPIRE, the data specification development framework and the thematic data specifications can be reused in other environments at local, regional, national and global level contributing to improvements in the coherence and interoperability of data in spatial data infrastructures.

Natural Risk Zones – Executive Summary

INSPIRE Directive (2007/2/EC) defines Natural Risk Zones theme as: “Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions.”

Version 2.0 of the data specification presents some further refinement of this definition and scope and provides implementation guidelines through a UML model that will be the basis for the Implementing Rules.

This specification is the work of the Natural Risk Zones thematic working group. A multinational team of experts volunteered from the community of SDICs (Spatial Data Interest Communities) and LMOs (Legally Mandated Organisations) of INSPIRE.

This version has been compiled using reference material submitted by SDICs and LMOs and the responses to a user requirements survey. The team themselves have had to draw on their own expertise and that of their organisations and other groups to develop agreed use cases in a selection of areas pertinent to Natural Risk Zones.

The scope of the Natural Risk Zones data specification is potentially very large and chapter 2 of this report develops a scope for the work. Natural Risk Zones also involves significant engagement with other thematic areas from INSPIRE. This involvement stems from the nature of hazard, exposure, vulnerability and risk as defined later in this document. Several other thematic areas will input attributes vital to understanding the nature of hazard, yet others are vital in the understanding of exposure. In working on the scope of the Natural Risk Zones theme four use cases were created; Floods, Landslide, Forest Fire and Earthquake. These use cases are listed in Annex C and detail the links to other INSPIRE thematic areas.

The approach taken to model Natural Risk Zones is generic in its treatment of each of hazard, exposure, vulnerability and risk, with a core model, whilst allowing extensibility to be more specific where possible and required. Flood risk is significantly more precisely defined than other hazards, due in part to the development of the Floods Directive (2007/60/EC). In version 2.0 of the specification we have been able to demonstrate the extensibility of the model, providing an example application schema specifically targeted at floods.

One of the main purposes of hazard and risk maps is to inform in a clear way thus supporting effective communication between modellers, data providers, policy makers and the citizen. We hope that this data specification can play a part in making this communication better.

Acknowledgements

Many individuals and organisations have contributed to the development of these Guidelines.

The Thematic Working Group Natural Risk Zones (TWG-NZ) included:
Matthew Harrison (TWG Facilitator), Florian Thomas (TWG Editor), José I. Barredo, Venco Bojilov, Andrea Camia, Raquel Canet Castella, Otakar Cerba, George Exadaktylos, Cristiano Giovando, Miguel Llorente Isidro, Manuela Pfeiffer, Robert Tomas (European Commission contact point).

Other contributors to the INSPIRE data specifications are the Drafting Team Data Specifications, the JRC data specifications team and the INSPIRE stakeholders - Spatial Data Interested Communities (SDICs) or Legally Mandated Organisations (LMOs).

Contact information
Vanda Nunes de Lima
European Commission Joint Research Centre
Institute for Environment and Sustainability
Spatial Data Infrastructures Unit
TP262, Via Fermi 2749
I-21027 Ispra (VA)
ITALY
E-mail: vanda.lima@jrc.ec.europa.eu
Tel.: +39-0332-7865052
Fax: +39-0332-7866325
http://ies.jrc.ec.europa.eu/
http://ec.europa.eu/dgs/jrc/
http://inspire.jrc.ec.europa.eu/

Table of contents

1 Scope

This document specifies a harmonised data specification for the spatial data theme *Natural Risk Zones* as defined in Annex III of the INSPIRE Directive.

This data specification provides the basis for the drafting of Implementing Rules according to Article 7 (1) of the INSPIRE Directive [Directive 2007/2/EC]. The entire data specification will be published as implementation guidelines accompanying these Implementing Rules.

2 Overview

2.1 Name

INSPIRE data specification for the theme Natural Risk Zones.

2.2 Informal description

Definition:

Below is the definition of Natural Risk Zones as provided by the INSPIRE Directive.

Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions. [Directive 2007/2/EC]

As predicted by the Data Specification Drafting Team, in light of Annex I and the greater detail that a dedicated Annex II or III Thematic Working Group can enter into, this is here updated using the latest research and experience available.

Description:

"Natural risk zones" are zones where natural hazards areas intersect with highly populated areas and/or areas of particular environmental/ cultural/ economic value. Risk in this context is defined as:

Risk = Hazard x Vulnerability x Exposure

of the environmental, cultural and economic assets in the zone considered.

The definition of each of these terms almost has a discipline of their own. For the purposes of the INSPIRE natural risk zones thematic working group we have decided to adopt the existing, yet specific definitions below.

Risk
Risk is the combination of the consequences of an event (hazard) and the associated likelihood/probability of its occurrence. (ISO 31010)

Comment: This definition closely follows the definition of the ISO/IEC Guide 73. The word "risk" has two distinctive connotations: in popular usage the emphasis is usually placed on the concept of chance or possibility, such as in "the risk of an accident"; whereas in technical settings the emphasis is usually placed on the consequences, in terms of "potential losses" for some particular cause, place and period. It can be noted that people do not necessarily share the same perceptions of the significance and underlying causes of different risks.(UNISDR 2009)

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. (UNISDR 2009)

Comment: The hazards of concern to disaster risk reduction as stated in footnote 3 of the Hyogo Framework are "… hazards of natural origin and related environmental and technological hazards and risks." Such hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis.(UNISDR2009)

Exposure

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. (UNISDR 2009)

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.(UNISDR 2009)

Comment: There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure. However, in common use the word is often used more broadly to include the element's exposure. UNISDR (2009)

One of the reasons for the difficulty in terminology is that the language of risk has developed across a broad range of disciplines, including those beyond the scope of this thematic working group, including financial risk, disaster management etc. Diagram 1 attempts to demonstrate the relationship between the various concepts defined above in a spatial context.

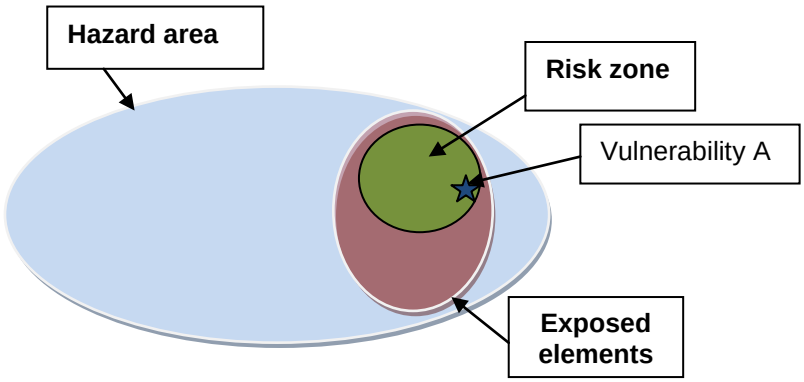


Diagram 1. Diagram depicting the main concepts in the natural risk zones model

$$R = H * E * V$$

For example:

Chance of flood magnitude A = 1% annual chance of occurrence (Hazard)

Exposed elements = 1,000 houses are within area delineated by flood magnitude A.

Vulnerability = 50%; value of average damage expected to each house exposed.

R(isk) = 0.01 * 1,000 * 0.5 = **1% chance <u>every year</u> of having 5 houses destroyed due to floods of magnitude A**.

Some of the confusion arises from the inexact use of language when both specialists and non-specialists are talking about the concept of risk. Vulnerability and exposure are the terms most frequently interchanged and indeed in the Forest Fire Use case in Annex C vulnerability is used throughout where we have formally used the term exposure in the model. The terms used in the model follow the UNISDR2009 definitions and more recently the “Risk Assessment and Mapping Guidelines for Disaster Managment” document of the Council of the European Union.

In the insurance industry risks are referred to using the term “Perils”. Limited further work will be undertaken in the coming months with the insurance and reinsurance industry to understand their requirements, bearing in mind that INSPIRE Directive first applies to public authorities. This sector are large users of Public Sector hazard, risk and vulnerability Information and are a significant part of an international risk management framework that will, we hope, benefit from this data specification. Work is continuing elsewhere in the Commission regarding updating “Proposal for a Directive of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance - Solvency II {SEC(2007) 870} {SEC(2007) 871} /* COM/2007/0361 final - COD 2007/0143 */” known as Solvency II. This will have implications for the Insurance industry regarding provision of insurance for perils and this data specification should align with the proposals where possible.

As another example of the wider use of Nautral Risk Zones information, in the EU the Structural Eurocodes or Eurocodes are the current building standards for Europe and they are published by the European Committee for Standardization. Eurocode 1, for example, considers fire action on building structures, whereas Eurocode 8 refers to earthquake resistant buildings. So, it is important always to associate "vulnerability" assessment of building structures with the application or not of Eurocodes. In order to make an assessment as of whether an "exposed" engineering structure (asset) is also "vulnerable" and "how vulnerable (i.e. a damage assessment) it is" against a given hazard class (e.g. flood, fire, landslide etc) one should know the design and construction (or retrofitting) characteristics of this particular structure as well as if this design (retrofitting) is based on some standards or codes of practice. For example if a building or retaining wall etc is made from fire resistant materials, then it is not vulnerable at large extent to a fire, or if a building is earthquake resistant, it is not expected to suffer serious damages in an earthquake, unlike another building that is old and has been constructed without special consideration to earthquakes.

Thematic Working Group Scope

The data and information that are included in this data specification takes as one starting point the existence of the delineation of a hazard area. As a consequence, this data specification does not include the modelling of the processes and scientific models that were used in the identification of hazard areas.

The data specification includes discussion of natural hazards only, not technological hazards. It is anticipated that some technological hazards could precipitate natural hazards (and *vice versa*), in which case the model would remain valid as causative factors are not modelled. It is also true that the core of the model may be valid for the modelling of other risks beyond the scope of the Natural Risk Zones specification. The model hasn’t been designed with these in mind but may be useful in these circumstances.

Hazards can be single, sequential or combined in their origin and effects. The data model is designed so that it could also operate for multi-risk circumstances.

The model will only include measured past events and modelled future events. It does not deal with events as they are happening. This is the domain of emergency response which is largely out of scope.

The core model is extensible in many directions, to cover many domains and in version 2.0 we have included a Floods application schema as an example of how that may be achieved.

Many of the hazards are sudden in their nature. However, several categories of natural hazards with major impacts on civil security and on environmental/ cultural and economic assets are not sudden in nature. They may be permanent phenomena going unnoticed (e.g..: radon gas emanations, deficit or excess of elements in soils and water), or slow phenomena (slow ground motion). These hazards are considered within scope.

The thematic working group believes that it is important for all potential users of natural risk zones information to know what hazard is causing a particular risk zone. It is important for the mitigation and management of the risk. There are few definitive sources of natural hazard classification and as a result the thematic working group have agreed on a very high level hazard type classification as adopted by the two largest natural hazard databases; maintained by re-insurer Munich Re and CRED (Centre of Research on the Epidemiology of Disasters). This is included in the model. It is highly recommended that at member state level data providers add to the limited codelist provided in the model to list detailed hazard types. One option for these detailed hazard types is included below, table 1. This is a table that attempts to list and characterize the main types of hazard as recognised by the experts in the creation of this document and accompanying model. This model was initially proposed by the Spanish Geological Survey and has had subsequent modifications by the thematic working group. Whilst it is by no means exhaustive, the group feels that it is representative and by considering the hazards identified there, much of the range of hazards considered to be in scope will have been covered. In the annex B to this document, definitions and descriptions for those hazards listed here are provided.

Category	Item
Biohazard	Biohazard
Climate	Climate
	Glaciation
	Impact winter - Volcanic Winter
	Natural desertification
Cosmic	Cosmic
	Gamma Radiation
	Gravity Field Alterations
	Magnetic Disruptions
	Meteorites
	Solar Storm
Geologic/Earthquake	Earthquake
	liquefaction
	peak ground acceleration
	peak ground linear dislocation
	seismic wave amplification
Geologic/Erosion	Erosion
	shoreline recession
	soil depletion
Meterological/Flood	Flood
	exurgences
	natural reservoir failure
	water table risings
	Fluvial
	Groundwater
	Pluvial
	Seawater
Forest Fire (WildFire)	Forest Fire (WildFire)
Geologic/ Ice	Ice
	Gas Hydrate Instabilisation
	Moving Ice Body
	Permafrost Alteration
Geologic/Landslide	Landslide
	debris flow

	Karstic Or Pseudo Karstic Collapse
	Mudflow
	Rockfall
	Sand Dune Movement
	Shore Line And Cliff Recession
	Slide
	Soil Creep (slow earthflow)
	spreads
	Subsidence
	topple
	Snow Avalanche
Meteorological	Meteorological
	Lightning
	Drought
	Extreme Temperature
	Freezing rain
	Freezing Thawing
	Hail
	Hurricane
	Snow
	Tempest
	Tornado
	Oceanic
Geologic/ Rock Or Soil	RockOrSoil
	Compressibility
	Loessic Soil Collapse
	Shrink Swell Clays
	Solubility
	Unconsolidated Sands
Geologic/ToxicMaterial	ToxicMaterial
	Asbestos
	gases
	Methane And Carbon Dioxide
	Natural Radioactivity
	Potentially Harmful Elements
	toxicMaterial/Radon
	Salts
	Spontaneous Combustion
Geologic/Tsunami	Tsunami
Geologic/Volcano	Volcano
	Ash
	Ejected Material
	Explosions
	Jokulhaup
	Lahar
	Lava
	Pyroclastic Flow
	Volcanic Gases

Table 1. Non-exhaustive classification of hazards included as an example to demonstrate scope of Natural Risk Zones.

Exposed elements and links to other thematic working groups

Knowledge about elements exposed to the specific hazard is also of utmost importance. So assessment of the level of threat that a certain hazard (flood, landslide, forest fires, etc...) poses to life, health, property or environment should be conducted. Here, data and services about settlements, infrastructures, land use and many others will be needed and provided by the other Annex I, II and III thematic working groups. Examples of these would include but not be limited to: Buildings, Transport networks, Land use, Industrial and production facilities, Agricultural and Aqua-cultural facilities, Utility and government services. In our data model we have a feature type with both an unspecified geometry and an attribute that refers to an empty codelist to contain the type of these exposed elements. In Annex B a table is provided containing a French example of such exposed elements. This will form the basis for the codelist, although member states may have further or more detailed requirements.
There has been discussion with Area Management and Land-Use about the monitoring of Risk Zones. Links are provided in the model for risk zones that would fall under the jurisdiction of the Area Management model with a flag for their legal status, which is likely in some member states.

Use examples

This section describes the groups that will use the information in the model. Further, more detailed examples are given for floods, landslide, forest fire and earthquake in annex C.

The different kinds of users for managing hazard and risk and hazard and risk information may be grouped into four:

- assessment of natural and technological risks – mapping of areas prone to be hit by hazards
- planning phase for securing public safety- long term regulation and management of land and activities
- reporting, trends and overall policy development , commonly at national and international level
- disaster response and emergency operations

Four different forms of usage are identified below, including an outline of their spatial data needs. Based on the data, different kinds of services may be developed and used.

- **Susceptibility analysis, mapping and prediction:** Data sets describing and analysing the natural phenomena causing hazards, commonly detailed data with high accuracy is needed, such as measuring stations, detailed thematic mapping through fieldwork (e.g. specific aspects of soil and land cover) , air photo interpretation or remote sensing, analysis of detailed elevation models, water flow data linked to the river and lake network, meteorological and climate data, seismic activity mapping etc. Work is seen to be carried out by both local authorities, national mapping agencies, national thematic agencies or international organisations.
- **Physical and sector disaster-prevention planning:** Making disaster-resistant communities by long term physical and sector planning, usually carried out at local and regional level. The mapping carries of by thematic agencies as described over will is used and transformed into simplified data sets and planning documents showing areas of high risk and restriction zones at or around high risk areas. The delimitation of the restriction zones would need population data, land use plans etc.
- **Reporting, indicators, trends, overall policy development:** The needs for spatial data by this use is limited. Usually one will need reporting units such as countries, NUTS regions, or catchment areas. There will be some use of generalised versions of data sets to be used under the other use categories. Overall trends in frequency of natural hazards is for some of the phenomena linked to the environmental situation – climate change in particular and land cover changes in particular. Data needed for analysing links and dependencies are needed.
- **Emergency operations/disaster response:** The emergency operations for both natural and technological hazards needs more or less the same kinds of data. In order to make emergency management a faster and more accurate means to reduce effects, data are needed in several parts of the operation;
  - Monitoring; continuous or real time situation reports, giving information on trends, direction etc. Using GNSS linked to detailed topographic map data
  - Overview and identification of qualities at land and sea; persons, property, production activities, infrastructure and environmental qualities that can be affected by the hazard/ disaster. It is essential to access the extensiveness of the anticipated damage caused by natural and technological hazards. There is a need to know about population information at the lowest possible level, property information making it possible to identify owners of individual properties, address register for information purposes and identification, mapping of areas/ infrastructure affected, such as roads, rail, telecommunication lines, water, gas pipe lines, oil installation at sea, storage areas for hazardous substances, resources such as important groundwater bodies,

other extraction points for water or other resources, land use, location of high value environmental areas (biodiversity, recreation, cultural heritage sites etc)

- Location of resources needed to perform the operation; Infrastructure, road and rail capacity, water supply points, depot for emergency equipment (oil spill extraction boats, vehicles etc) location and capacity of hospitals, information to see vehicle information on location, allocating resources, deploying personnel. Included here is also the administrative boundaries for responsibility areas of different bodies involved in the operation.

2.3 Normative References

[Directive 2007/2/EC] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[ISO 19107] EN ISO 19107:2005, Geographic Information – Spatial Schema

[ISO 19108] EN ISO 19108:2005, Geographic Information – Temporal Schema

[ISO 19108-c] ISO 19108:2002/Cor 1:2006, Geographic Information – Temporal Schema, Technical Corrigendum 1

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19113] EN ISO 19113:2005, Geographic Information – Quality principles

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19123] EN ISO 19123:2007, Geographic Information – Schema for coverage geometry and functions

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19138] ISO/TS 19138:2006, Geographic Information – Data quality measures

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

NOTE This is an updated version of "EN ISO 19125-1:2006, Geographic information – Simple feature access – Part 1: Common architecture". A revision of the EN ISO standard has been proposed.

[Regulation 1205/2008/EC] Regulation 1205/2008/EC implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

2.4 Terms and definitions

General terms and definitions helpful for understanding the INSPIRE data specification documents are defined in the INSPIRE Glossary[13].

Specifically, for the theme Natural Risk Zones, the following terms are defined:

[13] The INSPIRE Glossary is available from http://inspire-registry.jrc.ec.europa.eu/registers/GLOSSARY

(1) Hazard
A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. (UNISDR 2009)

EXAMPLE Earthquake hazard.

(2) Vulnerability
The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.(UNISDR 2009)

EXAMPLE Elderly residents

(3) Risk
Risk is the combination of the consequences of an event (hazard) and the associated likelihood/probability of its occurrence. (ISO 31010).

EXAMPLE 10000 People will lose their potable water supply with a percentage likelihood due to earthquakes of magnitude 6 or above.

(4) Exposure
People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. (UNISDR 2009)

EXAMPLE A hospital is in the affected area

2.5 Symbols and abbreviations

None

2.6 Notation of requirements and recommendations

To make it easier to identify the mandatory requirements and the recommendations for spatial data sets in the text, they are highlighted and numbered.

IR Requirement X	Requirements that are reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

DS Requirement X	Requirements that are not reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

Recommendation 1 Recommendations are shown using this style.

2.7 Conformance

DS Requirement 1	Any dataset claiming conformance with this INSPIRE data specification shall pass the requirements described in the abstract test suite presented in Annex A.

3 Specification scopes

This data specification does not distinguish different specification scopes, but just considers one general scope.

NOTE For more information on specification scopes, see [ISO 19131:2007], clause 8 and Annex D.

4 Identification information

NOTE Since the content of this chapter was redundant with the overview description (section 2) and executive summary, it has been decided that this chapter will be removed in v3.0.

5 Data content and structure

IR Requirement 1	Spatial data sets related to the theme *Natural Risk Zones* shall be provided using the spatial object types and data types specified in the application schema(s) in this section.

IR Requirement 2	Each spatial object shall comply with all constraints specified for its spatial object type or data types used in values of its properties, respectively.

Recommendation 1	The reason for a void value should be provided where possible using a listed value from the VoidValueReason code list to indicate the reason for the missing value.

NOTEThe application schema specifies requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc. All properties have to be reported, if the relevant information is part of the data set. Most properties may be reported as “void”, if the data set does not include relevant information. See the Generic Conceptual Model [INSPIRE DS-D2.5] for more details.

5.1 Basic notions

This section explains some of the basic notions used in the INSPIRE application schemas. These explanations are based on the GCM [DS-D2.5].

5.1.1 Stereotypes

In the application schemas in this sections several stereotypes are used that have been defined as part of a UML profile for use in INSPIRE [INSPIRE DS-D2.5]. These are explained in Table 1 below.

Table 1 – Stereotypes (adapted from [INSPIRE DS-D2.5])

Stereotype	Model element	Description

applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
featureType	Class	A spatial object type.
type	Class	A conceptual, abstract type that is not a spatial object type.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
enumeration	Class	A fixed list of valid identifiers of named literal values. Attributes of an enumerated type may only take values from this list.
codeList	Class	A flexible enumeration that uses string values for expressing a list of potential values.
placeholder	Class	A placeholder class (see definition in section 5.1.2).
voidable	Attribute, association role	A voidable attribute or association role (see definition in section 5.1.3).
lifeCycleInfo	Attribute, association role	If in an application schema a property is considered to be part of the life-cycle information of a spatial object type, the property shall receive this stereotype.
version	Association role	If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general.

5.1.2 Placeholder and candidate types

Some of the INSPIRE Annex I data specifications (which were developed previously to the current Annex II+III data specifications) refer to types that thematically belong and were expected to be fully specified in Annex II or III spatial data themes. Two kinds of such types were distinguished:

- *Placeholder types* were created as placeholders for types (typically spatial object types) that were to be specified as part of a future spatial data theme, but which was already used as a value type of an attribute or association role in this data specification.

  Placeholder types received the stereotype «placeholder» and were placed in the application schema package of the future spatial data theme where they thematically belong. For each placeholder, a definition was specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these definitions in the specification work of the Annex II or III theme.

  If necessary, the attributes or association roles in the Annex I data specification(s) that have a placeholder as a value type shall be updated if necessary.

- *Candidate types* were types (typically spatial object types) for which already a preliminary specification was given in the Annex I data specification. Candidate types did not receive a specific stereotype and were placed in the application schema package of the future spatial data theme where they thematically belong. For each candidate type, a definition and attributes and association roles were specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these specifications in the specification work of the Annex II or III theme.

  If the type could not be incorporated in the Annex II or III data specification according to its preliminary specification, it should be moved into the application schema of the Annex I theme where it had first been specified. In this case, the attributes or association roles in the Annex I data specification(s) that have the type as a value type shall be updated if necessary.

Open issue 1: For all Annex II+III themes for which placeholders and candidate types were specified in an Annex I data specification, it should be clearly indicated in the data specification, how the placeholder and candidate types were taken into account. If the proposed solution would require any changes to an Annex I data specification (and the corresponding section in the IR for interoperability of spatial data sets and services), this should also be clearly indicated.

A thorough investigation of the implications of the proposed changes of candidate types (in particular related to requirements of Annex I maintenance) will have to be performed for v3.0 of the data specifications.

5.1.3 Voidable characteristics

If a characteristic of a spatial object is not present in the spatial data set, but may be present or applicable in the real world, the property shall receive this stereotype.

If and only if a property receives this stereotype, the value of *void* may be used as a value of the property. A *void* value shall imply that no corresponding value is contained in the spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs, even though the characteristic may be present or applicable in the real world.

It is possible to qualify a value of void in the data with a reason using the VoidValueReason type. The VoidValueReason type is a code list, which includes the following pre-defined values:

- *Unpopulated*: The characteristic is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the “elevation of the water body above the sea level” has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be ‘Unpopulated’. The characteristic receives this value for all objects in the spatial data set.
- *Unknown*: The correct value for the specific spatial object is not known to, and not computable by the data provider. However, a correct value may exist. For example when the “elevation of the water body above the sea level” *of a certain lake* has not been measured, then the reason for a void value of this property would be ‘Unknown’. This value is applied on an object-by-object basis in a spatial data set.

NOTEIt is expected that additional reasons will be identified in the future, in particular to support reasons / special values in coverage ranges.

The «voidable» stereotype does not give any information on whether or not a characteristic exists in the real world. This is expressed using the multiplicity:

- If a characteristic may or may not exist in the real world, its minimum cardinality shall be defined as 0. For example, an if an Address may or may not have a house number, the multiplicity of the corresponding property shall be 0..1.
- If at least one value for a certain characteristic exists in the real world, the minimum cardinality shall be defined as 1. For example, if an Administrative Unit always has at least one name, the multiplicity of the corresponding property shall be 1..*.

In both cases, the «voidable» stereotype can be applied. A value (the real value or void) only needs to be made available for properties that have a minimum cardinality of 1.

5.1.4 Code lists and Enumerations

5.1.4.1. Style

All code lists and enumerations use the following modelling style:

- No initial value, but only the attribute name part, is used.
- The attribute name conforms to the rules for attributes names, i.e. is a lowerCamelCase name. Exceptions are words that consist of all uppercase letters (acronyms).

5.1.4.2. Governance of code lists

Two types of code lists are defined in INSPIRE. These two types are distinguished using the tagged value “extendableByMS” in the UML data model:

- *Code lists that **may not** be extended by Member States.* For these code lists, the tagged value is set to “false”. They shall be managed centrally in the INSPIRE code list register, and only values from that register may be used in instance data.
- *Code lists that **may** be extended by Member States.* For these code lists, the tagged value is set to “true”.

5.2 Application schema Core_Model

5.2.1 Description

5.2.1.1. Narrative description

The common schema covers elements seen as necessary by the thematic working group to describe natural risk zones. Included in this draft is a separate application schema for flooding described later designed to demonstrate the extensibility of the data model into a domain-specific and well regulated area.

The common schema allows the user to model the main concepts of risk as defined in chapter 2 (Hazard, vulnerability, exposure and risk).

A natural risk zone is a feature which results from the coincidence over the same area of a natural hazard and exposed elements that are vulnerable to this hazard.

This model is based upon ISO 19103 Spatial schema, and therefore concerns vector features.

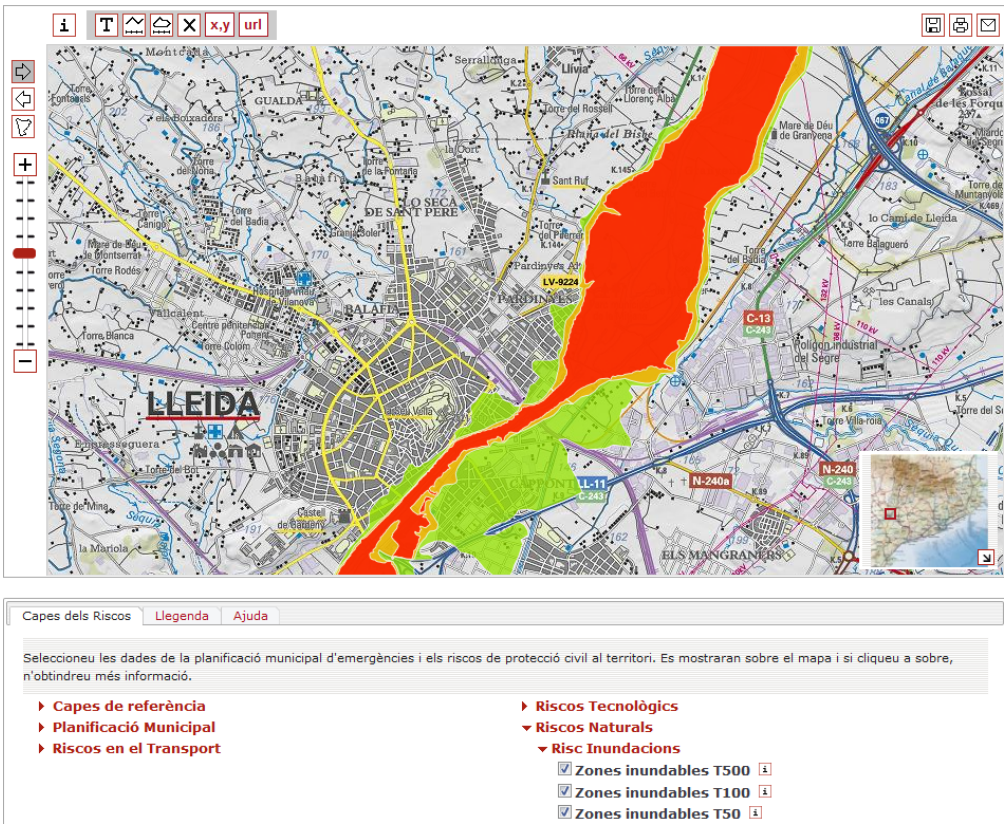


Figure 1 – Example of natural risk zones data covered by the Core model : "Mapa de Protecció Civil de Catalunya". http://taure.icc.cat/pcivil/map.jsp

HAZARD AREA

A hazard area ("HazardArea") has either a surface (which itself can be a single or a multi-surface) geometry, or as a solid (which itself can also be a single or a multi-solid) geometry. Apart from the Inspire Identifier, it has one mandatory attribute: the type of hazard ("TypeOfHazard").
The type of hazard refers to the "NaturalRiskOrHazardClassification" data type.

The "NaturalRiskOrHazardClassification" data type is one central attribute of the core model. As there is currently no list or thesaurus or classification of natural hazards or risks that can be considered as an international standard, this data type deals with two challenges: creating an interoperable list of hazard in respect of enabling the provision of more specific information about the type of hazard.
This challenge has been met by the creation of a coexistence of a mandatory attribute ("riskOrHazardCategory") that makes reference to an enumeration of high-level values of categories of hazards ("HazardCategoryValue") with a voidable attribute ("specificRiskOrHazardType") that provides additional information about the type of hazard. A single category of hazard can be divided into several hazard types.

The specific risk or hazard type values are code lists which are not described in this model: its extension is left up to each data provider in their own code list registers.

IR Requirement 3 Each hazard area must have a hazard type value.

Open issue 2: The modelling of multi-risk/ multi-hazard assessment requires further work before version 3.0. For version 2.0 it is stated that a risk zone is linked to one hazard area and that one (or several) hazard area(s) can result from the co-occurrence of several source hazards.

Any hazard area feature is either a observed ("ObservedHazard") or modelled or determined ("ModelledOrDeterminedHazard"). As a consequence, the hazard area feature class is abstract.

The type of hazard ("TypeOfHazard") is managed in the same way as the type of risk ("TypeOfRisk"). Both attributes refer to the "NaturalRiskOrHazardClassification" data type.

Apart from the hazard type and Inspire Id, there are two voidable attributes:
- the level of hazard ("LevelOfHazard")
- the likelihood of occurrence ("LikelihoodOfOccurence").

This concept of level of hazard can integrate the notion of intensity. When described qualitatively, it can also address susceptibility. The likelihood of occurrence is a general concept relating to the chance of an event occurring. This refers to the "LikelihoodOfOccurrence" data type.

A level of hazard can be expressed either qualitatively, or quantitatively. A qualitative assessment resides in choosing a value (or a word) among a pre-determined list. For example, assessing that there is a "medium", or "high" level of hazard is a qualitative assessment. Contrary to this concept, a quantitative assessment involves applying a value among a range of possible values (the range being defined by the scale). For example, assessing the level of an earthquake magnitude along a scale is a quantitative assessment.
The data type is therefore made of 4 attributes, 2 for a qualitative assessment ("qualitativeLevelHazardAssessmentMethod" and "qualitativeValue"), and 2 for the quantitative assessment ("quantitativeLevelHazardAssessmentMethod" and "quantitativeValue").
By assessment, we mean the combination of a value with a reference of the scale or method which is used to express the level of risk / hazard. The value is not useful if the method is not indicated as well. The qualitative value is a character string; the quantitative value is a number. The reference is a citation.

Both the level of risk (respectively the level of hazard) can be assessed qualitatively and / or quantitatively.

A likelihood of occurrence can be expressed either qualitatively, or quantitatively. The process of modelling this specific issue is similar to the level of risk and level of hazard processes to the main extent. 4 attributes are set: 2 for a quantitative assessment ("quantitativeLikelihoodAssessmentMethod" and "quantitativeLikelihood"), and 2 for the qualitative assessment ("qualitativeLikelihoodAssessmentMethod" and "qualitativeLikelihood").

Open issue 3: Inclusion of the notion of susceptibility in the likelihood of occurrence. The qualitative assessment of the likelihood of occurrence is sometimes known as susceptibility.

Yet, the quantitative assessment attribute is not a Number: it is either a probability of occurrence, or a return period. A return period is a long-term average interval of time or number of years within which an event will be equalled or exceeded. The probability of occurrence is the inverse value of the return period.
The "LikelihoodOfOccurrence" data type also encompasses a piece of information about the period of validity of the assessment of the hazard: the "validAssessmentPeriod" attribute.
In a hypothetical case of forest fires, a dataset could be provided where two polygons are shown, one referring to the summer season whereas the other takes into consideration the winter season. Showing both polygons at the same time provides an overview of the year-round chances and extent for forest fires, but both polygons would not refer to the same season and therefore are not valid outside the time-frame provided in the valid assessment period attribute. It is a sort of multi-temporal hazard analysis that can also be taken care of with this attribute. The valid assessment period differs from return period (or chances, frequency) because the return period is bounded by the season or cycle considered.

A hazard area can also result from the coincidence of several other hazards (for example, a forest fire can occur because of the coincidence of both a drought hazard and a storm hazard over the same area at the same time). To model this, an internal association link is set. A (or several) hazard areas can be the source of ("sourceHazard") another hazard area, which is in the case the result of "ResultHazard").

The modelled or determined hazard ("ModelledOrDeterminedHazard") is generated from the hazard area ("HazardaArea") feature class. In addition, it has a attribute about the determination method ("DeterminationMethod"), which is an enumeration that captures whether the hazard area is either modelled ("modelled"), or determined through to indirect determination ("indirectDetermination") i.e. the identification of evidence etc.

The observed hazard ("ObservedHazard") is generated from the hazard area feature class as well.
An observed hazard represents a feature of the real world that had or that still has an existence: the observed hazard feature has hence two attributes that describes the life cycle of the real feature: "valid From" and "validTo".

Moreover, an observed hazard can have a name (for example: the "flood of Paris of 1910"). An attribute ("nameOfEvent") is modelled to specify this name.

EXPOSED ELEMENTS

Exposed elements are "People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. "

It is assumed that any feature which is within the scope of the INSPIRE Directive can be considered as being exposed to a specific risk. As a consequence, a feature that is modelled in another INSPIRE theme (a building, for example) can fall within the scope of this natural risk zone model for as much as it is considered as being exposed to a risk, and for which a value of vulnerability (for a certain risk zone) is calculated.

The exposed element ("ExposedElement") may have a geometry that is provided by a certain organisation (which may not be concerned by natural risk zones), but may be taken as an exposed element by another organisation (which is concerned by natural risk zones). In order to cope with this issue, it was decided not to make association links between natural risk zones and almost all other themes. It was decided to copy the geometry of the original feature, assign it a attribute that provide piece of information about its nature ("TypeOfElement"), plus attributes that are specific to the natural risk zones : the vulnerability of the exposed element ("VulnerabilityOfElement").
In other words, the provider that calculates vulnerability for a certain exposed element for a certain risk will copy the geometry of the feature in the "ExposedElement" feature class, complete the type of exposed element ("TypeOfElement") attribute. This provider is likely to be different to the body who will provide the geometry of the building (which body will therefore not be considered as a natural risk zones data provider).

The same exposed element can have a different level of vulnerability depending on the type of natural risk it is exposed to. The vulnerability piece of information is modelled as a set of attributes of the association class between the risk zone feature class ("RiskZone") and the exposed element feature class ("ExposedElement").

An exposed element has a geometry (which can be of any kind), and has a type of element as a mandatory attribute. The "typeOfElement" refers to an empty code list ("TypeOfExposedElementValue"). This codelist aims at featuring the major categories of exposed elements. This code list is empty in the INSPIRE context and must be extended by each data provider in their own codeList register. Moreover, an exposed element represents a feature of the real world that had or that still has an existence: the exposed element feature has hence two attributes that describes the life cycle of the real feature: "validFrom" and "validTo".

VULNERABILITY

The vulnerability ("VulnerabilityOfElement") can be assessed either qualitatively or quantitatively. It is modelled in a similar way to the level of hazard and the level of risk. 4 attributes are set: 2 for a quantitative assessment ("quantitativeVulnerabilityAssessmentMethod" and "quantitativeValue"), and 2 for the qualitative assessment ("qualitativeVulnerabilityAssessmentMethod" and "qualitativeValue"). 2 attributes model the value of the vulnerability and 2 attributes are reference to the method or the scale that the value of vulnerability comes from.

RISK ZONES

A risk zone ("RiskZone") is a feature that is either a surface (which itself can be a single or a multi-surface) geometry, or as a solid (which itself can also be a single or a multi-solid) geometry. Apart from the Inspire Identifier, it has one mandatory attribute: the type of risk ("typeOfRisk").
The type of risk refers to the "naturalRiskOrHazardClassification" data type.
A risk zone is linked to at least one hazard area and to at least one exposed element.

A risk zone represents a feature of the real world that exists: the risk zone feature has hence two attributes that describe the life cycle of the real feature: "validFrom" and "validTo".
A risk zone is either modelled or determined using proxy methods. The "DeterminationMethod" attribute is an enumeration that enables the provision of this piece of information.

A risk zone feature has a level of risk ("levelOfRisk").
A level of risk can be expressed either qualitatively, or quantitatively. A qualitative assessment resides in choosing a value (or a word) among a pre-determined list. For example, assessing that there is a "moderate" or "high" level of risk is a qualitative assessment. Contrary to this concept, a quantitative assessment involves applying a value among a range of possible values (the range being defined by the scale). For example, assessing the level of potential losses of an earthquake of a given magnitude along a scale is a quantitative assessment.
The data type is therefore made of 4 attributes, 2 for a quantitative assessment ("qualitativeLevelRiskAssessmentMethod" and "qualitativeValue"), and 2 for the quantitative assessment ("quantitativeLevelRiskAssessmentMethod" and "quantitativeValue"). By "assessment", we mean the combination of a value with a reference of the scale or method which is used to express the level of risk / hazard. The value is not useful if the method is not indicated as well. The qualitative value is a character string; the quantitative value is a number. The reference is a document reference ("DocumentReference").

Both the level of risk (respectively the level of hazard) can be assessed qualitatively and / or quantitatively.

IR Requirement 4 Each risk zone must have a risk type value.

The definition of a risk zone may have an impact on the local regulation. A boolean attribute is set to indicate whether the risk zone feature is legally binding or not. Moreover, an attribute is set so as to provide a reference about the legal basis if the risk zone is legally binding.

LINKS WITH OTHER THEMES

An association link is set between the “Risk zone” feature type and the “Environmental Monitoring Facility” feature type. A risk zone feature can actually be monitored, and therefore be linked to the environmental monitoring facility.

An association link is set between the “Risk zone” feature type and the “Management Restriction and Regulation Zone” modelled in “Area management, restriction, regulation zones and reporting Units” theme, as a link is set with the “CoreLandUseObject” modelled in the “Land Use” theme.

Those two links are set in the case when a risk zone feature has an impact upon the land use planning (to a broad extent).

Recommendation 1 If a risk zone or a risk coverage is legally binding, then it should be linked to a feature of Land-Use "CoreLandUseObject" or to a Area Management Restriction Regulation Zones and Reporting Units "ManagementRestrictionOrRegulationZone"

ENUMERATIONS, CODELISTS AND DATA TYPES

All the references are modelled as a subset of attributes of the ISO 19115 CI_Citation leaf. This subset is available in the “DocumentReference” data type.

IR Requirement 5 Either the locationOfResource or the contactInformation attribute must be completed.

IR Requirement 6 Either the phone, or the address, or the online resource must be completed.

IR Requirement 7 If the address is completed, then either the individual name or the organisation must be completed.

5.2.1.2. UML Overview

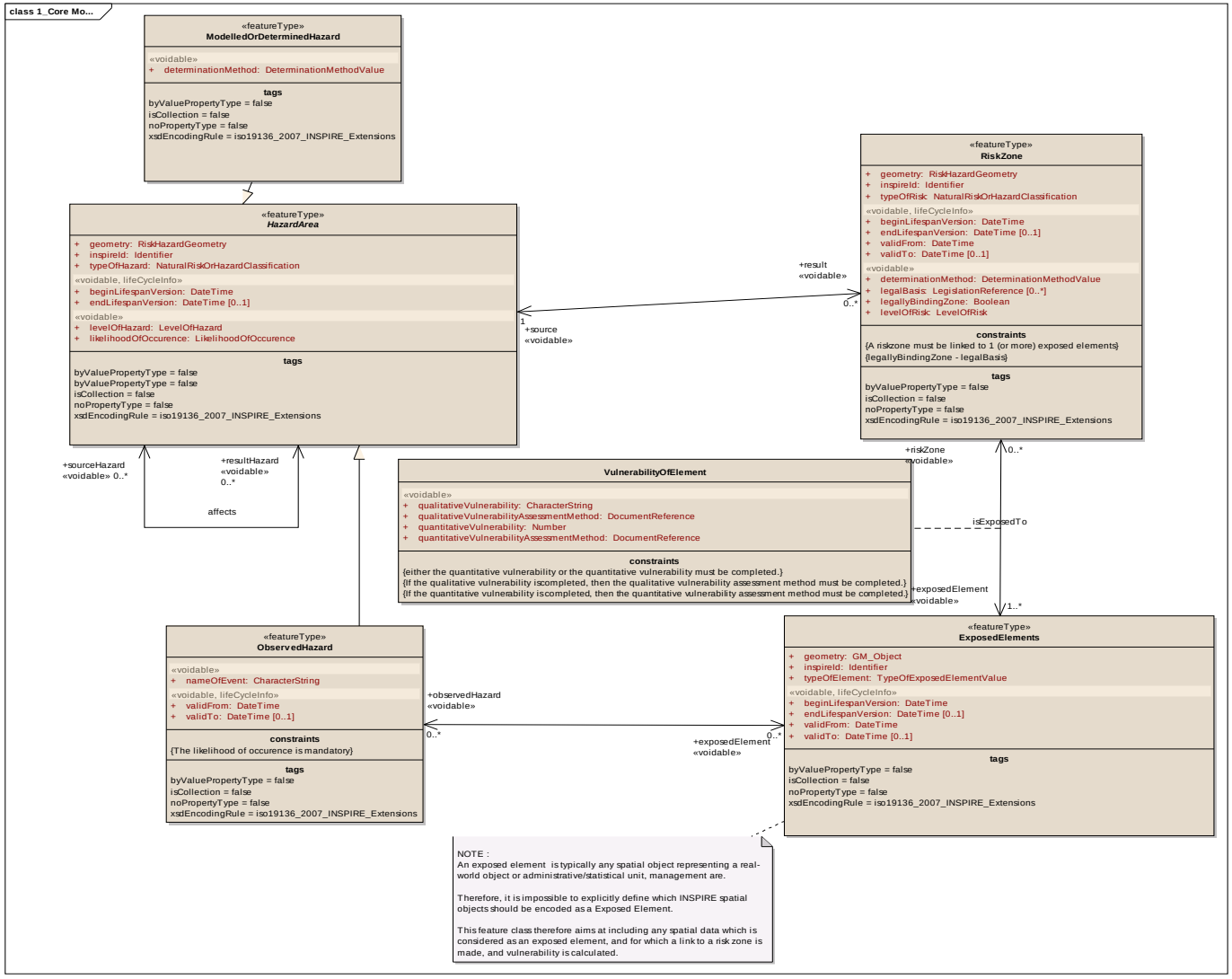


Figure 2– UML class diagram: Overview of the Core_Model

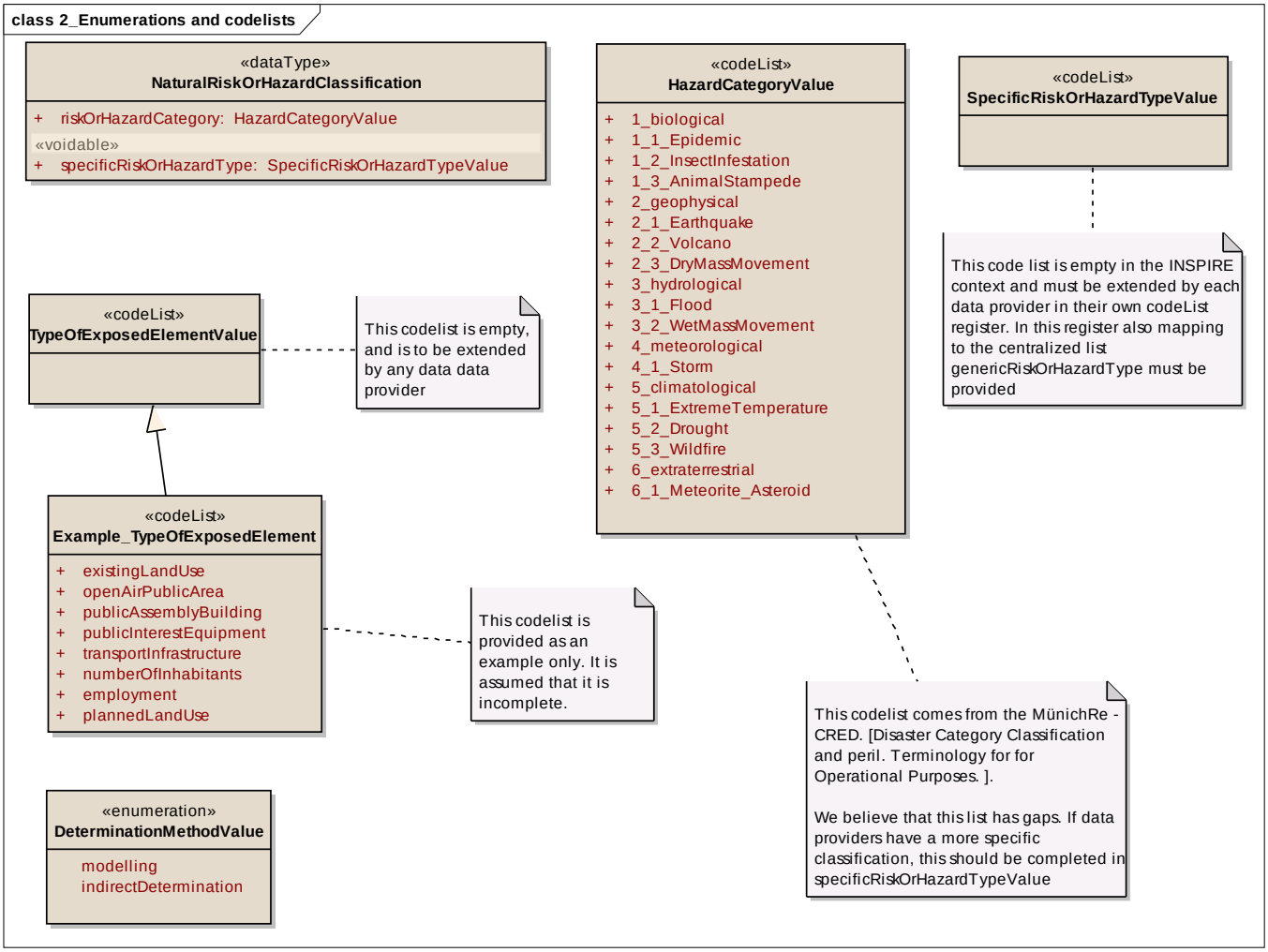


Figure 3 – UML class diagram: Overview of the enumerations and codelists

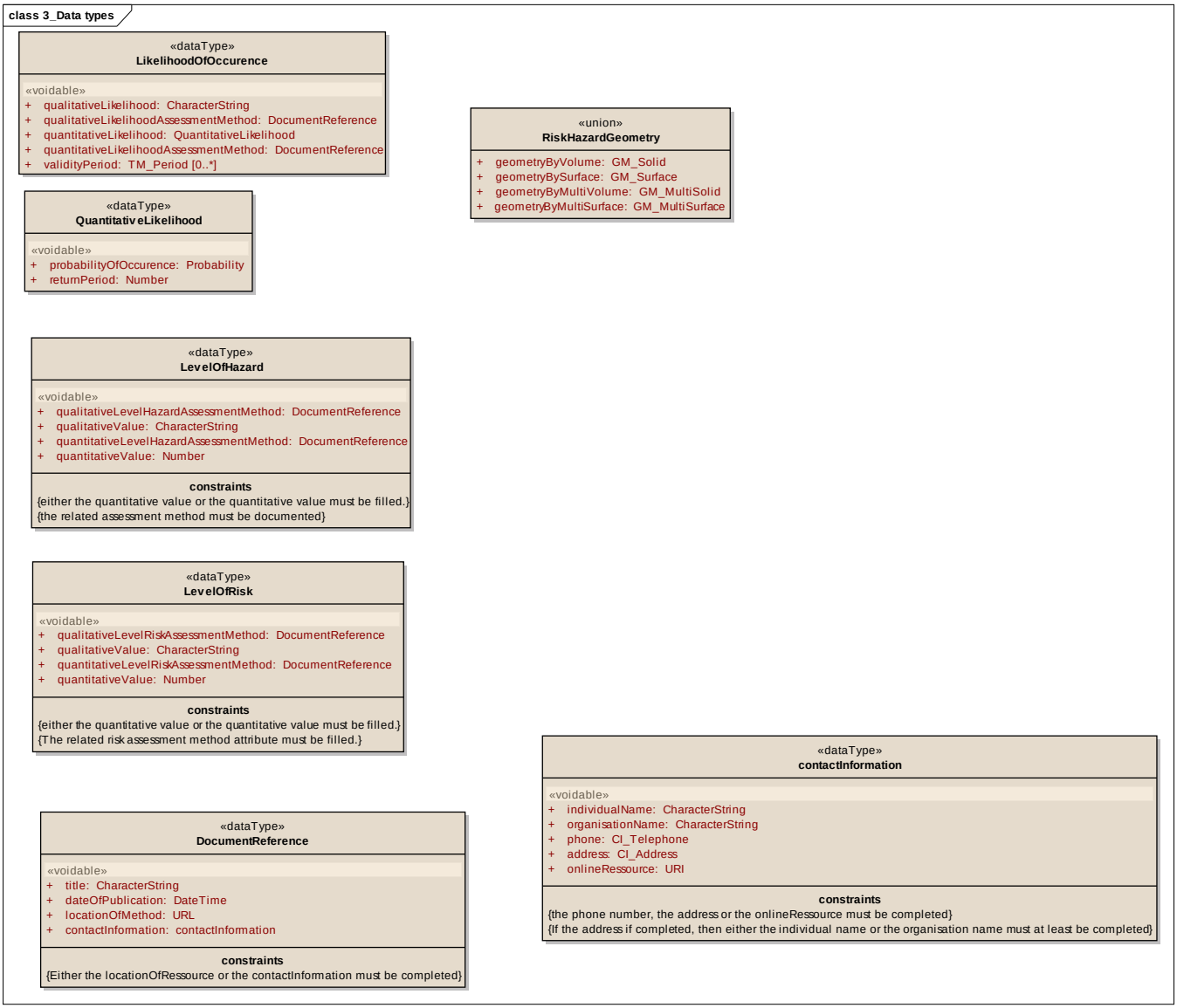


Figure 4 – UML class diagram: Overview of the data types

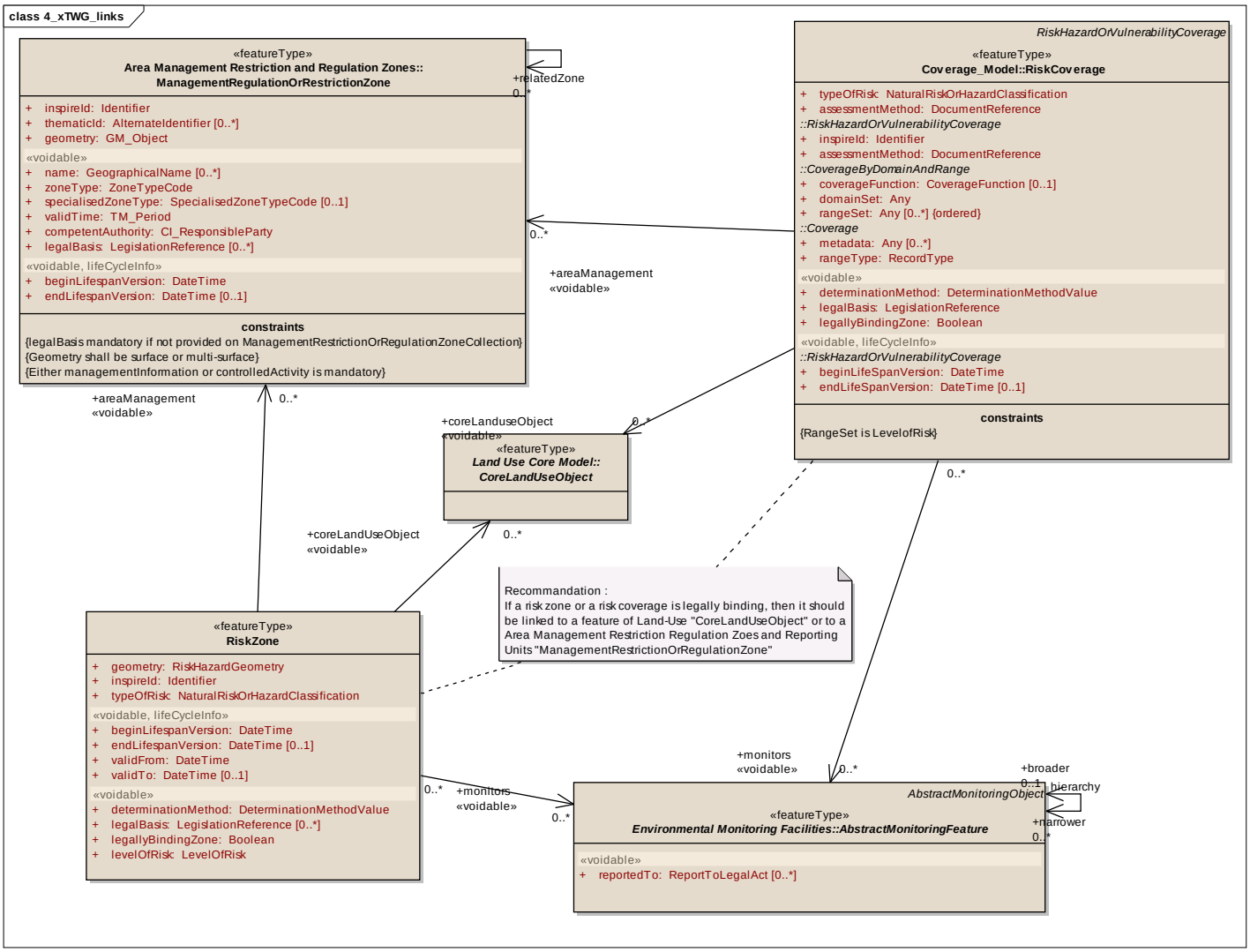


Figure 5 – UML class diagram: Overview of the Links between Natural Risk Zones and other INSPIRE Themes

5.2.1.3. Consistency between spatial data sets

IR Requirement 8	When a risk zone feature is associated with a hazard area, then the risk zone feature and the hazard area feature must overlay (at least partially).

IR Requirement 9	When a risk zone feature is associated with an exposed element, then the exposed element must overlay with the risk zone feature.

5.2.1.4. Identifier management

Each spatial object type has a mandatory identifier attribute specified and as such each spatial object needs to provide a unique identifier. This identifier shall be maintained by the national or regional authority. The identifier shall consist of two parts: the namespace and a local id. The namespace is to uniquely

identify a national registry wherein the identifier is registered, whereas id is to uniquely identify an object within this namespace. The pragmatic approach to making it internationally unique is to add a prefix of the Member State identifier along with a theme specific identifier for the namespace.
Since INSPIRE objectives refer to data exchange only, the maintenance and management of unique INSPIRE identifiers is out of INSPIRE scope, and is in the responsibility of the Member States.

5.2.1.5. Geometry representation

IR Requirement 10	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.2.1.6. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanObject" and "endLifespanObject" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 2	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.3 Application schema Core_Model

5.3.1 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue Core_Model
Scope	Core_Model

Version number	2.0
Version date	2011-06-15
Definition source	INSPIRE data specification Core_Model

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
DeterminationMethodValue	Core_Model	«enumeration»	5.2.2.3.1
DocumentReference	Core_Model	«dataType»	5.2.2.2.1
Example_TypeOfExposedElement	Core_Model	«codeList»	5.2.2.4.1
ExposedElements	Core_Model	«featureType»	5.2.2.1.1
HazardArea	Core_Model	«featureType»	5.2.2.1.2
HazardCategoryValue	Core_Model	«codeList»	5.2.2.4.2
LevelOfHazard	Core_Model	«dataType»	5.2.2.2.2
LevelOfRisk	Core_Model	«dataType»	5.2.2.2.3
LikelihoodOfOccurence	Core_Model	«dataType»	5.2.2.2.4
ModelledOrDeterminedHazard	Core_Model	«featureType»	5.2.2.1.3
NaturalRiskOrHazardClassification	Core_Model	«dataType»	5.2.2.2.5
ObservedHazard	Core_Model	«featureType»	5.2.2.1.4
QuantitativeLikelihood	Core_Model	«dataType»	5.2.2.2.6
RiskZone	Core_Model	«featureType»	5.2.2.1.5
SpecificRiskOrHazardTypeValue	Core_Model	«codeList»	5.2.2.4.3
TypeOfExposedElementValue	Core_Model	«codeList»	5.2.2.4.4
contactInformation	Core_Model	«dataType»	5.2.2.2.7

5.3.1.1. Spatial object types

5.3.1.1.1. ExposedElements

ExposedElements

Definition: SOURCE : [UNISDR, 2009] People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.
Status: Proposed
Stereotypes: «featureType»

Attribute: beginLifespanVersion

Value type: DateTime
Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: geometry

Value type: GM_Object
Definition: Geometric representation of the exposed element.
Multiplicity: 1

Attribute: inspireId

ExposedElements

Value type: Identifier
Definition: External object identifier of the spatial object.
Description: `An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.`

`--Description --`
`An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon`

Multiplicity: 1

Attribute: typeOfElement

Value type: TypeOfExposedElementValue
Definition: A denomination of the exposed element.
Multiplicity: 1

Attribute: validFrom

Value type: DateTime
Definition: The time when the phenomenon started to exist in the real world.
Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: validTo

Value type: DateTime
Definition: The time from which the phenomenon no longer exists in the real world.
Multiplicity: 0..1
Stereotypes: «voidable,lifeCycleInfo»

Association role: ExternalFeature

Value type: GovernmentalService
Definition: A feature that can be considered as vulnerable compared to the risk zone or the observed hazard area.
Multiplicity: 0..*

Association role: externalFeature

Value type: Building
Definition: A feature that can be considered as vulnerable compared to the risk zone or the observed hazard area.
Multiplicity: 0..*

Association role: externalFeature

Value type: MiningFeature
Definition: A feature that can be considered as vulnerable compared to the risk zone or the observed hazard area.
Multiplicity: 0..*

Association role: frMap

Value type: FloodRiskMap
Definition: The flood risk map upon which is an exposed element.
Multiplicity: 0..*

ExposedElements

Association role: observedHazard

Value type: ObservedHazard
Definition: The observed hazard to which some elements may have been exposed in the past.
Multiplicity: 0..*
Stereotypes: «voidable»

Association role: pFRA

Value type: PreliminaryFRAssessment
Definition: The preliminary flood risk assessment that contains the exposed element.
Multiplicity: 0..*

Association role: riskZone

Value type: RiskZone
Definition: The risk zone that is linked to an exposed element.
Multiplicity: 0..*
Stereotypes: «voidable»

5.3.1.1.2. HazardArea

HazardArea (abstract)

Definition: Area affected by a hazard.
Description: `A natural hazard is a natural process or phenomenon that may cause loss of life, injury or other impacts, property damage, loss livelihoods and services, social and economic disruption, or environmental damage. [Council of The European Union - Commission Staff Working Paper - Risk Assessment and Mapping Guidelines for Disaster Management].`
Status: Proposed
Stereotypes: «featureType»

Attribute: beginLifespanVersion

Value type: DateTime
Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: geometry

Value type: RiskHazardGeometry
Definition: Geometric representation of spatial extent covered by the hazard area.
Multiplicity: 1

Attribute: inspireId

Value type: Identifier
Definition: External object identifier of the hazard area.

HazardArea (abstract)

Description: An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity: 1

Attribute: levelOfHazard

Value type: LevelOfHazard
Definition: Assessment of the level of the hazard.
Description: The level of hazard can either be described quantitatively or qualitative. This notion can integrate the notion of intensity. When described qualitatively, it can also adress susceptibility.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: likelihoodOfOccurence

Value type: LikelihoodOfOccurence
Definition: Likelihood is a general concept relating to the chance of an event occuring. Likelihood is generally expressed as a probability or a frequency. [EXCIFF].
Multiplicity: 1
Stereotypes: «voidable»

Attribute: typeOfHazard

Value type: NaturalRiskOrHazardClassification
Definition: A generic classification and a specific classification of the type of hazard.
Multiplicity: 1

Association role: result

Value type: RiskZone
Definition: The risk zone that result from the hazard area.
Multiplicity: 0..*
Stereotypes: «voidable»

Association role: resultHazard

Value type: HazardArea
Definition: The hazard that results from the occurence of another hazard.
Multiplicity: 0..*
Stereotypes: «voidable»

Association role: sourceHazard

Value type: HazardArea
Definition: The natural hazard that is the source of another natural hazard.
Multiplicity: 0..*
Stereotypes: «voidable»

5.3.1.1.3. ModelledOrDeterminedHazard

ModelledOrDeterminedHazard

Subtype of: HazardArea
Definition: A hazard which extent is modeled, or inferred by the interpretation of indirect artefacts.
Status: Proposed
Stereotypes: «featureType»

ModelledOrDeterminedHazard

Attribute: determinationMethod

Value type:	DeterminationMethodValue
Definition:	Specifies if the hazard area results is delineated after a modelling or determined after interpretation of indirect artefacts.
Multiplicity:	1
Stereotypes:	«voidable»

5.3.1.1.4. ObservedHazard

ObservedHazard

Subtype of:	HazardArea
Definition:	A hazard which occurred, or is currently occuring, and which has been observed.
Status:	Proposed
Stereotypes:	«featureType»

Attribute: nameOfEvent

Value type:	CharacterString
Definition:	common name of the observed hazard.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: validFrom

Value type:	DateTime
Definition:	The time when the phenomenon started to exist in the real world.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: validTo

Value type:	DateTime
Definition:	The time from which the phenomenon no longer exists in the real world.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Association role: exposedElement

Value type:	ExposedElements
Definition:	The element that was exposed to a hazard that has been observed.
Multiplicity:	0..*
Stereotypes:	«voidable»

Constraint: The likelihood of occurence is mandatory

Natural language:	The likelihood of occurence is mandatory
OCL:	inv: self.likelihoodOfOccurence.notEmpty()

5.3.1.1.5. RiskZone

RiskZone

Definition:	A risk zone is the spatial extent of a combination of the consequences of an event (hazard) and the associated probability/likelihood of its occurence.
Status:	Proposed
Stereotypes:	«featureType»

Attribute: beginLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.

RiskZone

Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: determinationMethod

Value type: DeterminationMethodValue
Definition: A simplified enumeration to describe the method used to define the area of risk.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: endLifespanVersion

Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: geometry

Value type: RiskHazardGeometry
Definition: Geometric representation of spatial extent covered by this risk zone.
Multiplicity: 1

Attribute: inspireId

Value type: Identifier
Definition: External object identifier of the risk zone.
Description: `An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.`
Multiplicity: 1

Attribute: legalBasis

Value type: LegislationReference
Definition: Legal basis upon which the risk zone coverage is based (if any).
Multiplicity: 0..*
Stereotypes: «voidable»

Attribute: legallyBindingZone

Value type: Boolean
Definition: A boolean to express wether the risk zone feature has an impact on the use of the zone, based on a legal basis.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: levelOfRisk

Value type: LevelOfRisk
Definition: The level of risk is an assessment of the combination of the consequences of an event (hazard) and the associated probability/likelihood of the occurence of the event.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: typeOfRisk

Value type: NaturalRiskOrHazardClassification
Definition: A generic classification and a specific classification of the type of risk.
Multiplicity: 1

RiskZone

Attribute: validFrom

Value type:	DateTime
Definition:	The time when the phenomenon started to exist in the real world.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: validTo

Value type:	DateTime
Definition:	The time from which the phenomenon no longer exists in the real world.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Association role: areaManagement

Value type:	ManagementRegulationOrRestrictionZone
Definition:	The area management to which the risk zone is linked.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: contains

Value type:	FloodRiskMap
Definition:	The flood risk map contains between 1 and 3 risk zones, each of them corresponding to a potential floooded area.
Multiplicity:	0..1

Association role: coreLandUseObject

Value type:	CoreLandUseObject
Definition:	The land use object to which the risk zone is linked.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: exposedElement

Value type:	ExposedElements
Definition:	The exposed element that is linked to the risk zone.
Multiplicity:	1..*
Stereotypes:	«voidable»

Association role: monitors

Value type:	AbstractMonitoringFeature
Definition:	The monitoring features that monitors the risk zone.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: source

Value type:	HazardArea
Definition:	The hazard area that is linked to the risk zone.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: A riskzone must be linked to 1 (or more) exposed elements

Natural language:	A riskzone must be linked to 1 (or more) vulnerable feature or to 1 vulnerable zone
OCL:	inv: self.involvedFeature.notEmpty()

Constraint: legallyBindingZone - legalBasis

RiskZone	
Natural language:	If the risk zone attribute “legallyBinding is set to “True”, then the attribute “legalBasis” must not be empty.
OCL:	inv: self.legallyBindingZone = 'True' implies self.legalBasis.notEmpty()

5.3.1.2. Data types

5.3.1.2.1. DocumentReference

DocumentReference	
Definition:	the piece of information which is required to get further information about a method that is described and explained in a paper.
Status:	Proposed
Stereotypes:	«dataType»
Attribute: contactInformation	
Value type:	contactInformation
Definition:	Data that enable the user to contact a person in order to get more information about a method.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: dateOfPublication	
Value type:	DateTime
Definition:	Date when the reference was published.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: locationOfMethod	
Value type:	URL
Definition:	A URI that enables to locate and get the reference document.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: title	
Value type:	CharacterString
Definition:	Name by which the cited information is known.
Multiplicity:	1
Stereotypes:	«voidable»
Constraint: Either the locationOfRessource or the contactInformation must be completed	
Natural language:	Either the locationOfRessource or the contactInformation must be completed.
OCL:	inv: self.locationOfMethod.isEmpty() implies self.contactInformation.notEmpty() and self.contactInformation.isEmpty() implies self.locationOfMethod.notEmpty()

5.3.1.2.2. LevelOfHazard

LevelOfHazard	
Definition:	Assessment of the level of the hazard.
Status:	Proposed
Stereotypes:	«dataType»
Attribute: qualitativeLevelHazardAssessmentMethod	
Value type:	DocumentReference
Definition:	A reference to the method used to express the level of hazard or risk qualitatively.
Multiplicity:	1
Stereotypes:	«voidable»

LevelOfHazard

Attribute: qualitativeValue

Value type: CharacterString
Definition: A qualitative assessment of the level of hazard.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantitativeLevelHazardAssessmentMethod

Value type: DocumentReference
Definition: A citation to the method used to express the level of hazard quantitatively.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantitativeValue

Value type: Number
Definition: A quantitative assessment of the level of hazard.
Multiplicity: 1
Stereotypes: «voidable»

Constraint: either the quantitative value or the quantitative value must be filled.

Natural language: either the quantitative value or the quantitative value must be filled.
OCL: inv: self.qualititativeValue.isEmpty() implies self.quantitativeValue.notEmpty() and self.quantitativeValue.isEmpty() implies self.qualititativeValue.notEmpty()

Constraint: the related assessment method must be documented

Natural language: The related hazard assessment method attribute must be filled.
OCL: inv: self.quantitativeValue.notEmpty() implies self.quantitativeLevelHazardAssessmentMethod.notEmpty() inv: self.qualitativeValue.notEmpty() implies self.qualitativeLevelHazardAssessmentMethod.notEmpty()

5.3.1.2.3. LevelOfRisk

LevelOfRisk

Definition: The level of risk is an assessment of the combination of the consequences of an event (hazard) and the associated probability/likelihood of the occurence of the event.
Status: Proposed
Stereotypes: «dataType»

Attribute: qualitativeLevelRiskAssessmentMethod

Value type: DocumentReference
Definition: A citation to the method used to express the level of risk qualitatively.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: qualitativeValue

Value type: CharacterString
Definition: A qualitative assessment of the level of risk.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantitativeLevelRiskAssessmentMethod

Value type: DocumentReference
Definition: A citation to the method used to express the level of risk quantitatively.

LevelOfRisk

Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantitativeValue

Value type: Number
Definition: A quantitative assessment of the level of risk.
Multiplicity: 1
Stereotypes: «voidable»

Constraint: either the quantitative value or the quantitative value must be filled.

Natural language: either the quantitative value or the quantitative value must be filled.
OCL: inv: self.qualititativeValue.isEmpty() implies self.quantitativeValue.notEmpty() and self.quantitativeValue.isEmpty() implies self.qualititativeValue.notEmpty()

Constraint: The related risk assessment method attribute must be filled.

Natural language: The related risk assessment method attribute must be filled.
OCL: inv: self.quantitativeValue.notEmpty() implies self.quantitativeLevelRiskAssessmentMethod.notEmpty() inv: self.qualitativeValue.notEmpty() implies self.qualitativeLevelRiskAssessmentMethod.notEmpty()

5.3.1.2.4. LikelihoodOfOccurence

LikelihoodOfOccurence

Definition: SOURCE : [EXCIFF] Likelihood is a general concept relating to the chance of an event occuring. Likelihood is generally expressed as a probability or a frequency.
Status: Proposed
Stereotypes: «dataType»

Attribute: qualitativeLikelihood

Value type: CharacterString
Definition: A qualitative assessment of the likelihood of occurence of a hazard. Sometimes, this is known as susceptibility.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: qualitativeLikelihoodAssessmentMethod

Value type: DocumentReference
Definition: A citation to the method used to express the likelihood qualitatively, along to a predefined scale.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantitativeLikelihood

Value type: QuantitativeLikelihood
Definition: A frequency of occurence or return period of a hazard phenomenon. Sometimes, this is known as susceptibility.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: quantitativeLikelihoodAssessmentMethod

Value type: DocumentReference
Definition: A citation to the method used to express the likelihood quantitatively.
Multiplicity: 1

LikelihoodOfOccurence

Stereotypes: «voidable»

Attribute: validityPeriod

Value type: TM_Period
Definition: Future finite time frame where likelihood of occurrence assessment applies. It is an interval of dates, or the expression of a time frame for which the estimates are meant (eg: until 2090; summer of 2011; winter seasons until 2015).
Multiplicity: 0..*
Stereotypes: «voidable»

5.3.1.2.5. NaturalRiskOrHazardClassification

NaturalRiskOrHazardClassification

Definition: This class provides piece of information about the nature of the natural risk or hazard.
Status: Proposed
Stereotypes: «dataType»

Attribute: riskOrHazardCategory

Value type: HazardCategoryValue
Definition: A generic classification of types of natural risks or hazards.
Multiplicity: 1

Attribute: specificRiskOrHazardType

Value type: SpecificRiskOrHazardTypeValue
Definition: A classification of the natural risk or hazard according to a nomenclature that is specific to this dataset.
Multiplicity: 1
Stereotypes: «voidable»

5.3.1.2.6. QuantitativeLikelihood

QuantitativeLikelihood

Definition: A frequency of occurence or return period of a hazard phenomenon.
Status: Proposed
Stereotypes: «dataType»

Attribute: probabilityOfOccurence

Value type: Probability
Definition: The probability of occurence of a hazard event, expressed as a value between 0 and 1. This is the inverse value of the return period.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: returnPeriod

Value type: Number
Definition: Long-term average interval of time or number of years within which an event will be equalled or exceeded [UNESCO].
Multiplicity: 1
Stereotypes: «voidable»

5.3.1.2.7. contactInformation

contactInformation

Definition: Data that enable the user to contact a person in order to get more information about a method.
Status: Proposed
Stereotypes: «dataType»

contactInformation

Attribute: address

Value type: CI_Address
Definition: Physical and email address at which the organisation or individual may be contacted.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: individualName

Value type: CharacterString
Definition: Name of the responsible person- SURNAME, given name, title separated by a delimiter.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: onlineRessource

Value type: URI
Definition: Online information that can be used to contact the individual or organisation.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: organisationName

Value type: CharacterString
Definition: Name of the responsible organisation.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: phone

Value type: CI_Telephone
Definition: Telephone numbers at which the organisation or individual may be contacted.
Multiplicity: 1
Stereotypes: «voidable»

Constraint: If the address if completed, then either the individual name or the organisation name must at least be completed

Natural language: If the address if completed, then either the individual name or the organisation name must at least be completed
OCL: inv: self.address.notEmpty() implies self.individualName.netEmpty() or self.organisationName.notEmpty()

Constraint: the phone number, the address or the onlineRessource must be completed

Natural language: Either the phone, or the address, or the onlineRessource must be completed
OCL: inv: self.phone.isEmpty() and self.address.isEmpty() implies self.onlineRessource.notEmpty() and self.phone.isEmpty() and self.onlineRessource.isEmpty() implies self.address.notEmpty() and self.address.isEmpty() and self.onlineRessource.isEmpty() implies self.phone.notEmpty()

5.3.1.3. Enumerations

5.3.1.3.1. DeterminationMethodValue

DeterminationMethodValue

Definition: An enumeration to describe the method used to define the area of hazard or risk.
Description: `There are several ways to delineate the perimeter of a hazard or a risk : to model it, or to assess it using indirect parameters or evidence.`

DeterminationMethodValue	
Status:	Proposed
Stereotypes:	«enumeration»
Value: indirectDetermination	
Definition:	The area as it has been identified by artifacts or other indirect methods.
Value: modelling	
Definition:	The area as it could -or would- have been after having modelled the occurence of the event.

5.3.1.4. Code lists

5.3.1.4.1. Example_TypeOfExposedElement

Example_TypeOfExposedElement	
Subtype of:	TypeOfExposedElementValue
Definition:	This is an example of a type of exposed element. [NOTE]: This codelist is provided as an example only. It is assumed that it is incomplete.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May be extended by Member States.
Value: employment	
Definition:	Amount of jobs that are in the area of interest.
Value: existingLandUse	
Definition:	Land use of an homogeneous area.
Value: numberOfInhabitants	
Definition:	Amount of inhabitants that live in the area of interest.
Value: openAirPublicArea	
Definition:	Area that is open either temporally or permanently and that can host an important amount of people.
Value: plannedLandUse	
Definition:	Planned land use.
Value: publicAssemblyBuilding	
Definition:	Building that is open to the public.
Description:	`Public assembly building can either be public building or private buildings : shopping mall, retirement place, school, stadium, religious building, etc.... It is most most of the time a permanent use building.`
Value: publicInterestEquipment	
Definition:	Public interest equipment that can have an impact on people's safety, such as (but not restricted to) a power station, a water reservoir, a mobile phone antenna.
Value: transportInfrastructure	
Definition:	Any infrastructure dedicated to road, railway, maritime, air or fluvial transport.

5.3.1.4.2. HazardCategoryValue

HazardCategoryValue

HazardCategoryValue

Definition: SOURCE : [Disaster Category Classification and peril. Terminology for for Operational Purposes. Common accord Centre for Research on the Epidemiology of Disasters (CRED) and Munich Reinsurance Company (Munich RE)] A generic classification of types of natural risks or hazards. [NOTE] : only definitions are provided for top-level values.

Status: Proposed

Stereotypes: «codeList»

Governance: May be extended by Member States.

Value: 1_1_Epidemic

Definition:

Value: 1_2_InsectInfestation

Definition:

Value: 1_3_AnimalStampede

Definition:

Value: 1_biological

Definition: Hazards caused by the exposure of living organisms to germs and toxic substances. [CRED-Munich RE]

Description: `Epidemics, insect infestations and animal stampedes are biological risks or hazards.`

Value: 2_1_Earthquake

Definition:

Value: 2_2_Volcano

Definition:

Value: 2_3_DryMassMovement

Definition:

Value: 2_geophysical

Definition:

Value: 3_1_Flood

Definition:

Value: 3_2_WetMassMovement

Definition:

Value: 3_hydrological

Definition: Hazards caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up [CRED-Munich RE].

Description: `Floods and wet mass-movements are hydrological risks or hazards.`

Value: 4_1_Storm

Definition:

Value: 4_meteorological

Definition: Hazards caused by short lived/small to meso scale atmospheric processes (in the spectrum from minutes to days) [CRED-Munich RE].

Value: 5_1_ExtremeTemperature

HazardCategoryValue	
Definition:	
Value: 5_2_Drought	
Definition:	
Value: 5_3_Wildfire	
Definition:	
Value: 5_climatological	
Definition:	Hazards caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability) [CRED-Munich RE].
Description:	`Extreme temperature, droughts and wild fires are climatological risks or hazards.`
Value: 6_1_Meteorite_Asteroid	
Definition:	
Value: 6_extraterrestrial	
Definition:	Hazards coming from none terrestrial sources.
Description:	`Bodies from an extraterrestrial source that collide with the earth or it's atmosphere are extraterrestrial hazards.`

5.3.1.4.3. SpecificRiskOrHazardTypeValue

SpecificRiskOrHazardTypeValue	
Definition:	A classification of the natural risk or hazard according to a nomenclature that is specific to this dataset.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May be extended by Member States.

5.3.1.4.4. TypeOfExposedElementValue

TypeOfExposedElementValue	
Definition:	Elements of the real world that are potentially exposed to a natural risk.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May be extended by Member States.

5.3.1.5. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.3.1.5.1. AbstractMonitoringFeature

AbstractMonitoringFeature (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Environmental Monitoring Facilities::Environmental Monitoring Facilities [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	An abstract base class for environmental monitoring features in the real world (Environmental Monitoring Network, Environmental Monitoring Facility)

5.3.1.5.2. Boolean

Boolean	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Truth [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

Boolean	
Definition:	Most valuable in the predicate calculus, where items are either True or False, unless they are ill formed.

5.3.1.5.3. Building

Building	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Buildings::Building [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A building is a covered facility, usable for the protection of humans, animals, things or the production of economic goods. A building refers to any structure permanently constructed or erected on its site.

5.3.1.5.4. CI_Address

CI_Address	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Location of the responsible individual or organisation

5.3.1.5.5. CI_Telephone

CI_Telephone	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Telephone numbers for contacting the responsible individual or organisation

5.3.1.5.6. CharacterString

CharacterString	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Text [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.7. CoreLandUseObject

CoreLandUseObject (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Land Use::Land Use Core Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Object that is associated with an area that has a dominant homogeneous land use in a LandUseCoverage

5.3.1.5.8. DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.9. FloodRiskMap

FloodRiskMap

FloodRiskMap	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Floods_Example_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	SOURCE : [Chapter III, article 6, paragraph 5 of Directive 2007/60/CE] Flood risk maps show the potential adverse consequences expressed in terms of the type of the economic activity affected under each flood scenario (defined as 'potential flooded area' in the model).

5.3.1.5.10. GM_MultiSolid

GM_MultiSolid	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric aggregates [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.11. GM_MultiSurface

GM_MultiSurface	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric aggregates [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.12. GM_Object

GM_Object (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometry root [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	GM_Object (Figure 6) is the root class of the geometric object taxonomy and supports interfaces common to all geographically referenced geometric objects. GM_Object instances are sets of direct positions in a particular coordinate reference system. A GM_Object can be regarded as an infinite set of points that satisfies the set operation interfaces for a set of direct positions, TransfiniteSet<DirectPosition>. Since an infinite collection class cannot be implemented directly, a Boolean test for inclusion shall be provided by the GM_Object interface. This international standard concentrates on vector geometry classes, but future work may use GM_Object as a root class without modification. NOTE As a type, GM_Object does not have a well-defined default state or value representation as a data type. Instantiated subclasses of GM_Object will.

5.3.1.5.13. GM_Solid

GM_Solid	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	GM_Solid (Figure 13), a subclass of GM_Primitive, is the basis for 3-dimensional geometry. The extent of a solid is defined by the boundary surfaces.

5.3.1.5.14. GM_Surface

GM_Surface	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

GM_Surface	
Definition:	GM_Surface (Figure 12) a subclass of GM_Primitive and is the basis for 2-dimensional geometry. Unorientable surfaces such as the Möbius band are not allowed. The orientation of a surface chooses an "up" direction through the choice of the upward normal, which, if the surface is not a cycle, is the side of the surface from which the exterior boundary appears counterclockwise. Reversal of the surface orientation reverses the curve orientation of each boundary component, and interchanges the conceptual "up" and "down" direction of the surface. If the surface is the boundary of a solid, the "up" direction is usually outward. For closed surfaces, which have no boundary, the up direction is that of the surface patches, which must be consistent with one another. Its included GM_SurfacePatches describe the interior structure of a GM_Surface. NOTE Other than the restriction on orientability, no other "validity" condition is required for GM_Surface.

5.3.1.5.15. GovernmentalService

GovernmentalService	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Utility and Governmental Services::Utility and Governmental Services::Administrative and social governmental services [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Administrative and social governmental services provided by, or on behalf of, a Public Administrative Body, in order to be used in the treatment of environmental issues (broad meaning) for public use or to the benefit of citizens
Description:	`Administrative and social governmental services such as public administrations, civil protection, sites, schools, hospitals. The kinds of sites are commonly presented in governmental and municipal portals and map system as "point of interest"-data, and may be point-based location of a variety of categories of municipal and governmental services and social infrastructure`

5.3.1.5.16. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.

Description:	`NOTE1 External object identifiers are distinct from thematic object identifiers.`
	
	`NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object.`
	
	`NOTE 3 The unique identifier will not change during the life-time of a spatial object.`

5.3.1.5.17. LegislationReference

LegislationReference	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types 2 [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	information to unambiguously reference a legal act or a specific part of a legal act

5.3.1.5.18. ManagementRegulationOrRestrictionZone

ManagementRegulationOrRestrictionZone

ManagementRegulationOrRestrictionZone	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Area Management Restriction Regulation Zones and Reporting units::Area Management Restriction and Regulation Zones [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Area managed, regulated or used for reporting at international, European, national, regional and local levels.
Description:	`SOURCE [INSPIRE Directive]`

5.3.1.5.19. MiningFeature

MiningFeature (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::MineralResources::MineralResourcesCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	The abstract MiningFeature class represents a conceptual feature that exists coherently in the world. * this corresponds with a "Mine" or a "MiningActivity", locatable and identifiable features in time and/or space

5.3.1.5.20. Number

Number (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Numerics [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	The base type for all number data, giving the basic algebraic operations. Since all concrete types have finite representations, some part of this algebra for most types exhibit some inaccuracy. For example, Integers cannot divide very well, and reals and decimals cannot avoid certain types of inaccuracies that depend on their representation semantics.

5.3.1.5.21. PreliminaryFRAssessment

PreliminaryFRAssessment	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Floods_Example_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	SOURCE : [Flood Directive 2007/60/CE] Document as defined in Chapter II, article 4, paragraph 2 of Directive 2007/60/CE.

PreliminaryFRAssessment	
Description:	Based on available or readily derivable information, such as records and studies on long term developments, in particular impacts of climate change on the occurrence of floods, a preliminary flood risk assessment shall be undertaken to provide an assessment of potential risks. The assessment shall include at least the following: (a) maps of the river basin district at the appropriate scale including the borders of the river basins, sub-basins and, where existing, coastal areas, showing topography and land use; (b) a description of the floods which have occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed; (c) a description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged; and, depending on the specific needs of Member States, it shall include: (d) an assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity, taking into account as far as possible issues such as the topography, the position of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of existing manmade flood defence infrastructures, the position of populated areas, areas of economic activity and long-term developments including impacts of climate change on the occurrence of floods.

5.3.1.5.22. Probability

Probability	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Atmospheric Conditions::Specialised Observations [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.23. TM_Period

TM_Period	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19108:2006 Temporal Schema::Temporal Objects [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.24. URI

URI	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19139 Metadata - XML Implementation::Web environment [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.3.1.5.25. URL

URL

URL	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.4 Application schema Coverage_Model

5.4.1 Description

5.4.1.1. Narrative description

In order to provide greater granularity and continuous information (e.g. water depths for an area covered by a 50 years flood.) the Coverage model was developed. It also addresses the fact that hazard and risk data providers are commonly using this gridded data for modelling and for providing their data.
It is therefore assumed that exposed elements, vulnerability, hazard and risk datasets can potentially be delivered either with respect to ISO 19107 (Spatial Schema) or to ISO 19125 (Coverage schema).
The driving methodology and ideas underpin the core model underpin this coverage model as well.

The Thematic Working Group provides here version 2.0 of a coverage model for natural risk zones. There is ongoing discussion within the group about how this should be implemented. Presented below are some of the issues that remain.

Open issue 4: The modelling of multi-risk/ multi-hazard assessments. For version 2.0 it is stated that a risk zone is linked to one hazard area and that one (or several) hazard area(s) can result from the co-occurrence of several source hazards. It is currently believed that this simple relationship is the best way to model multi-risk or hazard, but does this work with real world data?

Open issue 5: Domain of hazard area coverage, risk zone coverage, and vulnerability coverage. It is currently specified that the domain of these coverages can be either a multi-surface, multi-solid, grid, rectified grid or referenceable grid. Is such a broad domain required? Is there anything missing?

Open issue 6: Constraints about the domain of the exposedElement coverage. Unlike the other features types that are modeled as coverages in this model, the feature type of exposed elements coverage has no specific constraint upon the domain. Is such a broad domain required?

Open issue 7: Inclusion of the notion of susceptibility in the likelihood of occurrence. The qualitative assessment of the likelihood of occurrence is sometimes known as susceptibility, this can also be quantitative on a nominal scale. Are both of these required?

Open issue 8: Inclusion of time dimension within the domain of the hazard coverage. Are the validFrom and ValidTo concepts the only ones that apply to modelling a hazard coverage?

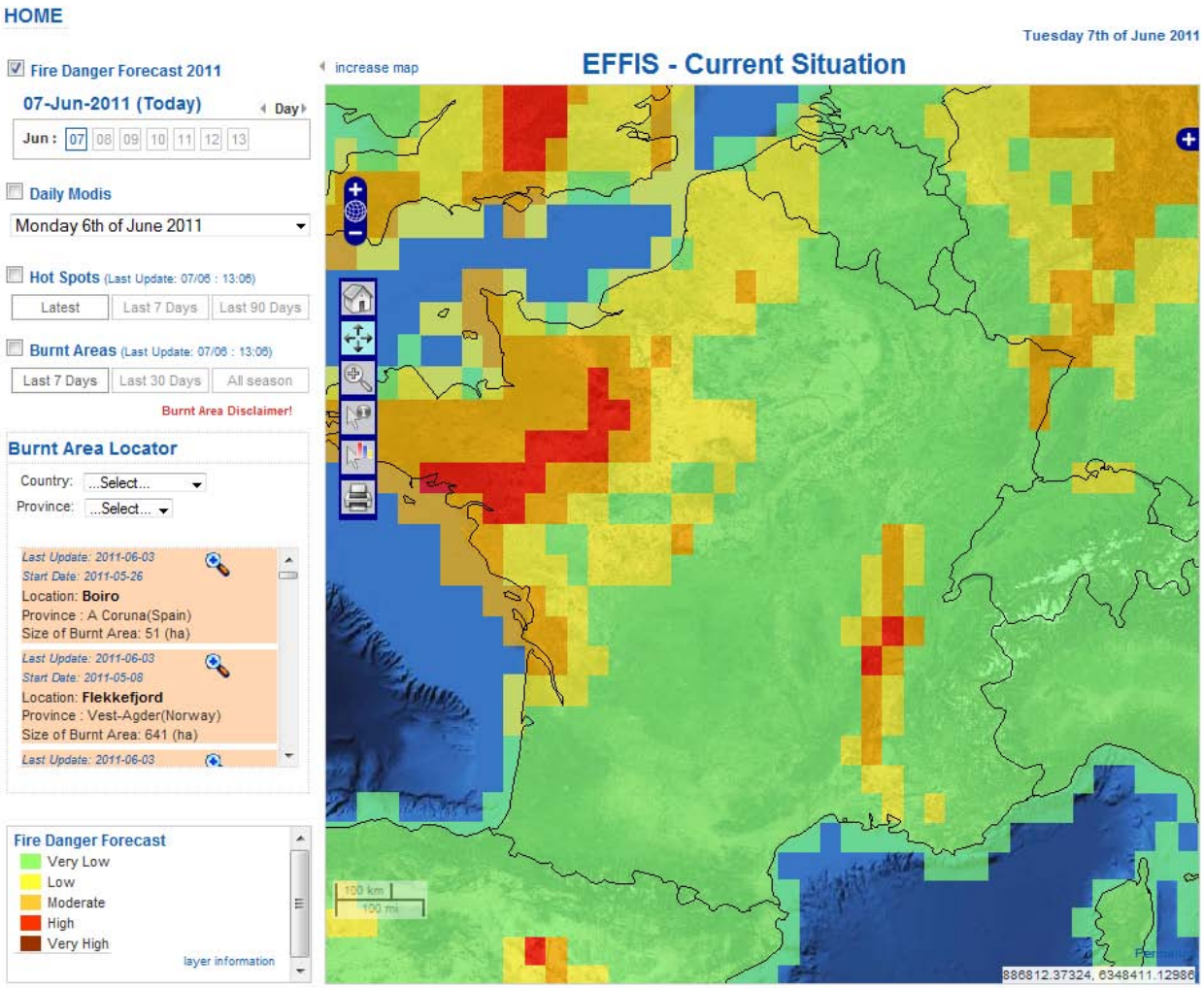


Figure 6 – Example of data covered by the Coverage model : European Forest Fire Information System : Forest danger forecast. http://effis.jrc.ec.europa.eu/current-situation

5.4.1.2. UML overview

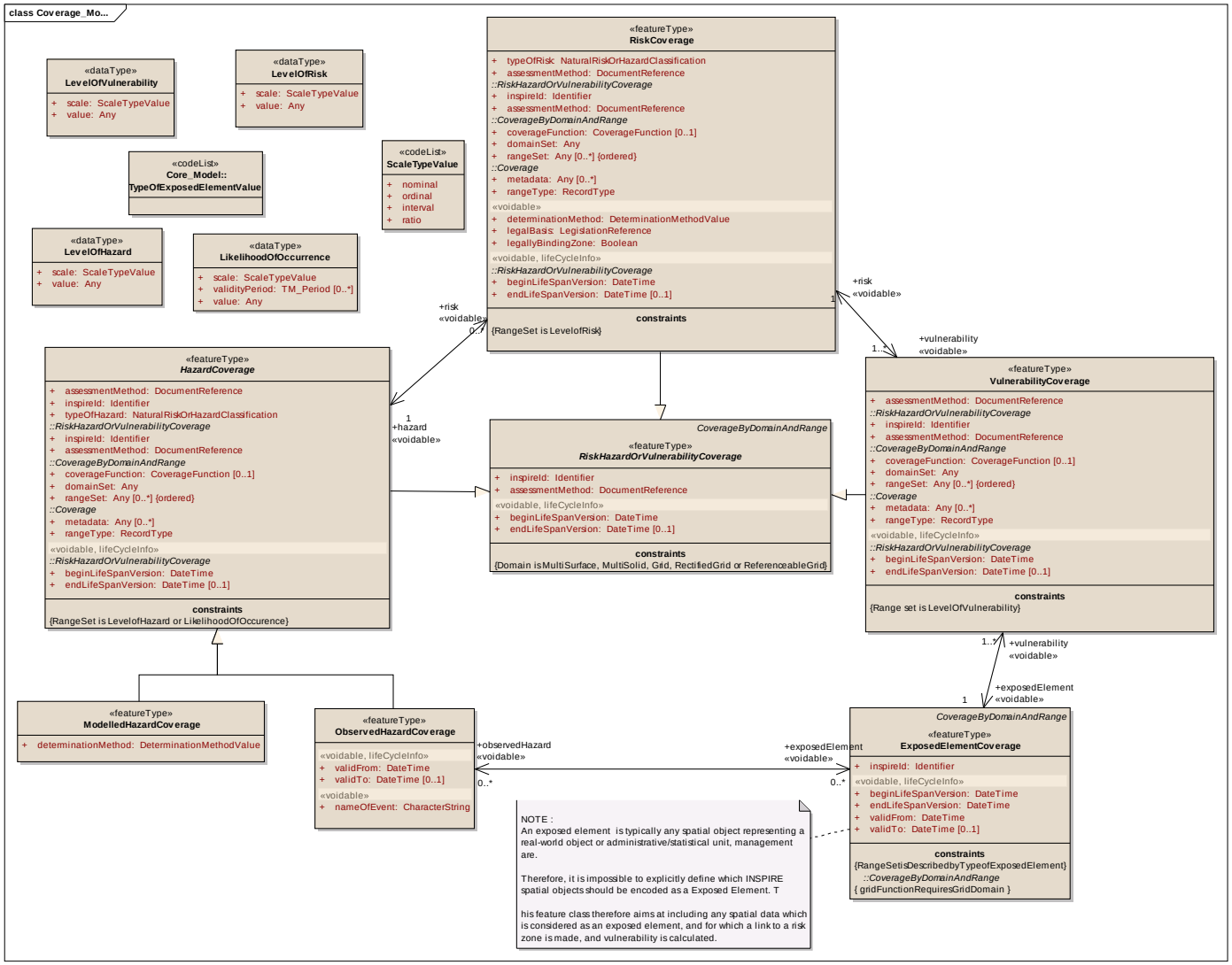


Figure 7 – UML class diagram: Overview of the Coverage model application schema

All the coverage feature types are modelled as “Domain and Range” coverages.

COMMON GENERIC COVERAGE FEATURE TYPE BETWEEN HAZARD, RISK AND VULNERABILITY
The “HazardCoverage”, “RiskCoverage” and “VulnerabilityCoverage” share a few common properties:

- The domain is either Grid, rectified Grid, referenceable Grid, multi-surface or multi-solid.
- There is an attribute “InspireId” (Identifier)
- There are attributes “BeginLifeSpanVersion” and “EndLifeSpanVersion”
- There is an attribute that documents the assessment method that is employed “Assessment”)

All those properties are defined in a generic abstract feature type “RiskHazardOrVulnerabilityCoverage”, from which the hazard coverage, the risk coverage and the vulnerability coverage are specialized.

HAZARD COVERAGE

The hazard coverage (“HazardCoverage”) is similar to the hazard area (“HazardArea”) from the core model. From this are generated the “ObservedHazardCoverage” feature class and the “ModelledOrDeterminedCoverage” feature class.
The hazard coverage has the type of hazard data (“TypeOfHazard”) as an attribute: it is therefore assumed that a hazard coverage feature concerns one –and one only- hazard type. The values that vary over space (and therefore declared as the range of the coverage) are either the level of hazard (“LevelOfHazard”), or the likelihood of occurrence (“LikelihoodOfOccurence”).
The level of hazard (“LevelOfHazard”) is the combination of a value (“value”) expressed according to a scale (“scale”). The scale is a codelist with refers to the Theory of scale types: a scale can be “nominal”, “ordinal”, “interval” or “ratio”).
The likelihood of occurrence (“LikelihoodOfOccurence”) is the combination of a value (“value”) expressed according to a scale (“scale”), and a period of validity (“validityPeriod”). This latter value is expressed as a data type from the Core_Model which is “QuantitativeLikelihood”. The quantitative likelihood is either expressed as a probability of occurrence (“probabilityOfOccurence”) or as a return period (“ReturnPeriod”).
The method that is employed to set the level of hazard is documented in the attribute “Assessment” of the “HazardCoverage” feature type.

RISK COVERAGE
In the same way the “RiskCoverage” is similar to the “RiskZone” feature class.It shares particularly the same associations linked with feature types that belong to specifications of other Annex II, Annex III INSPIRE themes. It contains the same attributes as the core_model “RiskZone” feature type, apart from the level of risk (“LevelOfRisk”). The level of risk varies over space in a risk coverage: as a consequence, the range of the “RiskCoverage” is the level of risk. It is therefore assumed that a risk coverage feature concerns one –and one only- risk type.
The level of risk (“LevelOfRisk”) is the combination of a value (“value”) expressed according to a scale (“scale”). The method that is employed to set the level of risk is documented in the attribute “Assessment” of the “RiskCoverage” feature type.

VULNERABILITY COVERAGE
Contrary to the core model, in which vulnerability is set as an association class between exposed element (“ExposedElement”) and risk zone (“RiskZone”), the vulnerability is modelled here as a feature type (“VulnerabilityCoverage”).
Several use cases evidenced the fact that vulnerability coverage is often broadcast as such, and is not displayed as an association class between an exposed element and a risk zone. Moreover, setting the vulnerability as a coverage feature makes the modelling of the level of vulnerability as a range far more obvious and simple than it would have been if vulnerability had been set as an association class.

The range of the vulnerability is the level of vulnerability (“LevelOfVulnerability”), which is also the combination of a value (“value”) expressed according to a scale (“scale”). The method that is employed to set the level of vulnerability is documented in the attribute “Assessment” of the “VulnerabilityCoverage” feature type.

Even though the modelling of vulnerability in the Coverage_Model differs from the Core_Model, the fact that vulnerability is calculated for one exposed element for a certain risk is maintained, by the multiplicity of the association links between VulnerabilityCoverage and ExposedElementCoverage on one hand, "VulnerabilityCoverage" and "RiskCoverage" on the other hand.
A vulnerability coverage feature is linked to:

- one -and one only- risk coverage feature
- one -and one only- exposed element coverage feature

EXPOSED ELEMENT COVERAGE
Unlike the 3 other coverage feature types, the exposed element coverage ("ExposedElementCoverage") has no constraint set for the domain. In the core_model, the exposed element feature type ("ExposedElement") has a generic geometry (GM_Object). In the same way, the exposed element coverage has no specific constraint upon the domain of the coverage.
As in the core_model, the exposed element coverage is linked to the observed hazard coverage.
The range of the exposed element is the type of exposed element ("TypeOfExposedElement"). This refers to the empty code list defined in the Core_Model "TypeOfExposedElementValue").

IR Requirement 11	A risk zone must be associated with at least one vulnerability coverage; the level of vulnerability of the same exposed element coverage depends upon the type of risk (and therefore depends upon the risk coverage feature).

IR Requirement 12	The record of "HazardCoverage" must be either "qualitativeValue", or "quantitativeValue", or "riskOrHazardCategory"

IR Requirement 13	The record of "RiskCoverage" must be either "qualitativeValue", or "quantitativeValue", or "riskOrHazardCategory"

No coverage specialization for the Floods Directive is made.

5.4.1.3. Consistency between spatial data sets

IR Requirement 14	When a risk zone feature is associated with a hazard area, then the risk zone feature and the hazard area feature must overlay (at least partially).

IR Requirement 15	When a risk zone feature is associated with en exposed element, then the exposed element must overlay with the risk zone feature.

5.4.1.4. Identifier management

Each spatial object type has a mandatory identifier attribute specified and as such each spatial object needs to provide a unique identifier. This identifier shall be maintained by the national or regional authority. The identifier shall consist of two parts: the namespace and a local id. The namespace is to uniquely identify a national registry wherein the identifier is registered, whereas id is to uniquely identify an object within this namespace. The pragmatic approach to making it internationally unique is to add a prefix of the Member State identifier along with a theme specific identifier for the namespace.
Since INSPIRE objectives refer data exchange only, the maintenance and management of unique INSPIRE identifiers is out of INSPIRE scope, and is in the responsibility of the Member States.

5.4.1.5. Geometry representation

IR Requirement 16	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTEThe specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTEThe topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.4.1.6. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanObject" and "endLifespanObject" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 1 If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.5 Application schema Coverage_Model

5.5.1 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue Coverage_Model
Scope	Coverage_Model
Version number	2.0
Version date	2011-06-15
Definition source	INSPIRE data specification Coverage_Model

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
ExposedElementCoverage	Coverage_Model	«featureType»	5.2.2.1.1
HazardCoverage	Coverage_Model	«featureType»	5.2.2.1.2
LevelOfHazard	Coverage_Model	«dataType»	5.2.2.2.1
LevelOfRisk	Coverage_Model	«dataType»	5.2.2.2.2
LevelOfVulnerability	Coverage_Model	«dataType»	5.2.2.2.3
LikelihoodOfOccurrence	Coverage_Model	«dataType»	5.2.2.2.4
ModelledHazardCoverage	Coverage_Model	«featureType»	5.2.2.1.3
ObservedHazardCoverage	Coverage_Model	«featureType»	5.2.2.1.4
RiskCoverage	Coverage_Model	«featureType»	5.2.2.1.5
RiskHazardOrVulnerabilityCoverage	Coverage_Model	«featureType»	5.2.2.1.6
ScaleTypeValue	Coverage_Model	«codeList»	5.2.2.3.1
VulnerabilityCoverage	Coverage_Model	«featureType»	5.2.2.1.7

5.5.1.1. Spatial object types

5.5.1.1.1. ExposedElementCoverage

ExposedElementCoverage

Subtype of: CoverageByDomainAndRange
Definition: A coverage of exposed elements.
Status: Proposed
Stereotypes: «featureType»

Attribute: beginLifeSpanVersion

Value type: DateTime
Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: endLifeSpanVersion

ExposedElementCoverage	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»
Attribute: inspireId	
Value type:	Identifier
Definition:	
Multiplicity:	1
Attribute: validFrom	
Value type:	DateTime
Definition:	The time when the phenomenon started to exist in the real world.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»
Attribute: validTo	
Value type:	DateTime
Definition:	The time from which the phenomenon no longer exists in the real world.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»
Association role: observedHazard	
Value type:	ObservedHazardCoverage
Definition:	The observed hazard to which some elements may have been exposed in the past.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: vulnerability	
Value type:	VulnerabilityCoverage
Definition:	The vulnerability coverage that is calculated after an exposed element coverage.
Multiplicity:	1..*
Stereotypes:	«voidable»
Constraint: RangeSetisDescribedbyTypeofExposedElement	
Natural language:	range set is described by type of exposed element
OCL:	inv: rangeSet.oclIsKindOf(TypeOfExposedElement)

5.5.1.1.2. HazardCoverage

HazardCoverage (abstract)	
Subtype of:	RiskHazardOrVulnerabilityCoverage
Definition:	A coverage of natural hazards.
Status:	Proposed
Stereotypes:	«featureType»
Attribute: assessmentMethod	
Value type:	DocumentReference
Definition:	A reference to the method used to express the level of hazard.
Multiplicity:	1
Attribute: inspireId	
Value type:	Identifier

HazardCoverage (abstract)

Definition:
Multiplicity: 1

Attribute: typeOfHazard

Value type: NaturalRiskOrHazardClassification
Definition: A generic classification and a specific classification of the type of hazard.
Multiplicity: 1

Association role: risk

Value type: RiskCoverage
Definition: -- Definition The risk zone coverage that result from the hazard area coverage.
Multiplicity: 0..*
Stereotypes: «voidable»

Constraint: RangeSet is LevelofHazard or LikelihoodOfOccurence

Natural language: range set is described by hazard range characteristics
OCL: inv: rangeSet.oclIsKindOf(LevelofHazard) or rangeSet.oclIsKindOf(LikelihoodOfOccurence)

5.5.1.1.3. ModelledHazardCoverage

ModelledHazardCoverage

Subtype of: HazardCoverage
Definition: A coverage for hazards which extent is modeled, or inferred by the interpretation of indirect artefacts
Status: Proposed
Stereotypes: «featureType»

Attribute: determinationMethod

Value type: DeterminationMethodValue
Definition: Specifies if the hazard area result is delineated after a modelling or determined after interpretation of indirect artefacts.
Multiplicity: 1

5.5.1.1.4. ObservedHazardCoverage

ObservedHazardCoverage

Subtype of: HazardCoverage
Definition: A coverage for observed hazards.
Status: Proposed
Stereotypes: «featureType»

Attribute: nameOfEvent

Value type: CharacterString
Definition: common name of the observed hazard.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: validFrom

Value type: DateTime
Definition: The time when the phenomenon started to exist in the real world.
Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: validTo

ObservedHazardCoverage	
Value type:	DateTime
Definition:	The time from which the phenomenon no longer exists in the real world.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Association role: exposedElement

Value type:	ExposedElementCoverage
Definition:	The element that was exposed to a hazard which has been observed.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.5.1.1.5. RiskCoverage

RiskCoverage	
Subtype of:	RiskHazardOrVulnerabilityCoverage
Definition:	A coverage of natural risks.
Status:	Proposed
Stereotypes:	«featureType»

Attribute: assessmentMethod

Value type:	DocumentReference
Definition:	A reference to the method used to express the level of risk.
Multiplicity:	1

Attribute: determinationMethod

Value type:	DeterminationMethodValue
Definition:	A simplified enumeration to describe the method used to define the area of risk.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: legalBasis

Value type:	LegislationReference
Definition:	Legal basis upon which the risk zone coverage is based (if any).
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: legallyBindingZone

Value type:	Boolean
Definition:	A boolean to express wether the risk zone feature has an impact on the use of the zone, based on a legal basis.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: typeOfRisk

Value type:	NaturalRiskOrHazardClassification
Definition:	A generic classification and a specific classification of the type of risk.
Multiplicity:	1

Association role: areaManagement

Value type:	ManagementRegulationOrRestrictionZone
Definition:	The area management to which the risk zone coverage is linked.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: coreLanduseObject

RiskCoverage	
Value type:	CoreLandUseObject
Definition:	The land use object to which the risk zone coverage is linked.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: hazard

Value type:	HazardCoverage
Definition:	The hazard area coverage that is source of the risk zone coverage.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: monitors

Value type:	AbstractMonitoringFeature
Definition:	The monitoring feature that monitors the risk zone coverage.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: vulnerability

Value type:	VulnerabilityCoverage
Definition:	- Definition -- The vulnerability coverage, calculated for an exposed element coverage, that is linked to a risk zone coverage
Multiplicity:	1..*
Stereotypes:	«voidable»

Constraint: RangeSet is LevelofRisk

Natural language:	range set is described by llevel of risk
OCL:	inv: rangeSet.oclIsKindOf(LevelOfRisk)

5.5.1.1.6. RiskHazardOrVulnerabilityCoverage

RiskHazardOrVulnerabilityCoverage (abstract)	
Subtype of:	CoverageByDomainAndRange
Definition:	An abstract feature type that contains the properties that are common to the hazard coverage feature type, the risk coverage feature type, and the vulnerability coverage feature type.
Status:	Proposed
Stereotypes:	«featureType»

Attribute: assessmentMethod

Value type:	DocumentReference
Definition:	A document reference to the method used to express the level of hazard / level of risk / level of vulnerability.
Multiplicity:	1

Attribute: beginLifeSpanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: endLifeSpanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.

RiskHazardOrVulnerabilityCoverage (abstract)	
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: inspireId

Value type:	Identifier
Definition:	
Multiplicity:	1

Constraint: Domain is MultiSurface, MultiSolid, Grid, RectifiedGrid or ReferenceableGrid

Natural language:	domain is a multi surface, multisolid, grid, rectified grid or referenceable grid
OCL:	inv: domainSet.oclIsKindOf(GM_MultiSurface) or domainSet.oclIsKindOf(CV_RectifiedGrid) or domainSet.oclIsKindOf(CV_Grid) or domainSet.oclIsKindOf(CV_ReferenceableGrid) or domainSet.oclIsKindOf(GM_MultiSolid)

5.5.1.1.7. VulnerabilityCoverage

VulnerabilityCoverage	
Subtype of:	RiskHazardOrVulnerabilityCoverage
Definition:	A coverage for vulnerability of exposed elements for a specific risk.
Status:	Proposed
Stereotypes:	«featureType»

Attribute: assessmentMethod

Value type:	DocumentReference
Definition:	A reference to the method used to express the level of vulnerability.
Multiplicity:	1

Association role: exposedElement

Value type:	ExposedElementCoverage
Definition:	The exposed elementcoverage for which vulnerability is calculated.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: risk

Value type:	RiskCoverage
Definition:	The risk zone coverage according to which vulnerability of exposed element is calculated.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: Range set is LevelOfVulnerability

Natural language:	range set is described by type of qualitative or quantitative vulnerability
OCL:	inv: rangeSet.oclIsKindOf(LevelOfVulnerability)

5.5.1.2. Data types

5.5.1.2.1. LevelOfHazard

LevelOfHazard	
Definition:	Assessment of the level of the hazard.
Status:	Proposed
Stereotypes:	«dataType»

Attribute: scale

LevelOfHazard

Value type:	ScaleTypeValue
Definition:	Type of scale according to which the value is expressed.
Description:	
Multiplicity:	1

Attribute: value

Value type:	Any
Definition:	The value that expresses the level of hazard.
Multiplicity:	1

5.5.1.2.2. LevelOfRisk

LevelOfRisk

Definition:	The level of risk is an assessment of the combination of the consequences of an event (hazard) and the associated probability/likelihood of the occurence of the event.
Status:	Proposed
Stereotypes:	«dataType»

Attribute: scale

Value type:	ScaleTypeValue
Definition:	Type of scale according to which the value is expressed.
Multiplicity:	1

Attribute: value

Value type:	Any
Definition:	the value that expresses the level of risk.
Multiplicity:	1

5.5.1.2.3. LevelOfVulnerability

LevelOfVulnerability

Definition:	SOURCE : [UNISDR, 2009] The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effect of a hazard. NOTE : It can also adress exposure.

Description:	`SOURCE : [Council of The European Union - Commission Staff Working Paper - Risk Assessment and Mapping Guidelines for Disaster Management]`
	
	`In probablistic/quantitative risk assessments the term vulnerability expresses the part of percentage of Exposure that is likely to be lost due to a certain hazard.`

Status:	Proposed
Stereotypes:	«dataType»

Attribute: scale

Value type:	ScaleTypeValue
Definition:	Type of scale according to which the value is expressed.
Multiplicity:	1

Attribute: value

Value type:	Any
Definition:	the value that expresses the level of vulnerability.
Multiplicity:	1

5.5.1.2.4. LikelihoodOfOccurrence

LikelihoodOfOccurrence

LikelihoodOfOccurrence	
Definition:	SOURCE : [EXCIFF] Likelihood is a general concept relating to the chance of an event occuring. Likelihood is generally expressed as a probability or a frequency.
Status:	Proposed
Stereotypes:	«dataType»
Attribute: scale	
Value type:	ScaleTypeValue
Definition:	Type of scale according to which the value is expressed.
Multiplicity:	1
Attribute: validityPeriod	
Value type:	TM_Period
Definition:	Future finite time frame where likelihood of occurrence assessment applies. It is an interval of dates, or the expression of a time frame for which the estimates are meant (eg: until 2090; summer of 2011; winter seasons until 2015).
Multiplicity:	0..*
Attribute: value	
Value type:	Any
Definition:	The value that expresses the likelihood of occurence.
Multiplicity:	1

5.5.1.3. Code lists

5.5.1.3.1. ScaleTypeValue

ScaleTypeValue	
Definition:	Type of scale of measure, as set in the "Therory of scale types".
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May be extended by Member States.
Value: interval	
Definition:	SOURCE: [Wikipedia] Quantitative attributes are all measurable on interval scales, as any difference between the levels of an attribute can be multiplied by any real number to exceed or equal another difference.
Value: nominal	
Definition:	SOURCE : [Wikipedia] Variables assessed on a nominal scale are called categorical variables.
Value: ordinal	
Definition:	SOURCE : [Wikipedia] Ordinal measurements describe order, but not relative size or degree of difference between the items measured.
Value: ratio	
Definition:	SOURCE: [Wikipedia] Scale according to which the [measurement is the estimation of the ratio between a magnitude of a continuous quantity and a unit magnitude of the same kind (Michell, 1997, 1999)].

5.5.1.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.5.1.4.1. AbstractMonitoringFeature

AbstractMonitoringFeature (abstract)

AbstractMonitoringFeature (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Environmental Monitoring Facilities::Environmental Monitoring Facilities [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	An abstract base class for environmental monitoring features in the real world (Environmental Monitoring Network, Environmental Monitoring Facility)

5.5.1.4.2. Any

Any	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Implementation::Records and Class Metadata [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	ISO 19103 Conceptual Schema Language Record Records and Class Metadata locate Return Any

5.5.1.4.3. Boolean

Boolean	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Truth [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Most valuable in the predicate calculus, where items are either True or False, unless they are ill formed.

5.5.1.4.4. CharacterString

CharacterString	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Text [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.5.1.4.5. CoreLandUseObject

CoreLandUseObject (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Land Use::Land Use Core Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Object that is associated with an area that has a dominant homogeneous land use in a LandUseCoverage

5.5.1.4.6. CoverageByDomainAndRange

CoverageByDomainAndRange (abstract)	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Coverages (Domain and Range) [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	coverage which provide the domain and range as separate properties

5.5.1.4.7. DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.5.1.4.8. DeterminationMethodValue

DeterminationMethodValue	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	An enumeration to describe the method used to define the area of hazard or risk.
Description:	`There are several ways to delineate the perimeter of a hazard or a risk : to model it, or to assess it using indirect parameters or evidence.`

5.5.1.4.9. DocumentReference

DocumentReference	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	the piece of information which is required to get further information about a method that is described and explained in a paper.

5.5.1.4.10. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.

Description:	`NOTE1 External object identifiers are distinct from thematic object identifiers.`
	
	`NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object.`
	
	`NOTE 3 The unique identifier will not change during the life-time of a spatial object.`

5.5.1.4.11. LegislationReference

LegislationReference	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types 2 [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	information to unambiguously reference a legal act or a specific part of a legal act

5.5.1.4.12. ManagementRegulationOrRestrictionZone

ManagementRegulationOrRestrictionZone	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Area Management Restriction Regulation Zones and Reporting units::Area Management Restriction and Regulation Zones [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Area managed, regulated or used for reporting at international, European, national, regional and local levels.
Description:	`SOURCE [INSPIRE Directive]`

5.5.1.4.13. NaturalRiskOrHazardClassification

NaturalRiskOrHazardClassification	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

NaturalRiskOrHazardClassification	
Definition:	This class provides piece of information about the nature of the natural risk or hazard.

5.5.1.4.14. TM_Period

TM_Period	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19108:2006 Temporal Schema::Temporal Objects [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.6 Application schema Floods_Example_Model

5.6.1 Description

5.6.1.1. Narrative description

The “Floods_Example_Model” application schema is a specialization of the Core_Model to the framework of floods, and particularly to the Floods Directive 2007/60/CE.
Hence in this application schema are found features classes already defined in the Core_Model:

- Risk zone
- Hazard area, and its two child classes :
  - Observed hazard
  - Modelled or determined hazard
- Exposed elements

The ‘Inundated land’ feature class, which a placeholder from Annex 1 ‘Hydrography’ TWG is also featured.
The application schema also specifies following classes:

- Flood risk map (“FloodRiskMap”)
- Flood hazard map (“FloodHazardMap”)
- Preliminary flood risk assessment (“PreliminaryFloodRiskAssessment”)
- Potential flooded area (“PotentialFloodedArea”)
- Potential flooded area element (“PotentialFloodedAreaElement”)

The Floods Directive specifies that a Preliminary Flood Risk assessment must be carried out. It must contain a description of “past flood events” and their “adverse consequences”. In this model, the “past flood events” are represented in the “InundatedLand” class. This feature class is generated from the observed hazard (“ObservedHazard”) class, with following constraint: inundated lands are observed hazard areas where a flood occurred.
As a consequence, the value for any “Inundated Land” objects for the inherited attribute “risk of hazard category” of the “hazard type” attribute is "Flood".

IR Requirement 17	All Inundated lands are floods.

The “adverse consequences” are modelled as exposed elements (“ExposedElement”) for past flood events.

These data can be obtained by navigating from the “InundatedLand” class to “ExposedElement” class. This navigation is made possible through the link between “ObservedHazard” and “ExposedElement”.

Inundated lands compose the Preliminary flood risk assessment document. This latter document is modelled in the “PreliminaryFloodRiskAssessment” class. It contains an identifier and a citation that references the document.

Once the preliminary flood risk assessment is carried out, three scenarios must be designed and modelled: a scenario of flood with a high probability, a scenario of flood with a medium probability and a scenario of flood with a low probability (to the exception of areas potentially endangered by specific floods: groundwater floods and tidal water floods). For each scenario, a flood risk map showing the potential adverse consequences must be designed.
The scenarios are modelled in the “PotentialFloodedArea” class, which is specialized from the “ModelledOrDeterminedHazard” class. It therefore inherits from the “likelihoodOfOccurrence” attribute, with an additional constraint: the likelihood of occurrence attribute must be completed following the specifications of Directive 2007/60/CE Chapter III, Article 6, Paragraph 3

A potential flooded area is a multi surface feature which is composed of several potential flooded area elements. Those features have specific attributes, such as the velocity of flow, the flood flow, the water height and the water level. A constraint is set to meet requirement of Directive 2007/60/CE Chapter III, Article 6, Paragraph 4.

Flood hazard maps are required by the Flood Directive. They are modelled in the “FloodHazardMap” feature class, which contains an identifier and a citation that references the document.
Following constraint is set to meet Chapter III, Article 6, Paragraph 3, Paragraph 6 and paragraph 7.

IR Requirement 18 A flood hazard map must contain at least one potential flooded area.

As for the “PreliminaryFloodRiskAssessment” class, the flood hazard map has an identifier and a citation that references the document.
The flood risk map is modelled in the “Flood Risk Map” class. It has an identifier and a citation that references the document.

IR Requirement 19 A flood risk map must contain at least one risk zone.

A flood risk map is composed of flood risk zones that must show the adverse consequence of the potential flooded areas previously designed. The flood risk zones are modelled in the core model “RiskZone” feature class. As potential flooded areas are generated from the “HazardArea” class, it is possible to associate the risk zones with the potential flooded area features with the directed association modelled in the Core_Model. Adverse consequences that are on the flood risk map are modelled as ‘Exposed elements’”.
These can be obtained by navigating from the “RiskZone” class to ‘ExposedElement” class by the directed association link starting from the “Risk Zone” class end, and ending in the ‘ExposedElement’ class.

5.6.1.2. UML Overview

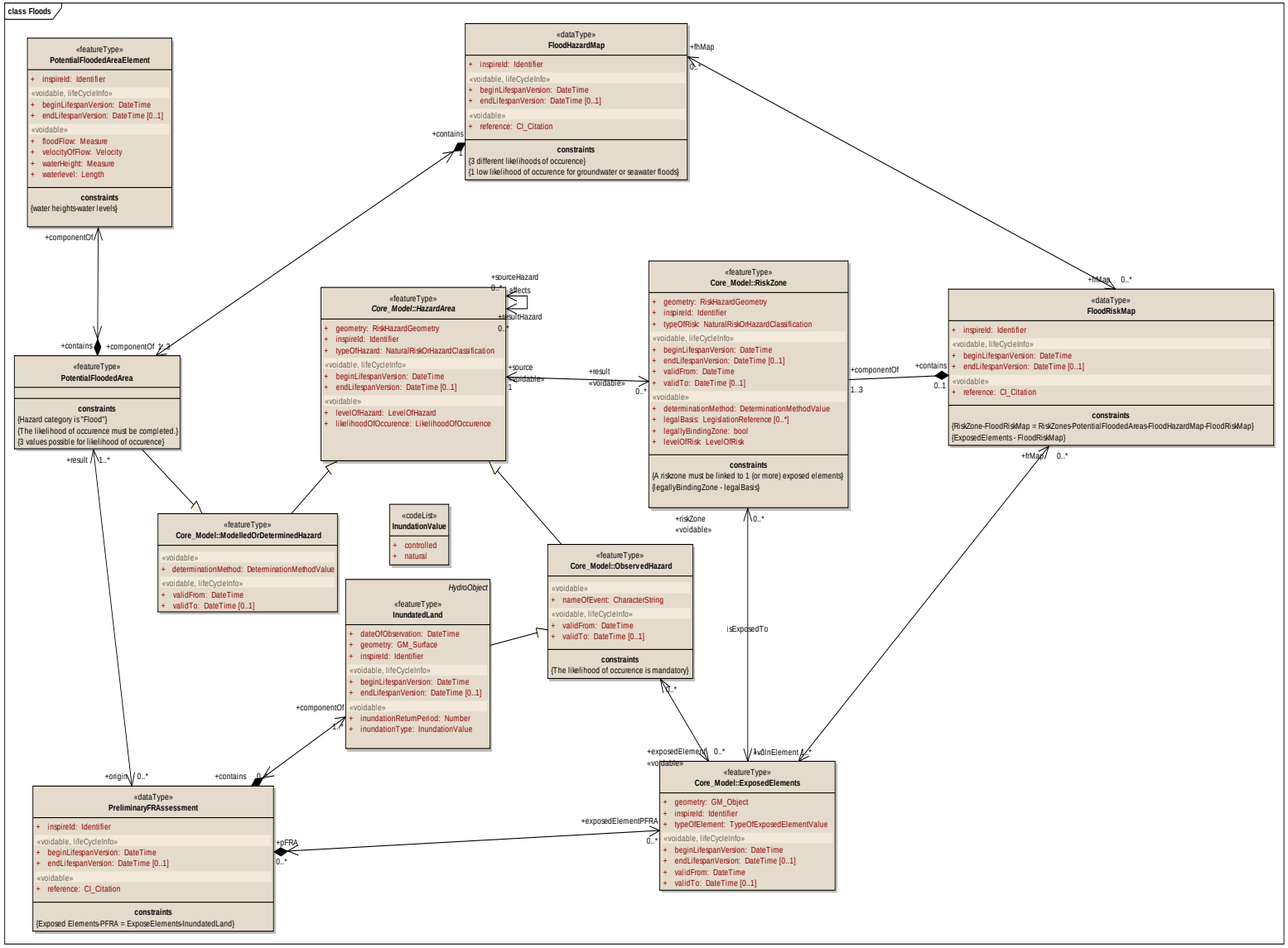


Figure 8 : Overview of the Floods_Example_Model

5.6.1.3. Identifier management

Each spatial object type has a mandatory identifier attribute specified and as such each spatial object needs to provide a unique identifier. This identifier shall be maintained by the national or regional authority. The identifier shall consist of two parts: the namespace and a local id. The namespace is to uniquely identify a national registry wherein the identifier is registered, whereas id is to uniquely identify an object within this namespace. The pragmatic approach to making it internationally unique is to add a prefix of the Member State identifier along with a theme specific identifier for the namespace. Since INSPIRE objectives refer data exchange only, the maintenance and management of unique INSPIRE identifiers is out of INSPIRE scope, and is in the responsibility of the Member States.

5.6.1.4. Geometry representation

IR Requirement 20	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTEThe specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTEThe topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.6.1.5. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanObject" and "endLifespanObject" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 2	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.7 Application schema Floods_Example_Model

5.7.1 Feature catalogue

Table 3 - Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue Floods_Example_Model
Scope	Floods_Example_Model
Version number	2.0
Version date	2011-06-15
Definition source	INSPIRE data specification Floods_Example_Model

Table 4 - Types defined in the feature catalogue

Type	Package	Stereotypes	Section
Embankment	Floods_Example_Model	«featureType»	5.2.2.1.1
FloodHazardMap	Floods_Example_Model	«dataType»	5.2.2.2.1
FloodRiskMap	Floods_Example_Model	«dataType»	5.2.2.2.2
InundatedLand	Floods_Example_Model	«featureType»	5.2.2.1.2
InundationValue	Floods_Example_Model	«codeList»	5.2.2.4.1
PotentialFloodedArea	Floods_Example_Model	«featureType»	5.2.2.1.3
PotentialFloodedAreaElement	Floods_Example_Model	«featureType»	5.2.2.1.4
PreliminaryFRAssessment	Floods_Example_Model	«dataType»	5.2.2.2.3
ProbabilityOfFlood	Floods_Example_Model	«enumeration»	5.2.2.3.1

5.7.1.1. Spatial object types

5.7.1.1.1. Embankment

Embankment

Subtype of:	ManMadeObject
Definition:	A man-made raised long mound of earth or other material.
Description:	SOURCE [DFDD]. NOTE 1 Includes retaining walls, harbours, dikes. NOTE 2 Regarded as a candidate spatial object in Annex III theme 'Natural risk zones' due to its role in limiting flooding.
Status:	Proposed
Stereotypes:	«featureType»

5.7.1.1.2. InundatedLand

InundatedLand

Subtype of:	HydroObject, ObservedHazard
Definition:	A tract periodically covered by flood water, excluding tidal waters.

InundatedLand

Description: SOURCE [DFDD].

NOTE 1 It may be caused by either uncontrolled inundation (for example: flooding due to a river overflowing its banks or low-lying regions accumulating standing water following severe rainfall) or controlled inundation (for example: flooded by the regulation of the level of a reservoir). [DFDD].

NOTE 2 Inundation for irrigation purposes is excluded.

NOTE 3 Regarded as a candidate spatial object in Annex III theme 'Natural risk zones' due to the relationship (by definition) with flooding.

Status: Proposed

Stereotypes: «featureType»

Attribute: beginLifespanVersion

Value type: DateTime

Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.

Multiplicity: 1

Stereotypes: «voidable,lifeCycleInfo»

Attribute: dateOfObservation

Value type: DateTime

Definition: Date of commencement.

Multiplicity: 1

Attribute: endLifespanVersion

Value type: DateTime

Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.

Multiplicity: 0..1

Stereotypes: «voidable,lifeCycleInfo»

Attribute: geometry

Value type: GM_Surface

Definition: The geometry of the inundated land, as a surface.

Multiplicity: 1

Attribute: inspireId

Value type: Identifier

Definition: External object identifier of the spatial object.

InundatedLand

Description: An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.

-- Description --

-- Description --
NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.

Multiplicity: 1

Attribute: inundationReturnPeriod

Value type: Number
Definition: The average period (in years) between the occurences of an inundation event.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: inundationType

Value type: InundationValue
Definition: The type of a land subject to inundation based on the cause of its flooding.
Description: SOURCE [DFDD].
Multiplicity: 1
Stereotypes: «voidable»

Association role: contains

Value type: PreliminaryFRAssessment
Definition: The preliminary flood risk assessment contains the delineation of the inundated lands that are on the area of interest of the preliminary flood assessment and the description of the exposed elements the inundated land is related to.
Multiplicity: 0..*

5.7.1.1.3. PotentialFloodedArea

PotentialFloodedArea

Subtype of: ModelledOrDeterminedHazard
Definition: --Definition-- SOURCE : [Flood Directive 2007/60/CE] Potential flooded areas as defined in Chapter III, article 6, paragraph 3 of Directive 2007/60/CE
Status: Proposed
Stereotypes: «featureType»

Association role: componentOf

Value type: PotentialFloodedAreaElement
Definition: the element of a potential flooded area.
Multiplicity:

Association role: contains

Value type: FloodHazardMap
Definition: The flood hazard map contains between 1 and 3 potential flooded areas.
Multiplicity: 1

PotentialFloodedArea

Association role: origin

Value type:	PreliminaryFRAssessment
Definition:	The preliminary flood risk assessment that backed the design of the potential flooded area.
Multiplicity:	0..*

Constraint: 3 values possible for likelihood of occurence

Natural language:	The likelihood of occurence attribute must take following values : "Low", "Medium" or "High"
OCL:	inv: self.likelihoodOfOccurence.qualitativeLikelihood = "Low" or self.likelihoodOfOccurence.qualitativeLikelihood = "Medium" or self.likelihoodOfOccurence.qualitativeLikelihood = "High"

Constraint: Hazard category is "Flood"

Natural language:	The generic risk or hazard category is "Flood" for all "potential flooded areas
OCL:	inv : self.typeOfHazard.genericRiskOrHazardType = 'flood'

Constraint: The likelihood of occurence must be completed.

Natural language:	The likelihood of occurence must be completed.
OCL:	inv: self.likelihoodOfOccurence.qualitativeLikelihood.notEmpty()

5.7.1.1.4. PotentialFloodedAreaElement

PotentialFloodedAreaElement

Definition:	SOURCE : [Flood Directive 2007/60/CE] An element of a potential flooded area, for which data about water height and/or water level, flood of flow and / or velocity of flow, is provided.
Status:	Proposed
Stereotypes:	«featureType»

Attribute: beginLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Value type:	DateTime
Definition:	--Definition-- Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: floodFlow

Value type:	Measure
Definition:	Stream discharge during a flood (expressed by volume per unit of time, usually m^3/s).
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: inspireId

Value type:	Identifier

PotentialFloodedAreaElement	
Definition:	External object identifier of the potential flooded area.
Description:	`An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.`
Multiplicity:	1

Attribute: velocityOfFlow	
Value type:	Velocity
Definition:	average speed (velocity) of the water, usually expressed by m/s.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: waterHeight	
Value type:	Measure
Definition:	Vertical distance between the water surface and the stream bed or the land surface in a flooded area.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: waterlevel	
Value type:	Length
Definition:	The elevation at which water stands respectively the level of the surface of a body of water.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: contains	
Value type:	PotentialFloodedArea
Definition:	The potential flooded area that is composed of elements.
Multiplicity:	

Constraint: water heights-water levels	
Natural language:	Either water heights or water levels must be filled
OCL:	Inv : self.waterHeight.isEmpty() implies self.waterLevel.notEmpty() and self.waterLevel.isEmpty() implies self.waterHeight.notEmpty()

5.7.1.2. Data types

5.7.1.2.1. FloodHazardMap

FloodHazardMap	
Definition:	SOURCE : [Flood Directive 2007/60/CE] Map as defined in Chapter III, article 6, paragraph 3 of Directive 2007/60/CE.
Status:	Proposed
Stereotypes:	«dataType»

Attribute: beginLifespanVersion	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

FloodHazardMap

Attribute: endLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: inspireId

Value type:	Identifier
Definition:	External object identifier of the flood hazard map.
Description:	An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: reference

Value type:	DocumentReference
Definition:	A reference to the Flood Hazard Map document.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: componentOf

Value type:	PotentialFloodedArea
Definition:	The potential flooded area is designed and is integrated in a flood hazard map.
Multiplicity:	1..3

Association role: frMap

Value type:	FloodRiskMap
Definition:	The flood risk map that is linked to the flood hazard map.
Multiplicity:	0..*

Constraint: 1 low likelihood of occurence for groundwater or seawater floods

Natural language:	For groundwater or seawater floods, then it is possible for a FloodHazardMap to fill in only one low probability potential flooded area.
OCL:	inv : self.componentOf.typeOfHazard.specificRiskOrHazardType = 'groundwater' or self.componentOf.typeOfHazard.specificRiskOrHazardType = 'seawater' implies self.componentOf.likelihoodOfOccurence.qualitativeLikelihood = 'low'

Constraint: 3 different likelihoods of occurence

Natural language:	A flood hazard map must contain one high probability potential flooded area, one medium probability potential flooded area and one low probability potential flooded area.
OCL:	inv : self.componentOf.typeOfHazard.specificRiskOrHazardType = 'groundwater' or self.componentOf.typeOfHazard.specificRiskOrHazardType = 'seawater' implies self.componentOf.likelihoodOfOccurence.qualitativeLikelihood = 'low' and self.componentOf.likelihoodOfOccurence.qualitativeLikelihood = 'medium' and self.componentOf.likelihoodOfOccurence.qualitativeLikelihood = 'high'

5.7.1.2.2. FloodRiskMap

FloodRiskMap

FloodRiskMap

Definition:	SOURCE : [Chapter III, article 6, paragraph 5 of Directive 2007/60/CE] Flood risk maps show the potential adverse consequences expressed in terms of the type of the economic activity affected under each flood scenario (defined as 'potential flooded area' in the model).
Status:	Proposed
Stereotypes:	«dataType»

Attribute: beginLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: inspireId

Value type:	Identifier
Definition:	External object identifier of the flood risk map.
Description:	`"An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.`
Multiplicity:	1

Attribute: reference

Value type:	DocumentReference
Definition:	A reference to the Flood Risk map document.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: fhMap

Value type:	FloodHazardMap
Definition:	The flood hazard map that linked to the flood risk map.
Multiplicity:	0..*

Association role: vulnElement

Value type:	ExposedElements
Definition:	The exposed element that is on a flood risk map.
Multiplicity:	1..*

Constraint: ExposedElements - FloodRiskMap

Natural language:	The exposed elements that are on the flood risk Map are those linked to the risk zones that are on the same flood risk Map
OCL:	Inv: self.vulnFeature = self.componentOf.involvedFeature

Constraint: RiskZone-FloodRiskMap = RiskZones-PotentialFloodedAreas-FloodHazardMap-FloodRiskMap

FloodRiskMap	
Natural language:	The risk zones composing the Flood Risk Map are those derived from the potential flooded areas that are in the Flood Hazard Map which is linked to the Flood Risk Map
OCL:	Inv: self.FHMap.componentOf.riskZone = self.componentOf

5.7.1.2.3. PreliminaryFRAssessment

PreliminaryFRAssessment	
Definition:	SOURCE : [Flood Directive 2007/60/CE] Document as defined in Chapter II, article 4, paragraph 2 of Directive 2007/60/CE.
Description:	Based on available or readily derivable information, such as records and studies on long term developments, in particular impacts of climate change on the occurrence of floods, a preliminary flood risk assessment shall be undertaken to provide an assessment of potential risks. The assessment shall include at least the following: (a) maps of the river basin district at the appropriate scale including the borders of the river basins, sub-basins and, where existing, coastal areas, showing topography and land use; (b) a description of the floods which have occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed; (c) a description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged; and, depending on the specific needs of Member States, it shall include: (d) an assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity, taking into account as far as possible issues such as the topography, the position of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of existing manmade flood defence infrastructures, the position of populated areas, areas of economic activity and long-term developments including impacts of climate change on the occurrence of floods.
Status:	Proposed
Stereotypes:	«dataType»

Attribute: beginLifespanVersion	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: endLifespanVersion	
Value type:	DateTime

PreliminaryFRAssessment	
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»
Attribute: inspireId	
Value type:	Identifier
Definition:	External object identifier of the preliminary flood risk assessment.
Description:	An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1
Attribute: reference	
Value type:	DocumentReference
Definition:	A reference to the Prelininary Flood Risk Assessment document.
Multiplicity:	1
Stereotypes:	«voidable»
Association role: componentOf	
Value type:	InundatedLand
Definition:	The inundated land that is in a preliminary flood risk assessment.
Multiplicity:	1..*
Association role: exposedElementPFRA	
Value type:	ExposedElements
Definition:	The exposed element that is in a preliminary flood risk assessment.
Multiplicity:	0..*
Association role: result	
Value type:	PotentialFloodedArea
Definition:	The potential flooded area that is designed aftyer a prliminary flood risk assessment.
Multiplicity:	1..*
Constraint: Exposed Elements-PFRA = ExposeElements-InundatedLand	
Natural language:	Exposed elements that are linked must be the ones linked to the Inundated Lands
OCL:	Inv: self.FHMap.inundatedLandVulnFeature = self.componentOf.involvedFeature

5.7.1.3. Enumerations

5.7.1.3.1. ProbabilityOfFlood

ProbabilityOfFlood	
Definition:	An assessment of the level probability the flood can occur on the area.
Description:	[2007/60/EC]. A flood can have a low probability of occurence, a medium probability of occurence or a high probability of occurence.
Status:	Proposed
Stereotypes:	«enumeration»
Value: high	
Definition:	Floods with a likely return period usually between 5 and 50 years.

ProbabilityOfFlood	
Value: low	
Definition:	Floods with a likely return period usually between 200 and 1000 years (or extreme events).
Value: medium	
Definition:	Floods with a likely return period usually between 100 and 200 years (2007/60/EC = 100 years).

5.7.1.4. Code lists

5.7.1.4.1. InundationValue

InundationValue	
Definition:	The type of a land subject to inundation.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	May not be extended by Member States. Centrally managed in INSPIRE code list register. URN: urn:x-inspire:def:codeList:INSPIRE:InundationValue
Value: controlled	
Definition:	A tract periodically flooded by the regulation of the level of water impounded by a dam.
Description:	`SOURCE [Based on DFDD].`
Value: natural	
Definition:	A tract periodically covered by flood water, excluding tidal waters.

5.7.1.5. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.7.1.5.1. DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	

5.7.1.5.2. DocumentReference

DocumentReference	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	the piece of information which is required to get further information about a method that is described and explained in a paper.

5.7.1.5.3. ExposedElements

ExposedElements	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	SOURCE : [UNISDR, 2009] People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

5.7.1.5.4. GM_Surface

GM_Surface	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	GM_Surface (Figure 12) a subclass of GM_Primitive and is the basis for 2-dimensional geometry. Unorientable surfaces such as the Möbius band are not allowed. The orientation of a surface chooses an "up" direction through the choice of the upward normal, which, if the surface is not a cycle, is the side of the surface from which the exterior boundary appears counterclockwise. Reversal of the surface orientation reverses the curve orientation of each boundary component, and interchanges the conceptual "up" and "down" direction of the surface. If the surface is the boundary of a solid, the "up" direction is usually outward. For closed surfaces, which have no boundary, the up direction is that of the surface patches, which must be consistent with one another. Its included GM_SurfacePatches describe the interior structure of a GM_Surface. NOTE Other than the restriction on orientability, no other "validity" condition is required for GM_Surface.

5.7.1.5.5. HydroObject

HydroObject (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex I::Hydrography::Hydro - base [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	An identity base for hydrographic (including man-made) objects in the real world.
Description:	NOTE Derived 'views' of real-world hydrographic objects are represented through specialisations in other application schemas; all representations of the same real-world object share a common geographic name or hydrographic identifier.

5.7.1.5.6. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.7.1.5.7. Length

Length	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

Length	
Definition:	The measure of distance as an integral, i.e. the limit of an infinite sum of distances between points on a curve. For example the length of curve, the perimeter of a polygon as the length of the boundary.

5.7.1.5.8. ManMadeObject

ManMadeObject (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex I::Hydrography::Hydro - Physical Waters [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	An artificial object which lies inside a body of water and has one of the following types of function: - Retains the water; - Regulates the quantity of water; - Alters the course of the water; - Allows watercourses to cross each other.

5.7.1.5.9. Measure

Measure	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	The result from performing the act or process of ascertaining the extent, dimensions, or quantity of some entity. A measure is always associated to a unit of measure. Ratio measures where the two base measures are in the same units (often considered unit-less) should be associated to UnitOfMeasure (same meter/meter for map scale) so that conversions to non-unitless ratios can be accomplished (such as miles/inch).

5.7.1.5.10. ModelledOrDeterminedHazard

ModelledOrDeterminedHazard	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A hazard which extent is modeled, or inferred by the interpretation of indirect artefacts.

5.7.1.5.11. Number

Number (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Primitive::Numerics [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	The base type for all number data, giving the basic algebraic operations. Since all concrete types have finite representations, some part of this algebra for most types exhibit some inaccuracy. For example, Integers cannot divide very well, and reals and decimals cannot avoid certain types of inaccuracies that depend on their representation semantics.

5.7.1.5.12. ObservedHazard

ObservedHazard	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Natural Risk Zones::Core_Model [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A hazard which occurred, or is currently occuring, and which has been observed.

5.7.1.5.13. Velocity

Velocity

Velocity	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103:2005 Schema Language::Basic Types::Derived::Units of Measure [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	The measure of motion in terms of speed in a particular direction. It is usually calculated using the simple formula, the change in position during a given time interval.

6 Reference systems

6.1 Coordinate reference systems

6.1.1 Datum

IR Requirement 21 For the coordinate reference systems used for making available the INSPIRE spatial data sets, the datum shall be the datum of the European Terrestrial Reference System 1989 (ETRS89) in areas within its geographical scope, and the datum of the International Terrestrial Reference System (ITRS) or other geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. Compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well established and described relationship between both systems, according to EN ISO 19111.

6.1.2 Coordinate reference systems

IR Requirement 22 INSPIRE spatial data sets shall be made available using one of the three-dimensional, two-dimensional or compound coordinate reference systems specified in the list below.

Other coordinate reference systems than those listed below may only be used for regions outside of continental Europe. The geodetic codes and parameters for these coordinate reference systems shall be documented, and an identifier shall be created, according to EN ISO 19111 and ISO 19127.

1. Three-dimensional Coordinate Reference Systems
   - Three-dimensional Cartesian coordinates
   - Three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height), using the parameters of the GRS80 ellipsoid

2. Two-dimensional Coordinate Reference Systems
   - Two-dimensional geodetic coordinates, using the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Lambert Azimuthal Equal Area projection and the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Lambert Conformal Conic projection and the parameters of the GRS80 ellipsoid
   - Plane coordinates using the Transverse Mercator projection and the parameters of the GRS80 ellipsoid

3. Compound Coordinate Reference Systems
   - For the horizontal component of the compound coordinate reference system, one of the two-dimensional coordinate reference systems specified above shall be used
   - For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights within its geographical scope
   - Other vertical reference systems related to the Earth gravity field shall be used to express gravity-related heights in areas that are outside the geographical scope of EVRS. The geodetic codes and parameters for these vertical reference systems shall be documented and an identifier shall be created, according to EN ISO 19111 and ISO 19127
   - For the vertical component measuring the depth of the sea floor, where there is an appreciable tidal range, the Lowest Astronomical Tide shall be used as reference surface. In marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200 m, the depth of the sea floor shall be referenced to the Mean Sea Level
   - For the vertical component measuring depths above the sea floor in the free ocean, barometric pressure shall be used
   - For the vertical component in the free atmosphere, barometric pressure, converted to height using ISO 2533:1975 International Standard Atmosphere shall be used

6.1.3 Display

IR Requirement 23 For the display of the INSPIRE spatial data sets with the View Service specified in D003152/02 Draft Commission Regulation implementing Directive 2007/2/EC of the European Parliament and of the Council as regards Network Services, at least the two dimensional geodetic coordinate system shall be made available.

6.1.4 Identifiers for coordinate reference systems

IR Requirement 24 For referring to the non-compound coordinate reference systems listed in this Section, the identifiers listed below shall be used.

For referring to a compound coordinate reference system, an identifier composed of the identifier of the horizontal component, followed by a slash (/), followed by the identifier of the vertical component, shall be used.

- ETRS89-XYZ for Cartesian coordinates in ETRS89
- ETRS89-GRS80h for three-dimensional geodetic coordinates in ETRS89 on the GRS80 ellipsoid
- ETRS89-GRS80 for two-dimensional geodetic coordinates in ETRS89 on the GRS80
- EVRS for height in EVRS
- LAT for depth of the sea floor, where there is an appreciable tidal range
- MSL for depth of the sea floor, in marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200m
- ISA for pressure coordinate in the free atmosphere
- PFO for Pressure coordinate in the free ocean
- ETRS89-LAEA for ETRS89 coordinates projected into plane coordinates by the Lambert Azimuthal Equal Area projection

- ETRS89-LCC for ETRS89 coordinates projected into plane coordinates by the Lambert Conformal Conic projection
- ETRS89-TMzn for ETRS89 coordinates projected into plane coordinates by the Transverse Mercator projection

6.2 Temporal reference system

IR Requirement 25 The Gregorian Calendar shall be used for as a reference system for date values, and the Universal Time Coordinated (UTC) or the local time including the time zone as an offset from UTC shall be used as a reference system for time values.

6.3 Theme-specific requirements and recommendations on reference systems

There are no theme-specific requirements or recommendations on reference systems.

7 Data quality

This chapter includes a description of data quality elements and sub-elements as well as the associated data quality measures (section 7.1). The selected data quality measures should be used to evaluate quality of data sets for a specific data quality element / sub-element. The evaluation can be performed at the level of spatial object, spatial object type, dataset or dataset series.

The results of the evaluation are then reported at the spatial object type or dataset level in metadata utilising the same data quality elements and measures (see chapter 8).

NOTE The selection of appropriate data quality measures represents the first step towards the harmonisation of documenting data quality.

In addition, for some of the data quality elements described in section 7.1, minimum data quality requirements or recommendations may be defined. These are described in the section 1.2.

Recommendation 3 If data quality information is required at spatial object level then it should be modelled in the data model as an attribute of a relevant spatial object type.

7.1 Data quality elements and measures

Recommendation 4 To evaluate and report the data quality of data sets related to the spatial data theme **Natural Risk Zones**, the elements and measures listed in Table 1 should be used.

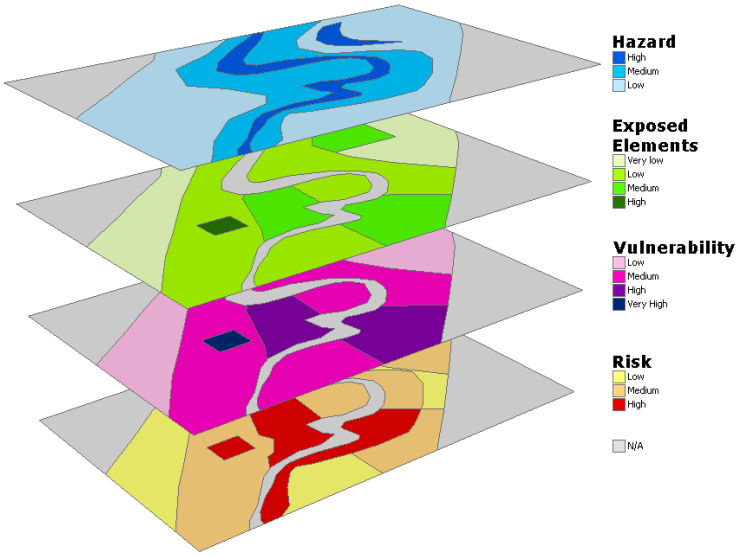
Table 2 – Data quality elements for evaluating and reporting the data quality of data sets related to the spatial data theme Natural Risk Zones

Section	Data quality element and sub-element
1.1.1	Logical Consistency – Conceptual Consistency

7.1.1 Logical Consistency – Conceptual Consistency

Conceptual Consistency should be documented using <Logical Consistency, from ISO 19138>.

Name	Logical Consistency
Alternative name	-
Data quality element	Logical Consistency
Data quality sub-element	Conceptual Consistency
Data quality basic measure	1) Counting-related data quality basic measures: Error count
Definition	Total number of items not compliant with the rules of the NZ conceptual schema.
Description	Spatial relations between basic object types: • A spatial object classified as "RiskZone" must spatially overlay one or several spatial objects classified as "HazardArea". • A spatial object classified as "RiskZone" must spatially overlay one or more spatial objects classified as "ExposedElements". • A spatial object classified as "ExposedElements" must spatially be within one or more spatial objects classified as "HazardArea". Spatial relations specifically for fluvial flood hazard / risk type (and not necessarily applicable for other hazard/risk types): • A fluvial flood prone area (spatial object type "HazardArea") or a fluvial flood risk area (spatial object type "RiskArea") with a certain return period (eg. T=500) shall include fluvial flood prone areas or risk areas (spatial object type "HazardArea" or "RiskArea") with lower return periods (eg. T=100, T=50, etc). • HazardArea or RiskArea for hazard type flood must be located in a certain coastal area, sub-basin, river basin and/or RBD
Evaluation scope	data set
Reporting scope	spatial object type: hazardArea, exposedElements, riskZone data set
Parameter	-
Data quality value type	Integer
Data quality value structure	-
Source reference	-

Example	
Measure identifier	11

7.2 Minimum data quality requirements and recommendations

IR Requirement 26 For the data quality elements listed in Table 2, all data sets related to the spatial data theme **Natural Risk Zones** shall meet the specified target results.

Table 3 – Data quality elements and measures for which minimum data quality requirements are defined for the spatial data theme Natural Risk Zones

Section	Data quality element and sub-element	Measure name(s)	Target result(s)	Condition
1.1	Logical Consistency - Conceptual Consistency	Conceptual schema compliance	Conformance level: 0 violations	

8 Dataset-level metadata

Metadata can be reported for each individual spatial object (spatial object-level metadata) or once for a complete dataset or dataset series (dataset-level metadata). Spatial object-level metadata is fully described in the application schema (section **5**). If data quality elements are used at spatial object level, the documentation shall refer to the appropriate definition in section 7. This section only specifies dataset-level metadata elements.

For some dataset-level metadata elements, in particular on data quality and maintenance, a more specific scope can be specified. This allows the definition of metadata at sub-dataset level, e.g.

separately for each spatial object type. When using ISO 19115/19139 to encode the metadata, the following rules should be followed:

- The scope element (of type DQ_Scope) of the DQ_DataQuality subtype should be used to encode the scope.
- Only the following values should be used for the level element of DQ_Scope: Series, Dataset, featureType.
- If the level is featureType the levelDescription/MDScopeDescription/features element (of type Set< GF_FeatureType>) shall be used to list the feature type names.

NOTEThe value featureType is used to denote spatial object type.

Mandatory or conditional metadata elements are specified in Section 8.1. Optional metadata elements are specified in Section 8. The tables describing the metadata elements contain the following information:

- The first column provides a reference to a more detailed description.
- The second column specifies the name of the metadata element.
- The third column specifies the multiplicity.
- The fourth column specifies the condition, under which the given element becomes mandatory (only for Table 1 and Table 2).

8.1 Common metadata elements

IR Requirement 27	The metadata describing a spatial data set or a spatial data set series related to the theme **Natural Risk Zones** shall comprise the metadata elements required by Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata) for spatial datasets and spatial dataset series (Table 1) as well as the metadata elements specified in Table 2.

Table 4 – Metadata for spatial datasets and spatial dataset series specified in Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata)

Metadata Regulation Section	Metadata element	Multiplicity	Condition
1.1	Resource title	1	
1.2	Resource abstract	1	
1.3	Resource type	1	
1.4	Resource locator	0..*	Mandatory if a URL is available to obtain more information on the resource, and/or access related services.
1.5	Unique resource identifier	1..*	
1.7	Resource language	0..*	Mandatory if the resource includes textual information.
2.1	Topic category	1..*	
3	Keyword	1..*	

4.1	Geographic bounding box	1..*	
5	Temporal reference	1..*	
6.1	Lineage	1	
6.2	Spatial resolution	0..*	Mandatory for data sets and data set series if an equivalent scale or a resolution distance can be specified.
7	Conformity	1..*	
8.1	Conditions for access and use	1..*	
8.2	Limitations on public access	1..*	
9	Responsible organisation	1..*	
10.1	Metadata point of contact	1..*	
10.2	Metadata date	1	
10.3	Metadata language	1	

Table 5 – Mandatory and conditional common metadata elements

INSPIRE Data Specification Natural Risk Zones **Section**	**Metadata element**	**Multiplicity**	**Condition**
8.1.1	Coordinate Reference System	1	
8.1.2	Temporal Reference System	0..*	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
8.1.3	Encoding	1..*	
8.1.4	Character Encoding	0..*	Mandatory, if an encoding is used that is not based on UTF-8.
8.1.5	Data Quality – Logical Consistency – Topological Consistency	0..*	Mandatory, if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.

8.1.1 Coordinate Reference System

Metadata element name	**Coordinate Reference System**
Definition	Description of the coordinate reference system used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo

INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1
Data type(and ISO 19115 no.)	189. MD_CRS
Domain	Either the referenceSystemIdentifier (RS_Identifier) or the projection (RS_Identifier), ellipsoid (RS_Identifier) and datum (RS_Identifier) properties shall be provided. NOTE More specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: ETRS_89 codeSpace: INSPIRE RS registry
Example XML encoding	<gmd:referenceSystemInfo> <gmd:MD_ReferenceSystem> <gmd:referenceSystemIdentifier> <gmd:RS_Identifier> <gmd:code> <gco:CharacterString>ETRS89 </gco:CharacterString> </gmd:code> <gmd:codeSpace> <gco:CharacterString>INSPIRE RS registry</gco:CharacterString> </gmd:codeSpace> </gmd:RS_Identifier> </gmd:referenceSystemIdentifier> </gmd:MD_ReferenceSystem> </gmd:referenceSystemInfo>
Comments	

8.1.2 Temporal Reference System

Metadata element name	**Temporal Reference System**
Definition	Description of the temporal reference systems used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
INSPIRE multiplicity	0..*
Data type(and ISO 19115 no.)	186. MD_ReferenceSystem
Domain	No specific type is defined in ISO 19115 for temporal reference systems. Thus, the generic MD_ReferenceSystem element and its reference SystemIdentifier (RS_Identifier) property shall be provided. NOTEMore specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: GregorianCalendar codeSpace: INSPIRE RS registry

Example XML encoding	<gmd:referenceSystemInfo> <gmd:MD_ReferenceSystem> <gmd:referenceSystemIdentifier> <gmd:RS_Identifier> <gmd:code> <gco:CharacterString>GregorianCalendar</gco:CharacterString> </gmd:code> <gmd:codeSpace> <gco:CharacterString>INSPIRE RS registry</gco:CharacterString> </gmd:codeSpace> </gmd:RS_Identifier> </gmd:referenceSystemIdentifier> </gmd:MD_ReferenceSystem> </gmd:referenceSystemInfo>
Comments	

8.1.3 Encoding

Metadata element name	**Encoding**
Definition	Description of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel
ISO 19115 number and name	271. distributionFormat
ISO/TS 19139 path	distributionInfo/MD_Distribution/distributionFormat
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1
Data type (and ISO 19115 no.)	284. MD_Format
Domain	See B.2.10.4. The property values (name, version, specification) specified in section 9 shall be used to document the default and alternative encodings.
Implementing instructions	
Example	name: **Natural Risk Zones** GML application schema version: version **2.0**, GML, version 3.2.1 specification: D2.8.**III**.**12** Data Specification on **Natural Risk Zones** – Draft Guidelines
Example XML encoding	<gmd:MD_Format> <gmd:name> <gco:CharacterString> **Natural Risk Zones** GML application schema </gco:CharacterString> </gmd:name> <gmd:version> <gco:CharacterString>**2.0**, GML, version 3.2.1</gco:CharacterString> </gmd:version> <gmd:specification> <gco:CharacterString>D2.8.**III**.**12** Data Specification on **Natural Risk Zones** – Draft Guidelines</gco:CharacterString> </gmd:specification> </gmd:MD_Format>
Comments	

8.1.4 Character Encoding

Metadata element name	**Character Encoding**
Definition	The character encoding used in the data set.
ISO 19115 number and name	
ISO/TS 19139 path	
INSPIRE obligation / condition	Mandatory, if an encoding is used that is not based on UTF-8.
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	
Domain	
Implementing instructions	
Example	-
Example XML encoding	<gmd:characterSet> <gmd:MD_CharacterSetCode codeListValue="8859part2" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/Codelist/ML_gmxCodelists.xml#CharacterSetCode">8859-2</gmd:MD_CharacterSetCode> </gmd:characterSet>
Comments	

8.1.5 Data Quality – Logical Consistency – Topological Consistency

Metadata element name	**Data Quality – Logical Consistency – Topological Consistency**
Definition	Correctness of the explicitly encoded topological characteristics of the dataset as described by the scope
ISO 19115 number and name	18. dataQualityInfo
ISO/TS 19139 path	dataQualityInfo
INSPIRE obligation / condition	Mandatory, if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	115. DQ_TopologicalConsistency
Domain	Lines 100-107 from ISO 19115
Implementing instructions	This metadata should be filled, at least, with these elements: - valueUnit: UnitOfMeasure - value: Record
Example	
Example XML encoding	
Comments	See clauses on topological consistency in section 7 for detailed information. This metadata element is mandatory if connectivity is not assured for network centrelines in the dataset. In this case the *Connectivity tolerance* parameter – as described in section 7 – must be provided in order to ensure automatic and unambiguous creation of centreline topology in post-process.

8.2 Metadata elements for reporting data quality

Recommendation 5 For reporting the results of the data quality evaluation quantitatively, the data quality elements and measures defined in chapter 7 should be used.

The scope for reporting may be different from the scope for evaluating data quality (see section 7). If data quality is reported at the data set or spatial object type level, the results are usually derived or aggregated.

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO 19115 number and name	80. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO 19115 no.)	Corresponding DQ_xxx element from ISO 19115, e.g. 109. DQ_CompletenessCommission
Domain	Lines 100-107 from ISO 19115 100. nameOfMeasure : CharacterString [0..*] 101. measureIdentification : MD_Identifier [0..1] 102. measureDescription : CharacterString [0..1] 103. evaluationMethodType : DQ_EvaluationMethodTypeCode [0..1] 104. evaluationMethodDescription : CharacterString [0..1] 105. evaluationProcedure : CI_Citation [0..1] 106. dateTime : DateTime [0..*] 107. result : DQ_Result [1..2]
Implementing instructions	**Recommendation 6** For each DQ result included in the metadata, at least the following properties should be provided: 100. nameOfMeasure NOTE This should be the name as defined in Chapter 7. 103. evaluationMethodType 104. evaluationMethodDescription NOTE If the reported data quality results are derived or aggregated (i.e. the scope levels for evaluation and reporting are different), the derivation or aggregation should also be specified using this property. 106. dateTime NOTE This should be data or range of dates on which the data quality measure was applied. 107. result NOTE This should be of type DQ_QuantitativeResult
Example	
Example XML encoding	
Comments	See Chapter 7 for detailed information on the individual data quality elements and measures to be used.

Open issue 9: In the ongoing revision of ISO 19115 and development of new ISO 19157 standard (Geographic Information – Data quality), a new element is introduced (DQ_DescriptiveResult). This element enables to describe and report qualitative results of the data quality evaluation and could be

used instead of DQ_QuantitativeResult. Once the new (version of the) standards are approved, these guidelines will be revisited and be updated if necessary.

Open issue 10: For reporting compliance with minimum data quality requirements and recommendations specified in section 7, the INSPIRE conformity metadata element should be used.

However, since this issue is part of the larger discussion on the Abstract Test Suite and the definition of conformance classes for the data specification, detailed instructions on how to provide metadata on compliance with minimum data quality requirements and recommendations will only be provided for v3.0.

8.3 Theme-specific metadata elements

No mandatory theme-specific metadata elements are defined for this theme.

No optional theme-specific metadata elements are defined for this theme.

Recommendation 7

8.3.1 Maintenance Information

Metadata element name	Maintenance information
Definition	Information about the scope and frequency of updating
ISO 19115 number and name	30. resourceMaintenance
ISO/TS 19139 path	identificationInfo/MD_Identification/resourceMaintenance
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..1
Data type(and ISO 19115 no.)	142. MD_MaintenanceInformation
Domain	This is a complex type (lines 143-148 from ISO 19115). At least the following elements should be used (the multiplicity according to ISO 19115 is shown in parentheses): – maintenanceAndUpdateFrequency [1]: frequency with which changes and additions are made to the resource after the initial resource is completed / domain value: MD_MaintenanceFrequencyCode: – updateScope [0..*]: scope of data to which maintenance is applied / domain value: MD_ScopeCode – maintenanceNote [0..*]: information regarding specific requirements for maintaining the resource / domain value: free text
Implementing instructions	
Example	
Example XML encoding	
Comments	

8.4 Guidelines on using metadata elements defined in Regulation 1205/2008/EC

8.4.1 Conformity

The *Conformity* metadata element defined in Regulation 1205/2008/EC allows to report the conformance with the Implementing Rule for interoperability of spatial data sets and services or another specification. The degree of conformity of the dataset can be *Conformant* (if the dataset is fully conformant with the cited specification), *Not Conformant* (if the dataset does not conform to the cited specification) or *Not evaluated* (if the conformance has not been evaluated).

Recommendation 8 The Conformity metadata element should be used to report conceptual consistency with this INSPIRE data specification. The value of Conformant should be used for the Degree element only if the dataset passes all the requirements described in the abstract test suite presented in Annex A. The Specification element should be given as follows:
- title: “INSPIRE Data Specification on <Theme Name> – Draft Guidelines”
- date:
  - dateType: publication
  - date: 2011-06-15

Open issue 11: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

This may also lead to an update of the recommendations on how to fill the conformity metadata element.

8.4.2 Lineage

Recommendation 9 Following the ISO 19113 Quality principles, if a data provider has a procedure for quality validation of their spatial data sets then the data quality elements listed in the Chapters 7 and 8 should be used. If not, the *Lineage* metadata element (defined in Regulation 1205/2008/EC) should be used to describe the overall quality of a spatial data set.

According to Regulation 1205/2008/EC, lineage “is a statement on process history and/or overall quality of the spatial data set. Where appropriate it may include a statement whether the data set has been validated or quality assured, whether it is the official version (if multiple versions exist), and whether it has legal validity. The value domain of this metadata element is free text”.

The Metadata Technical Guidelines based on EN ISO 19115 and EN ISO 19119 specify that the statement sub-element of LI_Lineage (EN ISO 19115) should be used to implement the lineage metadata element.

Recommendation 10 To describe the transformation steps and related source data, it is recommended to use the following sub-elements of LI_Lineage:
- For the description of the transformation process of the local to the common INSPIRE data structures, the LI_ProcessStep sub-element should be used.
- For the description of the source data the LI_Source sub-element should be used.

NOTE 1 This recommendation is based on the conclusions of the INSPIRE Data Quality Working Group to avoid overloading of the overall lineage statement element with information on the transformation steps and related source data.

NOTE 2 In order to improve the interoperability, domain templates and instructions for filling these free text elements (descriptions) may be specified in an Annex of this data specification.

Open issue 12: The suggested use of the LI_Lineage sub-elements needs to be discussed as part of the maintenance of the INSPIRE metadata Technical Guidelines.

8.4.3 Temporal reference

According to Regulation 1205/2008/EC, at least one of the following temporal reference metadata elements shall be provided: temporal extent, date of publication, date of last revision, date of creation. If feasible, the date of the last revision of a spatial data set should be reported using the *Date of last revision* metadata element.

8.4.4 Guidelines for Lineage completion

Because of the critical role that natural risk zones may play on human lives and natural resources, it is imperative that documentation is provided in a harmonized way, in order to understand the spatial and temporal accuracy of each dataset.

The hazard determination method must also be documented by accessible publications that satisfy international requirements for completeness and methodology validity.

The declared temporal accuracy of risk zone(s) should refer to date of last update and as far as possible also for input data “elements of risk” respectively input datasets should follow the relevant INSPIRE data specification.

In version 3.0 of the data specification it is proposed to provide a template for transformation source and lineage information

ProcessStep
The first lineage template will concern the process step for capturing (among other things) the description of the transformation process from the local Risk Zone datasets to the common INSPIRE one.

Source
The data provider may describe or at least list the type of data (hazards) that were use for delineating the risk zones.

9 Delivery

9.1 Delivery medium

DS Requirement 2	Data conformant to this INSPIRE data specification shall be made available through an INSPIRE network service.

DS Requirement 3	All information that is required by a calling application to be able to retrieve the data through the used network service shall be made available in accordance with the requirements defined in the Implementing Rules on Network Services.

EXAMPLE 1 Through the Get Spatial Objects function, a download service can either download a pre-defined data set or pre-defined part of a data set (non-direct access download service), or give direct access to the spatial objects contained in the data set, and download selections of spatial objects based upon a query (direct access download service). To execute such a request, some of the following information might be required:

- the list of spatial object types and/or predefined data sets that are offered by the download service (to be provided through the Get Download Service Metadata operation),
- and the query capabilities section advertising the types of predicates that may be used to form a query expression (to be provided through the Get Download Service Metadata operation, where applicable),
- a description of spatial object types offered by a download service instance (to be proviced through the Describe Spatial Object Types operation).

EXAMPLE 2 Through the Transform function, a transformation service carries out data content transformations from native data forms to the INSPIRE-compliant form and vice versa. If this operation is directly called by an application to transform source data (e.g. obtained through a download service) that is not yet conformant with this data specification, the following parameters are required:
Input data (mandatory). The data set to be transformed.

- Source model (mandatory, if cannot be determined from the input data). The model in which the input data is provided.
- Target model (mandatory). The model in which the results are expected.
- Model mapping (mandatory, unless a default exists). Detailed description of how the transformation is to be carried out.

9.2 Encodings

9.2.1 Default Encoding(s)

DS Requirement 4	Data conformant to the application schema(s) defined in section 5.2 shall be encoded using the encoding(s) specified in this section.

9.2.1.1. Default encoding for application schema Core_Model

IR Requirement 28	Data conformant to the application schema Core_Model shall be encoded using the encoding specified in this section.

Format name: Core_Model GML Application Schema
Version of the format: 3.0, GML, version 3.2.1
Reference to the specification of the format: ISO 19136:2007
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

9.2.1.2. Default encoding for application schema Coverage_Model

IR Requirement 29 Data conformant to the application schema Coverage_Model shall be encoded using the encoding specified in this section.

Format name: Coverage_Model GML Application Schema
Version of the format: 3.0, GML, version 3.2.1
Reference to the specification of the format: ISO 19136:2007
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

9.2.1.3. Default encoding for application schema Floods_Example_Model

IR Requirement 30 Data conformant to the application schema Flood_Example_Model shall be encoded using the encoding specified in this section.

Format name: Floods_Example_Model GML Application Schema
Version of the format: 3.0, GML, version 3.2.1
Reference to the specification of the format: ISO 19136:2007
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

10 Data Capture

There is no specific guidance required with respect to data capture.

11 Portrayal

This clause defines the rules for layers and styles to be used for portrayal of the spatial object types defined for this theme.

In section 11.1, the *types* of layers are defined that are to be used for the portrayal of the spatial object types defined in this specification. A view service may offer several layers of the same type, one for each dataset that it offers on a specific topic.

Section 11.2 specifies the styles that shall be supported by INSPIRE view services for each of these layer types.

In section 11.3, further styles can be specified that represent examples of styles typically used in a thematic domain. It is recommended that also these styles should be supported by INSPIRE view services, where applicable.

Where XML fragments are used in these sections, the following namespace prefixes apply:

- sld="http://www.opengis.net/sld" (WMS/SLD 1.1)
- se="http://www.opengis.net/se" (SE 1.1)
- ogc="http://www.opengis.net/ogc" (FE 1.1)

IR Requirement 31	If an INSPIRE view services supports the portrayal of data related to the theme **Natural Risk Zones**, it shall provide layers of the types specified in this section.

DS Requirement 5	If an INSPIRE view network service supports the portrayal of spatial data sets corresponding to the spatial data theme **Natural Risk Zones**, it shall support the styles specified in section 11.2. If no user-defined style is specified in a portrayal request for a specific layer to an INSPIRE view service, the default style specified in section 11.2 for that layer shall be used.

Recommendation 11	In addition to the styles defined in section 11.2, it is recommended that, where applicable, INSPIRE view services also support the styles defined in section 11.3.

11.1 Layers to be provided by INSPIRE view services

Open issue 13: In this section some very simple guidelines are provided regarding portrayal. Initially it was foreseen that member states should coordinate portrayal if required. There have also been suggestions made that guidance would assist and in certain domains, best practice might be followed. Please comment upon this chapter if you require specific guidelines from this document in version 3.0.

Layer Name	**Layer Title**	**Spatial object type(s)**	**Keywords**
NZ.RiskZone	Risk Zone	RiskZone	Risk zone
NZ.HazardArea	Hazard Area	HazardArea	Hazard Area
NZ.ExposedElements	Exposed Elements	ExposedElements	Exposed Elements

11.1.1 Layers organisation

None.

11.2 Styles to be supported by INSPIRE view services

11.2.1 Styles for the layer NZ.RiskZone AND NZ.HazardArea

The following chapter is applicable both for risk zones and for hazard areas.

The risk zones and the hazard areas are either 2D or 3D polygons.
Risk zones should be portrayed according to the values taken for the attributes “TypeOfRisk” and “LevelOfRisk”.
2 different cases are detailed here under:

1. A dataset that details the level of risk over a certain area for one type of risk
   The attribute “LevelOfRisk” has the information. It is either a qualitative or a quantitative concept. It is recommended that risk zones are portrayed with a classification: this requires no work when the level of risk is assessed qualitatively (when the “QualitativeValue” attribute is completed). When the level of risk is assessed quantitatively (when the “QuantitativeValue” attribute is completed), the user must set some classes depending upon a range of values. For this latter case, it is recommended to set no more than 5 classes.
   Each of those classes should be portrayed using shaded tones of colours (a colour ramp) (from a light blue to a dark blue, or from a light green to a dark red, for example).

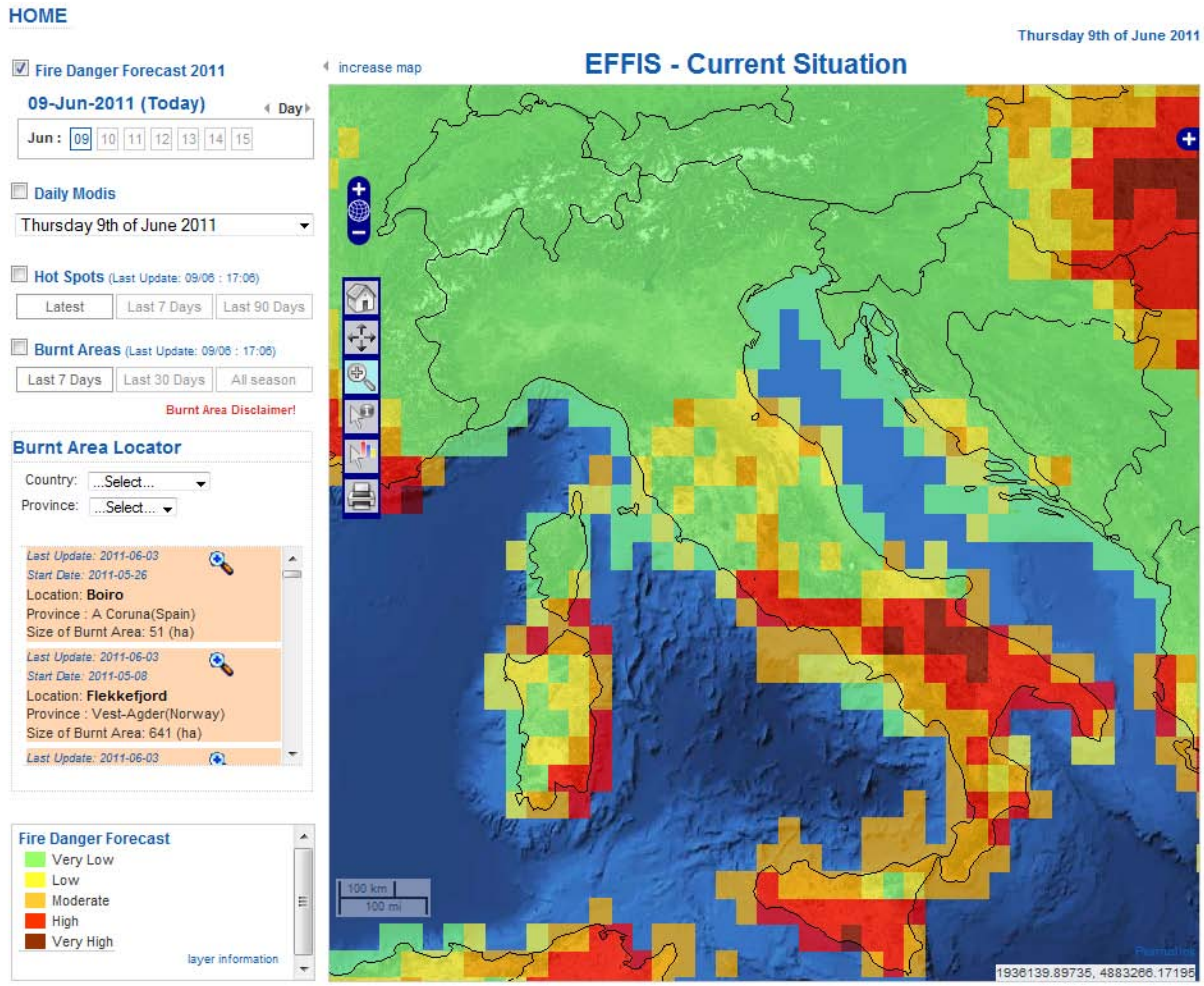


Figure 9 – Example of portrayal of levels of risk over a certain area for the type of risk "Forest fire"European Forest Fire Information System: Forest danger forecast. http://effis.jrc.ec.europa.eu/current-situation

2. A dataset that details the type of risk zones over a certain area.
   If a dataset concerns several types of risk, then the risk zones should be portrayed according to the types of risk (that is to say according to the values taken by the attribute "HazardCategoryValue" of the "NaturalRiskOrHazardClassification" data type, which is referenced by the "TypeOfRisk" attribute).

11.2.2 Styles for the layer NZ.ExposedElement

No guideline is provided for the portrayal of exposed elements. As those elements may fall under the scope of other INSPIRE theme (as the geometry of the features may be provided by another body than the one which uses them as exposed elements within the framework of natural risk zones), the portrayal is left to the data specifications of those themes.

11.3 Other recommended styles

No other styles are recommended.

Bibliography

[DS-D2.3] INSPIRE DS-D2.3, Definition of Annex Themes and Scope, v3.0, *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.3_Definition_of_Annex_Themes_and_scope_v3.0.pdf*

[DS-D2.5] INSPIRE DS-D2.5, Generic Conceptual Model, v3.3, *http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/D2.5_v3_3.pdf*

[DS-D2.6] INSPIRE DS-D2.6, Methodology for the development of data specifications, v3.0, *http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.6_v3.0.pdf*

[DS-D2.7] INSPIRE DS-D2.7, Guidelines for the encoding of spatial data, v3.2, *http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/D2.7_v3.2.pdf*

[ISO 19101] EN ISO 19101:2005 Geographic information – Reference model (ISO 19101:2002)

[ISO 19103] ISO/TS 19103:2005, Geographic information – Conceptual schema language

[ISO 19107] EN ISO 19107:2005, Geographic information – Spatial schema (ISO 19107:2003)

[ISO 19108] EN ISO 19108:2005 Geographic information - Temporal schema (ISO 19108:2002)

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

ISO/IEC 31010:2009 - Risk management -- Risk assessment techniques

UNISDR2009 - The United Nations International Strategy for Disaster Reduction

SEC(2010) 1626 final 5.01.2011 Risk Assessment and Mapping Guidelines for Disaster Management. Commission Staff Working Paper. Council of the European Union, Brussels http://register.consilium.europa.eu/pdf/en/10st17/st17833.en10.pdf

Annex A
(normative)

Abstract Test Suite

Any dataset conforming to this INSPIRE data specification shall meet all requirements specified in this document.

Open issue 14: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

Annex B
(informative)
CodeList Examples

B.1 *Classification of natural hazards*

As part of on-going discussions about natural hazard classifications, below is a classification of natural hazards that is proposed as an example for member states to use as a specialisation of the empty codelist specificRiskOrHazardTypeValue.

Category	Item	Definition	Description
Biohazard	Biohazard	Health issues related to biological agents such as virus, bacteria, fungi, parasites, plagues etc.	
Climate	Climate	Hazard resulting from climate change and affecting natural and human systems and regions.	Changes in the long term of variables describing climate (vegetation, temperature, humidity, wind direction, etc.)
	Glaciation	The geologic processes involved in the formation, movement, changes, and effects of large ice masses - glaciers- (USGS, on-line glossary, geologic processes).	Glaciation is an interval of time (thousands of years) within an ice age that is marked by colder temperatures and, thereby, glacier advances.
	Impact winter - Volcanic Winter	Impact winter or Volcanic Winter is the consequence of dust blasted into the stratosphere blocking out sunlight, and plunging Earth into darkness and refrigeration as consequence of a major asteroid impact or major volcanic eruption (Wolfe, 1991. Nature, 352: 420-423. McLean, D.M., 1991.	-

	Natural desertification	Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations (IPCC AR4 WG 2).	Loss-of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including those arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical, and biological or economic properties of soil; and (iii) long-term loss of natural vegetation (IPCC AR4 WG 2).
Cosmic	Cosmic	Hazards coming from none terrestrial sources	
	Gamma Radiation	Radiation from natural sources	Some outerspace phenomena, such as supernova, can cause gamma-ray bursts which can affect life on Earth.
	Gravity Field Alterations	Changes in the gravity field of the earth	-
	Magnetic Disruptions	This includes geomagnetic disturbances and geomagnetic storms. The first includes Earth's magnetism changes, and the later is a temporary disturbance of the Earth's magnetosphere caused by a disturbance in space weather.	Associated with solar flares and resultant solar coronal mass ejections (CME), a geomagnetic storm is caused by a solar wind shock wave and/or cloud of magnetic field which typically strikes the Earth's magnetic field 3 days after the event. The solar wind pressure on the magnetosphere and the solar wind magnetic field will increase or decrease depending on the Sun's activity. The solar wind pressure changes modify the electric currents in the ionosphere, and the solar wind's magnetic field interacts with the Earth's magnetic field causing the entire structure to evolve. Intense solar flares release very-high-energy particles that can cause radiation poisoning to humans (and mammals in general) in the same way as low-energy radiation from nuclear blasts.
	Meteorites	Bodies from an extraterrestrial source that collide with the earth or it's atmosphere.	
	Solar Storm	Periods of heightened solar activity associated with increased solar radiation.	
Earthquake	Earthquake	Sudden movement of the Earth caused by the abrupt release of accumulated strain along a fault in the interior.	The released energy passes through the Earth as seismic waves (low-frequency sound waves), which cause the shaking. Seismic waves continue to travel through the Earth after the fault motion has stopped. More than 90 % of earthquakes are related to plate tectonics and are caused at plate boundaries.

	liquefaction	Vibration induced increase of pore pressure leading to a decrease of shear strength and therefore the loss of the soil structure, what leads to soil compaction and subsequent behavior of the soil as if it were a fluid.	
	peak ground acceleration	Ground shaking harmful impact on solid buildings and constructs	The released energy passes through the Earth as seismic waves (low- and mid-frequency sound waves), which causes shaking. Shaking induced polymorph Ground acceleration causes substantial mechanical stress on solid buildings and any tall objects & constructs, up to their demolition above some peak ground acceleration level.
	peak ground linear dislocation	Ground dislocation harmful impact on solid buildings and constructs	The ground motion of the tectonic plates and the overlaid soil near the faults between tectonic plates can generate substantial ground dislocation and extended area subsidence (similar to landslide/Subsidence). Linear Ground dislocation can destroy buildings and other constructs if foundations of such buildings are affected by dislocation starting from given acceptable linear dislocation of the ground
	seismic wave amplification	Alteration of the amplitude of surface waves. It can be positive or negative.	The seismic waves propagation can show local cumulative maximums or minimums of sound energy by phase and amplitude to be transferred forward due to lithological properties of geologic materials, their geometry under the surface, and the geometry of the surface itself (slope and curvature).
Erosion	Erosion	Soil or rock weathering and transport by external geological agents (ice, water, wind)	
	shoreline recession	Not enough sediment arrival to the coast, coastal cliff recession, etc	
	soil depletion	Loosing soil properties mainly by water run-off in a weakening area due to long-lasting environmental pressures (such as desertification)	
Flood	Flood	'Flood' means the temporary covering by water of land not normally covered by water.	This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas. (2007/60/EC (FD))

	exurgences	Water comes from groundwater spontaneously, due to a breach in a confined aquifer or to a water table rising with only a few points of leak	
	natural reservoir failure	For example, a glacial lake built with a moraine where the moraine as a dam. The breach of that moraine might cause the sudden outflow of water in the lake.	
	water table risings	Rising of water tables in a region without point located source of water.	
	Fluvial	[Flood Directive Working Group] Flooding of land by waters originating from part of a natural drainage system, including natural or modified drainage channels.	This source could include flooding from rivers, streams, drainage channels, mountain torrents and ephemeral watercourses, lakes and floods arising from snow melt.
	Groundwater	[Flood Directive Working Group] Flooding of land by waters from underground rising to above the land surface.	This source could include rising groundwater and underground flow from elevated surface waters.
	Pluvial	[Flood Directive Working Group] Flooding of land directly from rainfall water falling on, or flowing over, the land.	This source could include urban storm water, rural overland flow or excess water, or overland floods arising from snowmelt.
	Seawater	[Flood Directive Working Group] Flooding of land by water from the sea, estuaries or coastal lakes.	This source could include flooding from the sea (e.g., extreme tidal level and / or storm surges) or arising from wave action or tsunami.

Forest Fire (WildFire)	Forest Fire (WildFire)	Forest fire means fire which breaks out and spreads on forest and other wooded land or which breaks out on other land and spreads to forest and other wooded land. The definition of forest fire excludes prescribed or controlled burning, usually with the aim of reducing or eliminating the quantity of accumulated fuel on the ground (Regulation EC 2152/2003 - Forest Focus). Wild Fire: Any fire occurring on wild regardless of ignition sources, damages or benefits (FAO, 2011, Wild Fire Management Terminology, FAO, updated September 2010).	The definition of fires considered as natural hazards does not include "prescribed burning", which is "a controlled application of fire to vegetation in either their natural or modified state, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives. The act or procedure of setting a prescribed fire is called prescribed burning" (FAO, 2011, Wild Fire Management Terminology, updated Jan 2005).
Ice	Ice	Hazards related to solidification of a material which would usually be liquid or gas above Zero degrees Celsius at surface atmospheric pressure.	
	Gas Hydrate Instabilisation	Frozen gas which can be present in marine sediments under high pressure. If this pressure is released these can change phase to their gas form which can lead to instability in the sediment or water column.	
	Moving Ice Body	A moving body of ice such as an iceberg.	
	Permafrost Alteration	The freezing or thawing of permafrost	
Landslide	Landslide	A sudden gravity-driven down-slope movement of slide mass composed of soil, rock and vegetation. Landslide is a general term used to describe the downslope movement of soil, rock, and organic materials under the effects of gravity and also the landform that results from such movement (USGS 2008)	

	debris flow	Debris flows are essentially large, extremely rapid, often open-slope flows formed when an unstable slope collapses and the resulting fragmented debris is rapidly transported away from the slope.	
	Karstic Or Pseudo Karstic Collapse	Steep-sided sink formed by collapse into a subterranean cavity. An underground cavern forms. Eventually the overlying rock is longer collapses	
	Mudflow	When a slope is so heavily saturated with water that it rushes downhill as a muddy river, carrying down debris and spreading out at the base of the slope; the fastest, wettest flow of weathered material down a hillside.A general term for a mass-movement landform and process characterized by a flowing mass of predominately fine-grained earth material possessing a high degree of fluidity during movement. The water content may range up to 60 percent (USGS 2008).	
	Rockfall	Falls are abrupt movements of masses of geologic materials, such as rocks and boulders, that become detached from steep slopes or cliffs. The falling mass may break on impact, may begin rolling on steeper slopes, and may continue until the terrain flattens.	Separation occurs along discontinuities such as fractures, joints, and bedding planes, and movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water.
	Sand Dune Movement	Large body of sand that moves under the action of wind or gravity.	
	Shore Line And Cliff Recession	Continuing landward movement of the shoreline or cliff due to erosion and slope failure; a net landward movement of the cliff or shoreline over a specified period.	

	Slide	A slide is a downslope movement of a soil or rock mass occurring on surfaces of rupture or on relatively thin zones of intense shear strain. Movement does not initially occur simultaneously over the whole of what eventually becomes the surface of rupture; the volume of displacing material enlarges from an area of local failure (USGS 2008).	
	Soil Creep (slow earthflow)	Creep is the informal name for a slow earthflow and consists of the imperceptibly slow, steady downward movement of slope-forming soil or rock. Movement is caused by internal shear stress sufficient to cause deformation but insufficient to cause failure. Generally, the three types of creep are: (1) seasonal, where movement is within the depth of soil affected by seasonal changes in soil moisture and temperature; (2) continuous, where shear stress continuously exceeds the strength of the material; and (3) progressive, where slopes are reaching the point of failure for other types of mass movements (USGS 2008).	
	spreads	An extension of a cohesive soil or rock mass combined with the general subsidence of the fractured mass of cohesive material into softer underlying material. Spreads may result from liquefaction or flow (and extrusion) of the softer underlying material. Types of spreads include block spreads, liquefaction spreads, and lateral spreads (USGS 2008).	

	Subsidence	Sinking or downward settling of the Earth's surface, not restricted in rate, magnitude, or area involved. Subsidence may be caused by natural geologic processes, such as solution, compaction, or withdrawal of fluid lava from beneath a solid crust or by human activity such as subsurface mining or the pumping of oil or ground water.	
	topple	A topple is recognized as the forward rotation out of a slope of a mass of soil or rock around a point or axis below the center of gravity of the displaced mass. Toppling is sometimes driven by gravity exerted by the weight of material upslope from the displaced mass. Sometimes toppling is due to water or ice in cracks in the mass. Topples can consist of rock, debris (coarse material), or earth materials (fine-grained material). Topples can be complex and composite.	
	Snow Avalanche	A snow mass with typically a volume greater than 100 m3 and a minimum length of 50 meters that slides rapidly downhill (EEA, 2010).	Avalanche formation is the result of a complex interaction between terrain, snow pack and meteorological conditions (EEA, 2010).
Meteorological	Meteorological	Weather phenomenon that could potentially be harmful to a person's life, health, property, or the environment.	"Weather" describes the state of the atmosphere referring to the short-term average (trend) and also to the size of the variations around the trend (weather variability). "Short-term" means usually variations taking place over a period of 30 years or less.
	Lightning	Atmospheric discharge of electricity	

Drought	Sustained and extensive occurrence of below-average water availability, caused by climate variability (EEA, 2010).	Drought should not be confused with aridity, which is a long-term average feature of a dry climate. Likewise, drought should not be confused with water scarcity, which reflects conditions of long-term imbalances between water availability and demands. Droughts can affect both high and low rainfall areas of Europe and can develop over short periods of weeks and months or much longer periods of several seasons, years and even decades. (EEA, 2010).
Extreme Temperature		
Freezing rain	Rain that falls in liquid form but freezes upon impact to form a coating of glaze upon the ground and on exposed objects, due to surface temperatures below freezing.	The glaze can accumulate to a thickness of several centimeters.
Freezing Thawing	The processes related to the phase change of ice to water or from water to ice.	
Hail	Precipitation in the form of spherical or irregular pellets of ice larger than 5 millimeters (0.2 inches) in diameter, that are individually called hail stones.	Hail stones on Earth consist mostly of water ice and measure between 5 millimetres (0.20 in) and 150 millimetres (5.9 in) in diameter, with the larger stones coming from severe thunderstorms.
Hurricane	A severe tropical cyclone having winds greater than 64 knots (74 miles per hour; 119 kilometers per hour), originating in the equatorial regions of the Atlantic Ocean or Caribbean Sea or eastern regions of the Pacific Ocean, traveling north, northwest, or northeast from its point of origin, and usually involving heavy rains.	
Snow	Frozen precipitation in the form of white or translucent hexagonal ice crystals that fall in soft, white flakes.	Snow can trigger other types of hazards, such as floods (snow melt) or avalanches (heavy snowfall on steep slopes).
Tempest	A violent windstorm, frequently accompanied by rain, snow, or hail.	
Tornado	A rotating column of air ranging in width from a few yards to more than a mile and whirling at destructively high speeds, usually accompanied by a funnel-shaped downward extension of a cumulonimbus cloud.	

	Oceanic	Navigational hazards caused by marine or submarine features (maelstroms, deep tides -upwellign, downwelling, etc)	
Rock Or Soil	RockOrSoil	Hazard relating to the structure or make up of rock or soil.	Rock or soil hazards include damages to human beings, land or property induced by phenomena such as compressibility, loessic soil collapse, shrink swell clays, solubility and unconsolidated sands.
	Compressibility	compressibility is a measure of the relative volume change of a fluid or solid as a response to a pressure change.	
	Loessic Soil Collapse	Loessic soil collapse means collapse (loss of strength, break-down) due to weight or external loads of a loessic material.	
	Shrink Swell Clays	capacity of clays to contract (shrink) or expand (swell)	
	Solubility	Rocks or the components of rocks that dissolve under the action of water.	
	Unconsolidated Sands	recently deposited, either geologically or by man, sand.	
ToxicMaterial	ToxicMaterial	Material that is potentially harmful	
	Asbestos	A naturally occurring fibrous mineral that when broken up finely causes a hazard to health.	
	gases	Gases of any origin or compound	
	Methan And Carbon Dioxide	Natural gas that may escape from fissures in the ground.	
	Natural Radioactivity	Radiation from natural sources	
	Potentially Harmful Elements	Elements naturally present in rock or soil that can cause harm.	
	toxicMaterial/Radon	Naturally occurring radioactive gas.	
	Salts	Naturally occurring hazardous mineral salts.	
	Spontaneous Combustion	Combustion that occurs without an external source of ignition.	
Tsunami	Tsunami	Long wavelength water body caused by earthquakes, volcanoes, landslides, meteorites, etc.	

Volcano	Volcano	An opening, or rupture, in the Earth's crust that allows hot magma, ash and gases to escape (EEA, 2010).	Volcanic eruptions are basically of two types: effusive eruptions (for example Kilauea and Mount Etna) characterised by almost continuous lava emission, and explosive eruptions (for example Vesuvius, Santorini and Mount St Helens), which are more rare but very devastating due to the interaction between gas and magma. Volcanoes are generally located along tectonic plate margins, but can also form in intra-plate areas characterised by rift processes as well as by mantle plumes (EEA, 2010).
	Ash	Fine particles of pulverized rock blown from an explosion vent. Ash may be either solid or molten when first erupted.	
	Ejected Material	A term referring to rock fragments ejected into the air by a volcano.	
	Explosions	Such as freatomagmatic explosions, dome explosions, and calderas	
	Jokulhaup	Icelandic term used to describe a glacier outburst flood resulting from the failure of a glacier-ice-dam, glacier-sediment-dam, or from the melting of glacier ice by a volcanic eruption.	
	Lahar	Landslide or mudflow of pyroclastic material on the flank of a volcano; deposit produced by such a landslide.	Lahars are described as wet if they are mixed with water derived from heavy rains, escaping from a crater lake or produced by melting snow. Dry lahars may result from tremors of a cone or by accumulating material becoming unstable on a steep slope. If the material retains much heat, they are termed hot lahars.
	Lava	An outpouring of lava onto the land surface from a vent or fissure. Also, a solidified tongue like or sheet like body formed by outpouring lava.	
	Pyroclastic Flow	Flowage of a mixture of hot gases and unsorted pyroclastic material that can move down the slopes of volcanoes.	The material can move at a maximum speed of 100 miles an hour and suppose one of the most dangerous hazards posed by volcanoes.
	Volcanic Gases	Volcanic gas is contained within magma. As the magma rises to the Earth's surface the gases are exsolved and can become a very important factor in the violence of an eruption.	Because some gases are toxic they can suffocate people. Examples of volcanic gases include steam, sulphur dioxide and carbon dioxide.

B.2 *Classification of exposed elements*

Below is a classification of exposed elements it could form part of the empty codelist typeOfExposedElementValue as required at member state level. This classification is provided as an example, and is extracted from [Le Plan de Prévention des Risques Technologiques - Guide méthodologique], *guidelines for the setup of technological hazard prevention plan*, Ministry of Ecology and Equipment of France.

Open issue 15: This is an example it is highly abstracted because in reality every physical element could be defined as an exposedElement. It has been used for the simplicity of modelling. Suggestions of more complete codelists or alternative ways of modelling would be appreciated.

	Item	description
Level 1 : major stakes		
existing land use	Activity Area	industrial area, business area
	Agricultural Area	
	Habitat	
	Non Urban Area	
open air public area	Permanent use	
	Temporal use	
public assembly building	Care building	hospital, retirement place, nursing home, etc…
	Leisure facility	Stadium, swimming-pool, auditorium, library, cinema, music-hall, gymnasium, etc..
	Public Service Building	city hall, post office, administrative building, etc…
	Religious Building	church, mosque, synagogue, temple, any other cult area
	Rescue Service	fire station, police station, emergency preparedness building, etc…
	Shopping Mall	
	Small trade and liberal activity	any small trade places that are outside shopping malls, excluding medical office, veterinary office, etc…
	Teaching building	
public interest equipment	Aerial Antenna	
	Collecting Tank	
	Power Station	
	Pressure regulator system	
	Reservoir and water tower	
transport	Airport	

	infrastructure	Common transport	bus, underground
		Non polluting transport	
		Railway	
		Road	
		Toxic material transport infrastructure	itineraries and parking places dedicated to toxic material transport
		Waterway	
Level 2 : complementary stakes			
	global assessment of number of inhabitants		
	global assessment of employment		
Level 3 : other available stakes			
	history of urbanisation		
	planned land use	local urban plans, land use plans	
	Specific stakes	specific economic stake, specific cultural stake, specific environment stake	

Annex C
(Informative)
Use Cases

Developing Use-Cases is a powerful method for creating information products, which has been adopted for INSPIRE data specification process. The INSPIRE Methodology for Data Specification Development (D2.6) foresees a user-driven specification method based on use-case development. This approach has been followed during the development of the Annex I Data themes and is now followed by the Annex II and III Thematic Working Groups (TWGs).

During the cross-theme meeting in Krakow (INSPIRE Conference) development of a common Use-Case was agreed. For example a Use-Case that would not only show possible inter-linkages and dependencies among INSPIRE Data themes, but also could serve as a real demonstrator of the interoperability of the INSPIRE data specifications.

It was agreed that a good example of such a common Use-Case would be Flood Mapping and that the TWG on Natural Risk Zones would prepare the first draft based on the work already done in TWG Hydrography (Annex I).

C.1 *Flood Mapping*

Introduction
One of the main purposes of flood maps is to inform in a clear way thus supporting effective communication. In addition to the representation of all main flood-related elements there is the need to provide a map background for spatial orientation and to understand spatial relationships. It is anticipated that in general the background map information for flood mapping will be hydrographic and topographic elements.

Floods are natural phenomena which cannot be prevented. As seen in the recent past in Pakistan (August 2010) and Tsunami in Thailand (December 2005) impacts of flooding can be enormous. Floods are a significant hazard across Europe. For example along the Rhine more than 10 million people live in the areas at risk of extreme floods. Coastal areas are also at risk of flooding e. g. by storm surges. Scale and frequency of floods are likely to increase as a result of climate change and as land pressures encourage more development on flood prone areas. In concurrence with human activities the number of people and economic assets located in flood risk zones continues to grow Centre for Research on the Epidemiology of Disasters (CRED) estimate that hydrological disasters averaged an economic impact of USD 7.7bn each year 2000-2007. This is in addition to significant loss of life.

It is this impact that brings floods into the scope of TWG Natural Risk Zones. The widely used formula Risk = Hazard x Vulnerability x Exposure clearly demonstrates the relationship between the three elements. It is the assertion of TWG Natural Risk Zones that our domain experts can provide understanding and interpretation of the Hazard element and that the Vulnerability and Exposure elements are provided by many of the other Annex I, II and III TWGs.

Background
The starting point for developing the Use Case Flood Mapping was analysis of the Use-Cases already defined by TWG Hydrography during the development of the data specifications of INSPIRE Annex I themes. These Use-cases were:

Physical Mapping
Reporting
Spatial Analyses & Modelling
Land Use Planning, Area Management & Prevention

All of these Use Cases provided by TWG HY contain “floods”: The response of User Requirement Survey for INSPIRE Annex II and III data themes addressed all these Uses-Cases with more or less detailed additional requirements. Most of these additional requirements are the legally binding contents of the implementation of Directive 2007/60/EC (known as the “Floods Directive”).

Maps with flood information are the result of the above mentioned Use-Cases. Flood map content are dependent upon scale (e.g. main spatial scales: strategic regional, local general, local site) and purpose (general public information, information for experts or organizations involved in risk management, decision makers). Different thematic maps are compiled depending upon purpose such as: Flood Event Maps, Flood Hazard Maps, Flood Risk Maps, etc.

TWG NZ agreed that for the purpose of cross TWG harmonisation and as a primer to further cross-TWG discussion it was best to combine all possible different mapping purposes into a simplified central Use Case “Flood Mapping” and provide some further detail with regard to “Flood Hazard Mapping” and “Flood Risk Mapping” to elaborate upon the differences between the two (general difference between Flood Hazard and Flood Risk is illustrated in figure 1 below). The main use case would be stand-alone and not contain any of the specific detail of special purpose mapping whilst also containing all flood-related information that could be of interest. The key to this approach is to demonstrate and elicit comment from the other Annex II and III TWGs. By providing detail we anticipate concrete data input (Scale, coverage, quality, used coordinate system, data format etc..) from the other TWGs and have included a table in section 4 where we suggest some linkages that should be considered and provide a framework within which to receive others.

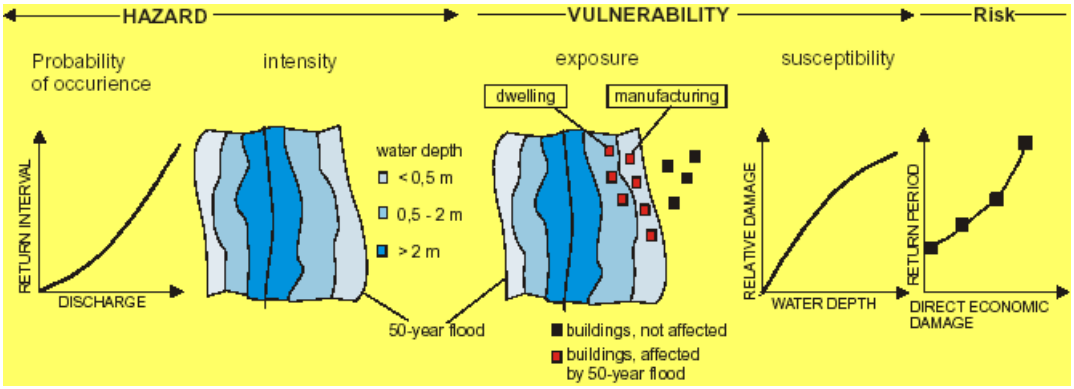


Figure 1: Relationship between Flood Hazard and Flood Risk

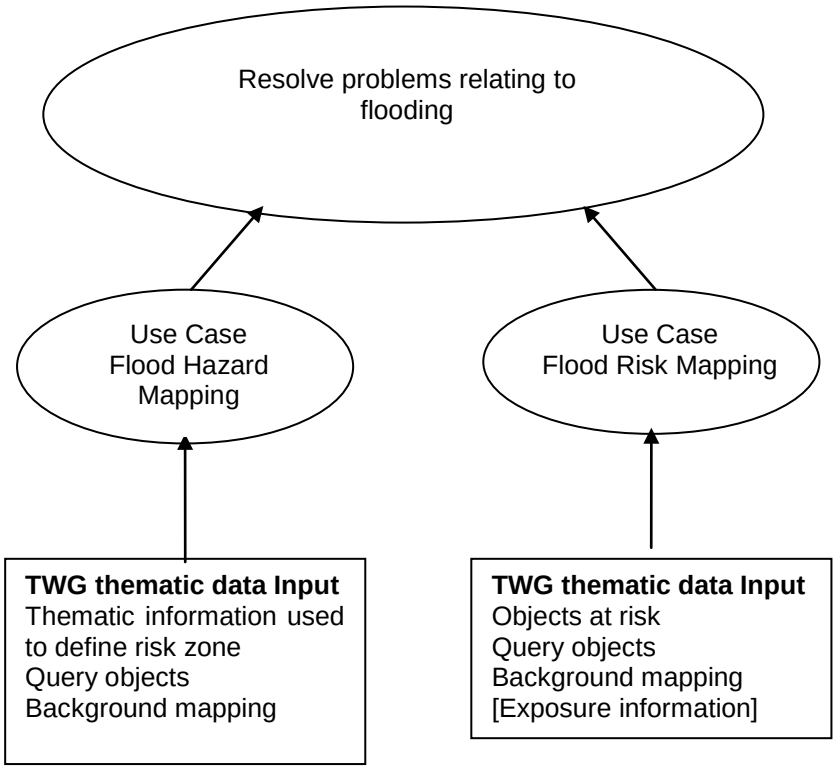


Figure 2. Schematic diagram showing relationships between the generic problem, and hazard and risk use cases presented. Also shown is the input required from the other TWGs.

Legislative Background

The most important background legislation in terms of "Flooding" is Directive 2007/60/EC on the assessment and management of flood risks with focus on prevention, protection and preparedness. Directive 2007/60/EC requires informing the general public about adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods. (Potential) adverse consequences depend on flood extent, flood depth or water level, flood velocity respectively water flow, flood duration etc. and are related with type of flood (e. g. riverine flood, storm surge, pluvial flood) respectively along with the mechanism or characteristics of flooding. Flood mapping is a crucial element/core component of flood risk management and the involvement of interested parties, public information and consultation.

MS have to provide geographical information and data to enable the Commission to produce several maps that will be visualized through WISE-Viewer (WISE = Water Information System for Europe). Art. 4 requires MS to accomplish Preliminary Flood Risk Assessment (PFRA) and to report about significant past flood events and other floods that occurred in the past which would have significant adverse consequences if they occurred again; Art. 5 requires that the PFRA shall be used as the basis for the identification of areas for which MS conclude that potential significant flood risk (APSFR) exist or might be considered likely to occur in the future. APSFR as results of PFRA are the basis for preparing following two types of maps required by Art 6 (Member States are requested to prepare these by 2013):

Flood hazard maps, showing the extent and expected water depths/levels of an area flooded in three scenarios, a low probability scenario or extreme events, in a medium probability scenario (at least with a return period of 100 years) and if appropriate a high probability scenario.

Flood risk maps, shall also be prepared for the areas flooded under these scenarios showing potential affected population, economic activities and the environment at potential risk from flooding, and other information that Member States may find useful to include, for instance other sources of pollution.

-

TWG NZ decided to focus on these two maps for defining specific cross-thematic issues.

Generic User Diagram

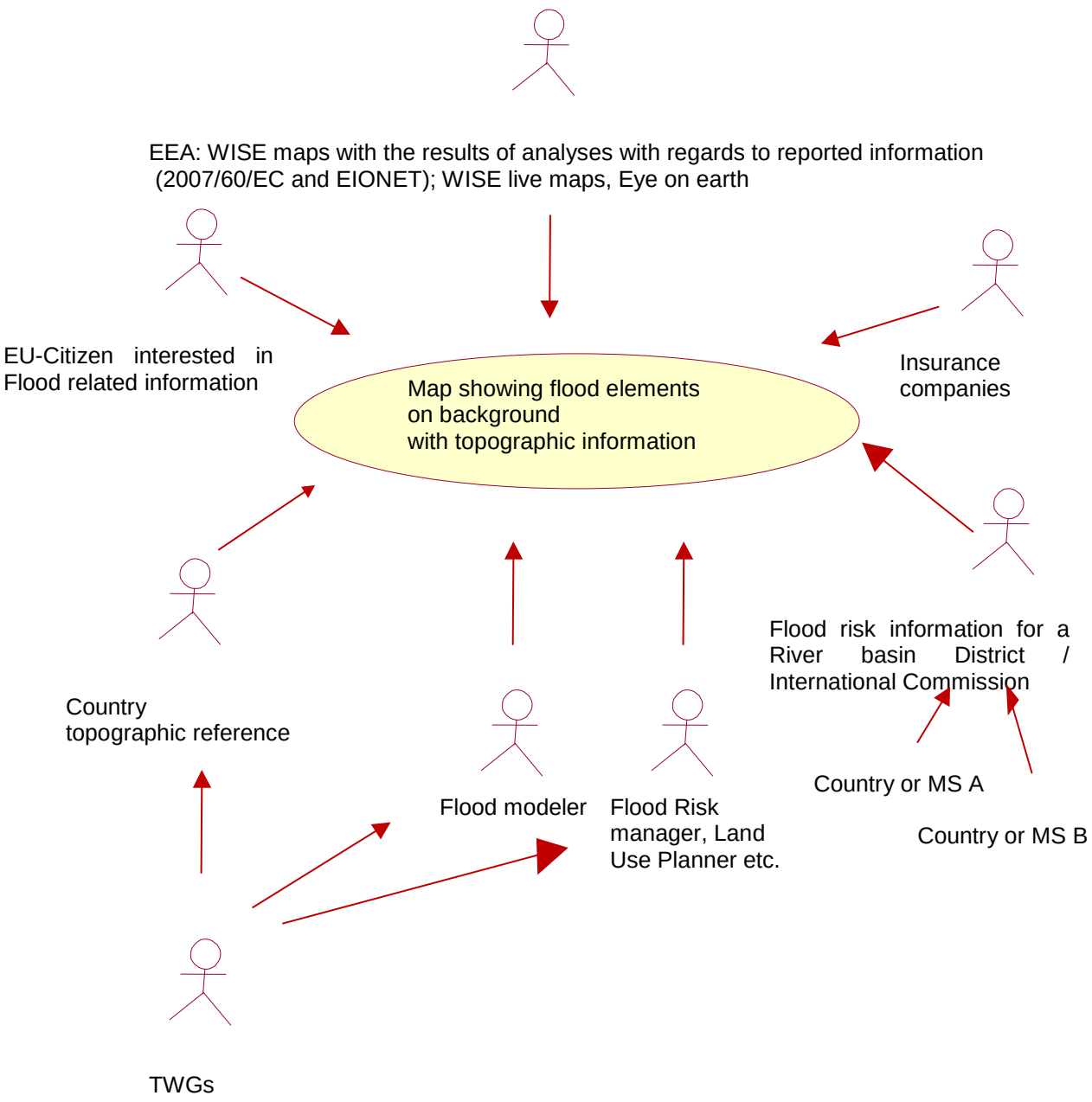


Figure 2. Diagram depicting the relationships of various actor-stakeholders in the flood mapping process.

Detailed description of the flood mapping use-case

Overview and actors involved

Described here is a use case that anyone with a flood question would follow. The actors here could range from the citizen to insurer or from the land planner to the European Commission.
The representation of all main flood related elements, as well as facilities and constructions related to the water network is needed to provide a map background for orientation and to understand spatial relationships.
Map references for thematic purposes usually include the representation of flood elements, topographic elements like e.g. main hydrographic elements (surface waters), infrastructure, settlements, administrative units, geographical names, Land Use, Elevation resp. relief etc.

One of the main purposes of maps is to communicate spatial information to the general public and/or experts in an understandable form and to support communication.

Detailed description of the High level Use-Case Flood mapping

Use Case Description	
Name	Generic Flood mapping for any actor from the citizen to the European Commission. It could be required for reporting purposes or for general information.
Priority	High / Medium
Description	The user analyzes cross-border datasets on flood-related information (for example those created in Use Cases Flood Hazard Maps and Flood Risk Maps) up to European extent by means of a GIS-application to create overview maps and/or tabulations on flooded areas, areas with flood hazard or flood risk. The results will be integrated in reports and composite assessments of the implementation of the EU Directives at the European, MS level or more detailed level. A data provider or modeler will present flood-related information in a spatial context to address the particular user requirement. Usually flood maps are prepared by public authorities and insurance companies. The content of a flood map depends on purpose (management, planning, public information, to assess insurance rates etc.) and scale (overview e. g. at river basin district level, detailed e. g for a selected municipality).
Pre-condition	The representation of all main flood related elements, as well as facilities and constructions related to the water network is needed to provide a map background for orientation and to understand spatial relationships. Feature classification may be required as reference data or defined rules to choose reference elements (features, dimensions). Portrayal: Generalisation and symbol assignment rules for reference data and flood related information Alternatively a set of pre-defined raster data.reference maps could be specified as context.

Use Case Description	
Flow of Events – Basic Path	
1. Step 1.	The data provider defines the purpose of a flood map (Flood Event Map, Flood Hazard Map, Flood Risk Map, Map for Land Use Planning, Urban and Regional Planning etc.)
2. Step 2	The map provider asks for a reference map (SDI/ view service …) and for flood-related information such as modeling results, locations of flood events etc
3. Step 3	Several objects or coverages are requested by the map provider for reference data at specific resolutions (DEM, Name and position of the hydrographic element, GIS-layer with topographic elements etc.) and flood-related information
4. Step 4	Generalisation and symbol assignment rules should be applied, suitability of flood-related information for each purpose should be checked by a competent authority to avoid false statements with respect to conclusions.
5. Step 5	Data provider delivers requested layer
6. Step 6	When thematic layers containing the same information from different providers are provided there may be a requirement to manipulate data before merging, analyzing etc. (e.g. recalculation of values, classes)
Flow of Events – Alternative Paths	
7. Step 3	Request, concurrent with delivery, a pre-defined target data model (e.g. features, values) to support merging, harmonization etc.
8. Step 4.	Pre-defined reference map selection
9. Step 5	Delivery of seamless and as far as possible harmonised requested layer
Post-condition	Layers coming from different thematic databases must be merged to produce the reference map: e. g. flood risk level information and verified by a competent authority.

Use Case Description	
Data source: Topographic Reference Data	
10. Description	Topographic reference data including hydrographic data There are two or roles for which topographic data are required: Topographic data as a visual background. The aim is here to use to help locating a flood risk zone in its surrounding. The scale of data ranges from 1:500 000 to 1:25 000. The data can be modeled in 2D geometry. There are no specific topological constraints on these data. Topographic data as a tool for modeling the flood hazard. Data here are used for the modeling of a flood hazard map. The scale of data here ranges from 1: 25 000 up to what is deemed necessary by the modeller. The geographical extent of these data is limited to the areas that are likely to be investigated as prospective flood hazard area, (whose decision to investigate is up to the modeller). Data can be modeled in 2D, 2.5D or 3D Item for topographic constraints.
11. Data provider	Mapping agency; Eurogeographics, OpenStreetMap, Google earth, EEA (WISE-reference datasets like ECRINS)
Geographic scope	Various (Pan-European, cross-border, national, regional, local)
Thematic scope	Spatial information supporting orientation on maps and understanding of spatial relationships. The aim of topographic data is to help locate a flood risk zone in its surrounding.
Scale, resolution	Various (depends on the purpose) For Topographic reference data, scale ranges from 1:500 000 to 1:25 000
Delivery	GIS-Raster files, GIS-Vector-files
Documentation	Metadata
Data source: Thematic information for example relating to elements at risk	
12. Description	For example building use information
13. Data provider	Topographic data providers. Data harmonized with cadastral information.
Geographic scope	Various (Pan-European, cross-border, national, regional, local)
Thematic scope	That useful to answer initial flood question.
Scale, resolution	Various (depends on the purpose)
Delivery	GIS-Raster files, GIS-Vector-files, GML-files, WFS

Use Case Description	
Documentation	Metadata, Model description

B.1.1 Flood Hazard mapping under 2007/60/EC

Article 6 of the Floods Directive requires Member States to prepare Flood Hazard Maps at the detailed scale ("most appropriate scale") for the areas with potentially significant flood risk. Depending on the location and type of map detailed scales may be different (generally scales for inland waters are 1:2.500 and 1:5.000). Member States may chose to develop several Flood Hazard Maps for each type of relevant flood (to address types of relevant floods an enumeration list was adjusted but not finally adopted by now, see Annex I).

Flood hazard maps must show the geographic area which could be flooded under following different flooding scenarios (art. 6.3):

- *floods with low probability, or extreme event scenarios;*
- *flood with a medium probability (likely return period ≥ 100 years);*
- *floods with a high probability, where appropriate.*

Member States have the flexibility to assign specific flood probabilities to these scenarios, for instance a low probability flood could be defined as a 1 in 1000 year event (0.1% probability) and a medium probability event could for instance be defined as a 1 in 200 year event (0.5% probability).
For each scenario, MS must prepare information of flood extents and water depth or levels (art 6.4). Where appropriate, Members States could also prepare information on flow velocities or the relevant water flow.
For coastal flooding where there is an adequate level of protection in place, and for groundwater flooding, MS can decide to limit the preparation of flood hazard maps to low probability or extreme events (art 6.6 and 6.7).
Flood hazard maps showing the extent of flooding under different flooding scenarios (high[14], medium[15], low probability floods[16]) at the appropriate scale, including water depth or water level and where appropriate the flow velocity or relevant water flow[17], for the areas identified under article 5 or article 13(1)(a) or (b) (art 6.3 and 6.4);

Attributes of Datatype "area with potential significant flood risk":

- Type of flood or floods (multiple attribution)

Overview and actors involved

There are a wide range of potential users for this information. It could be required for reporting purposes or strategic planning.

Use Case Description	
Name	Flood Hazard Mapping for any actor from the citizen to the European Commission. It could be required in terms of 2007/60/EC (mandatory) for reporting purposes or for general information.As an example required for a land use planner (his / her goal is the zonation of land for development).
Priority	High

[14] As appropriate in accordance with article 6.3(c), 6.6 and 6.7.
[15] As appropriate in accordance with article 6.6 and 6.7.
[16] As appropriate in accordance with article 6.3(c).
[17] Flow velocity and relevant water flow where appropriate in accordance with article 6.4 (c).

Use Case Description	
Description	For the purposes of the Floods Directive Flood hazard maps must show the geographic area which could be flooded under following different flooding scenarios: floods with low probability, or extreme event scenarios; flood with a medium probability (likely return period ≥ 100 years); floods with a high probability, where appropriate For these scenarios flood extents and water depth or levels have to be provided, where appropriate, also information on flow velocities or the relevant water flow. Topography (GIS-layer with administrative boundaries, cities, water bodies etc.) used as background information on maps (for spatial orientation). A land use planner may have to refer to these in the zonation of an area for development of a certain type relating to Member State planning regulation.
Pre-condition	Collection and composition of basic data (hydrological, topographic data, meteorological data); determination of modeling-software (1D, 2D or couplings, 3D) Feature classification as reference data or defined rules to choose reference elements (features, dimensions). Portrayal: Generalisation and symbol assignment rules for reference data and flood related information Another possibility could be to have a set of pre-defined reference maps as raster data.
Flow of Events – Basic Path	
Step 1.	Screen, check and analyse existing material (analog and digital information)
Step 2	Preliminary Flood Risk Assessment: identify significant past flood events and other floods that occurred in the past which would have significant adverse consequences if they occur again
Step 3	Identify locations/stretches of watercourses or coastlines/areas for which it's concluded that potential significant flood risk (APSFR) exists or might be considered likely to occur in the future.

Use Case Description	
Step 4	For APSFR identified in Step 3: Calculate the geographical area which could be flooded under different scenarios (floods with low probability or extreme event scenarios; flood with a medium probability (likely return period ≥ 100 years; floods with a high probability). For each scenario: prepare information on flood extents and water depth or levels, where appropriate also on flow velocities or the relevant water flow
Step 5	classification of water depths, water levels, velocities and/or water flows
Step 6	Define most appropriate map scale(s), definition of colours, symbols
Step 7	Combine relevant thematic information with topographic reference information (as described in chapter 3.1) to build-up Flood Hazard Maps
Data sources: Thematic information relating to floods	
Description	Carried out for different scenarios (floods with low probability, or extreme event scenarios; flood with a medium probability (likely return period ≥ 100 years); floods with a high probability, where appropriate): 1.Flood extent (extent of potential flooding as a surface covering the topography for a specified flood level/frequency) 2.water depth or level (in terms of flood inundation carried out by the use of 2D hydrodynamic models) 3.Flow velocity or the relevant water flow (current velocity could be presented as (magnitude) classes or vector (magnitude and direction); current velocity depends very much on local topography and may be of limited accuracy.
Data provider	Competent authorities (e.g. Water management administrations), Mapping agencies, meteorological services
Geographic scope	In terms of 2007/60/EC: River Basin District, Units of management, APSFR In terms of INSPIRE: Pan-European, cross-border, national, regional, local
Thematic scope	Spatial information supporting flood hazard assessment
Scale, resolution	Generally 1:2.500 – 1.10.000 for detailed maps provided by MS, 1:250.00 for WISE maps
Delivery	GIS-Vector files or GML-files, WMS

Use Case Description	
Documentation	Metadata, Model description (it is very important to describe precisely the specification that form the boundary conditions of the simulation used for scenarios because in terms of locations, conditions in the flooded area (like roughness etc.) there are an infinite number of possibilities)
Data source: Topographic Reference Data	
Description	In the directive there is no specification for Member States, WISE will use Google earth and other free available data

B.1.2 Flood Risk mapping under 2007/60/EC

Article 6 of the Floods Directive requires member states to prepare Flood Risk Maps for the areas of potentially significant flood risk. These maps must be prepared at the river basin level and at the "most appropriate" scale.

Flood risk maps showing the potential adverse consequences expressed in terms of the indicative number of inhabitants potentially affected under different flood scenarios (art 6.5(a));

Flood risk maps showing the potential adverse consequences expressed in terms of the type of economic activity of the area potentially affected under each flood scenario (art 6.5(b));

Flood risk maps showing the potential adverse consequences expressed in terms of the location of installations[18] which might cause accidental pollution in case of flooding and potentially affected areas identified in WFD Annex IV(1)(i) (iii) and (v) under different flooding scenarios (art 6.5(c));

Optional:

Areas vulnerable to floods with a high content of transported sediment and debris flows for each flood scenario (art 6.5(d)).

The location of other significant sources of pollution, including the areas potentially affected where possible (art 6.5(d)).

Attributes of Datatype "area with potential significant flood risk":
Type of flood or floods (multiple attribution)

Probabilities assigned to each flood scenario: high; medium and low.

potential adverse consequences associated with the particular flood scenarios expressed as in terms of indicative number of inhabitants potentially affected,

potential adverse consequences to the different types of economic activities in the areas potentially affected in association with the particular flood scenarios

potential adverse consequences in relation to IPPC installations and affected protected areas in association with the particular flood scenarios

(Optional) potential adverse consequences to the other information the MS considers useful in association with the particular flood scenarios

To address types of relevant floods and potential adverse consequences an enumeration list was adjusted but not finally adopted by now (see Annex I).

Overview and actors involved

There are a wide range of potential users for this information. It could be required for reporting purposes as per the Floods directive as detailed above or for Flood Risk Assessment and Flood Risk Management in general (as illustrated in figure 3). In the following we will consider the requirements of an insurer.

[18] With reference to Directive 2008/1/EC (ex. Directive 96/61/EC) concerning integrated pollution prevention and control.

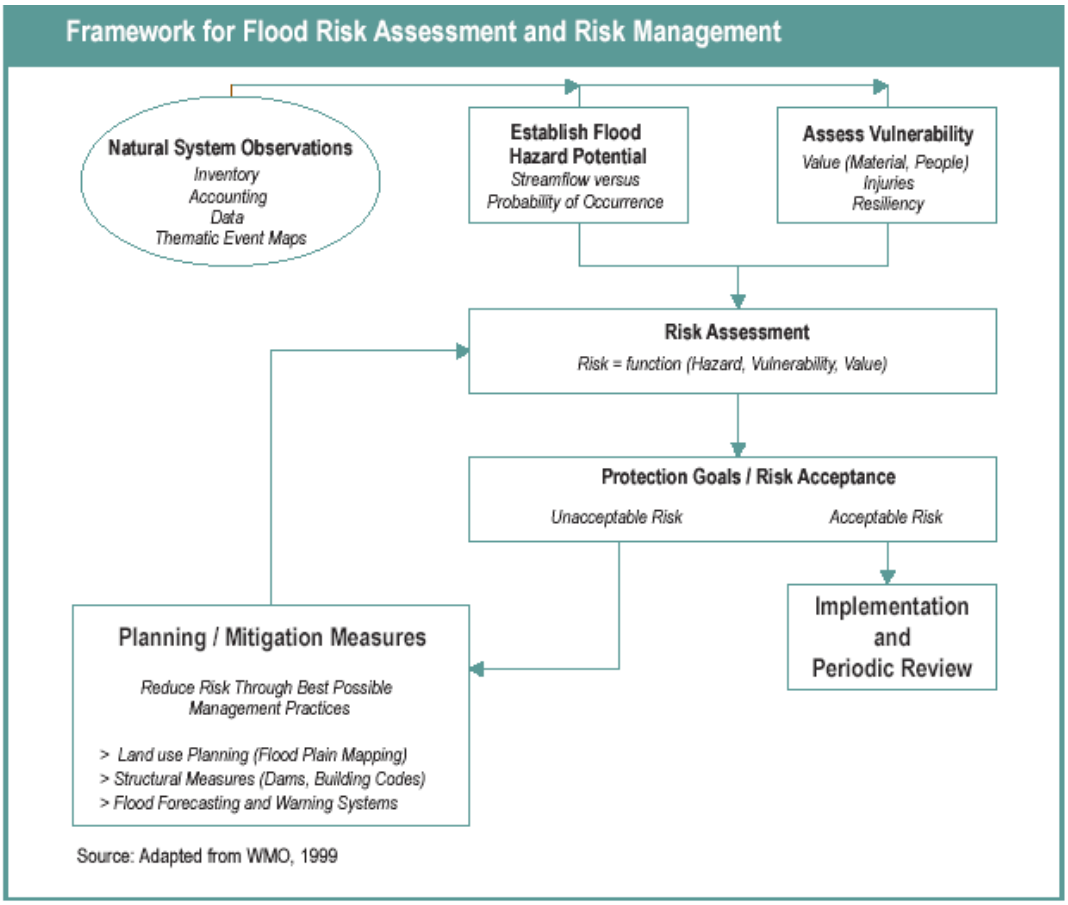


Figure 3: Framework for Flood Risk Management and Flood Risk Management

Use Case Description	
Name	Flood Risk Mapping for any actor from the citizen to the European Commission. It could be required in terms of 2007/60/EC (mandatory) for reporting purposes, for general information or by an insurer to manage their risk portfolio.
Priority	High
Description	Flood Risk Maps (in terms of 2007/60/EC) showing the potential adverse consequences associated with the particular flood scenarios have to be prepared by competent authorities of Member States for the areas of potentially significant flood risk at the river basin level and at the “most appropriate” scale. Flood Risk Maps usually base on Flood Hazard Maps (FHM) and have to be developed in terms of 2007/60/EC for the same scenarios as for Flood Hazard Maps and provide to COM and the public. An insurer will need to know both areas with flood hazard (as described above) but also information about assets and people at risk.

Use Case Description	
Pre-condition	Collection and composition of basic data for assessment of adverse consequences (statistical data about population like population density, data related to economic activity like Land Use data, protected sites under EC Environmental legislation, location of installations which might cause accidental pollution, data about cultural heritage, data about flood protection installations) Feature classification as reference data or defined rules to choose reference elements (features, dimensions). Portrayal: Generalisation and symbol assignment rules for reference data and flood related information Another possibility could be to have a set of pre-defined reference maps as raster data.
Flow of Events – Basic Path	
Step 1.	Collect relevant data from Flood Hazard assessment, screen, check and analyse existing material (analog and digital information) to carry out potential adverse consequences
Step 2	Prepare relevant data (e.g. reclassifying) for geoprocessing
Step 3	Assess potential adverse consequences for APSFR under the different scenarios
Step 4	Classify the risk assessment results (e.g. classes for number of potential affected inhabitants)
Step 5	Define the most appropriate map scale(s), definition of colours, symbols
Step 6	Combine relevant thematic information with topographic reference information (as described in chapter 3.1) to build-up Flood Risk Maps

Use Case Description	
Data source: Thematic information	
Description	For the purposes of insurance risk assessment: Carried out for the areas affected under the different scenarios (= input from Flood Hazard Maps): - indicative number of inhabitants and properties potentially affected - potential adverse consequences expressed in terms of the type of economic activity Potential industrial facilities affected. Economic value of asset, repair and any subsequent interruption of service due to a flooding event, Secondary costs related to pollution caused by a flood. Section 4 gives a more detailed list of the kinds of information that might be required to inform flood risk maps which would necessarily come from the other thematic working groups.-
Data provider	Competent authorities (e.g. Water management administrations, Mapping Agencies, Statistical Agencies, loss adjusters, underwriters)
Geographic scope	In terms of 2007/60/EC: River Basin District, Units of management, APSFR In terms of INSPIRE: Pan-European, cross-border, national, regional, local
Thematic scope	Spatial information supporting flood risk assessment respectively assessment of potential adverse consequences in the case of flooding Relevant information related to flood risk have to do with adverse consequences for human health, economic (property, infrastructure, rural land use and economic activities), environment and cultural heritage.
Scale, resolution	Generally 1:2.500 – 1.10.000 for detailed maps provided by MS, 1:250.00 for WISE maps
Delivery	GIS-Vector files or GML-files, WMS
Documentation	Metadata
Data source: Topographic Reference Data	
Description	No formal specification for Member States, WISE will use Google earth and other free available data

Cross Thematic Data requirements

This is a non-exhaustive list of examples of the types of data and information that might be required in the process of creation, querying and interpretation of flood hazard and flood risk models.

TWG	Affected?	UseCase	Datasets affected
Administrative Units (AU)	Yes	H. Level	Boundaries of administrative units from the cities to national borders, including toponyms.
Administrative Units (AU)	Yes	Risk	Competent Authorities for flood management, civil protection, disaster control, emergency management Municipalities and Authorities affected by events
Addresses (AD)	Yes	Risk	Address of competent authorities (flood management, civil protection etc.) Address of affected entities
Agricultural and aquacultural facilities (AF)	Yes	Risk	with regards to adverse consequences for economic activities and environment (accidental pollution) with regards to economic capacity at risk – asset maps also potential short-term storage of flood waters
Area management/restriction/regulation zones and reporting units (AM)	Yes	Risk	River basin management Units of management
Atmospheric conditions+Meteorological geographical features (AC-MF)	Yes	Hazard	wind field storm tracks wind speeds wind directions precipitation data (snow, hail, rainfall, ice pellets, …)/water quantity / precipitation areas evapotranspiration data air pressure- abnormal tidal conditions/ storm surges Flood forecast systems are closely connected with weather forecast systems (severe weather warnings)
Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	Yes	Risk	with regards to adverse consequences for environment (assets at risk)
Buildings	Yes	H. Level	Contour, height, Use (e.g. hospital) Model input/ vulnerability

Cadastral Parcels (CP)	Yes	Risk	Areas delineated by law as "flooding areas" (with restrictions in terms of flood management etc.) Areas with the obligation to pay contributions for flood protection Identification of damaged properties
Coordinate reference systems	Yes	-	No specific flood-related requirements
Elevation (EL)	Yes	Hazard	DEM (digital elevation models, e. g. to derive flood extents) depth > to derive inundation depth (raster cells respectively grid-data), contour lines (lines that join points of equal elevation) morphology of catchment area: relief, exposure slope/hillside profile fall/gradient of slope, base slope length of slope microrelief gravity drainage systems > (natural) flow directions coastline levees, dikes, dams cross-sections
Energy Resources	Yes	Hazard	Reservoirs used for energy generation
Environmental Monitoring Facilities (EMF)	Yes	Hazard	(water) gauges/gauging stations > discharges, water levels hydrometric stations
Geographical grid systems	?	Risk	Population density or similar coverage information
Geographical names (GN)	Yes	Risk	name of locations/areas affected by flood events
Geology + Mineral resources (GE-MR)	Yes	Hazard	Groundwater level subsurface runoff/interflow geology: rock (Limestone, chalk, sandstone), weathering, slope of stratification, Permeability Landforms (geomorphology): alluvial fans...
Human Health and Safety (HH)	Yes	Risk	civil protection (units) location of potential detrimental health effects
Hydrography (HY)	Yes	H. Level	Physical waters (watercourses, lakes)

Hydrography (HY)	Yes	Hazard	watercourses, waterlevel, hydraulic gradient catchments, riverbasins discharges (discharge per unit area) runoff characteristics bed load (mechanical effect) crossing (e. g. CrossingTypeValue = bridge) dams, barrages, weirs (and other flood defence architecture) pipelines sewerage systems hydrological network erosion > flow (max.) water depths / inundation depths velocities (max. in m³/s) hydro points of interest: e.g. documented water heights (signs) at buildings, dyke relocations river/floodplain restoration, polder, impounding reservoir (to reduce flood peaks) conveying water into rivers and lakes: drainage ditches, sewers (human activities) flow regimes flow path river characteristics (> hydrological regime)
LandCover (LC)	Yes	H. Level	Small-scale comprehensive land-cover
LandCover (LC)	Yes	Hazard	vegetation > surface roughness > surface run-off/(potential) interception/retention of precipitation/evapotranspiration snowfields/snow cover > melt rate > flood prediction and vulnerability
LandUse (LU)	Yes	Hazard Risk	Type of use with effects on evapo(trans)piration and soil characteristics respectively with different kinds of adverse consequences residential areas / zones/districts // rural communities asset maps industrial areas asset maps agriculture asset maps forest asset maps and vulnerability

Natural Risk Zones	Yes	H. Level Hazard Risk	Flood prone areas/ inundation areas Areas with potential significant flood risk
Oceanographic geographical features + Sea regions (OF-SR)	Yes	Hazard	under sea features promoting high waves / generating Tsunamis variation of water depth bathymetry of coastal zone resp. continental shelf areas areas of wave refraction and other phenomena which lead to focussing of wave energy upon particular sections of the coastline Approach of sea conditions that might affect land e.g High tides, storm surges
Orthoimagery (OI)	Yes	H. Level	orthoimages of areas affected by floods (historical and actual) for flood outlines (Georeferenced) historical (topographic) maps (e. g. for mapping past floods)
Production and industrial facilities (PF)	Yes	Risk	with regards to adverse consequences for economic activities and environment (accidental pollution) with regards to economic capacity at risk – asset maps

Protected Sites (PS)	Yes	Risk	cultural heritage protected areas as defined under article 6 and article 7 2000/60/EC respectively article 6 2007/60/EC: - Bathing (= bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC) - Birds (= areas as designated for the protection of wild birds under Directive 2009/147/EC) - Fish (= waterbodies as designated under 2006/44/EC) - Shellfish (= areas as designated under Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters (codified version)) - Habitats (= areas as designated for the protection of habitats under Directive 97/62/EC) - Nitrates (=areas as designated under Directive 91/676//EC) - UWWT (=sensitive areas which are subject to eutrophication as identified in Annex II.A(a) of 91/271/EEC) - WFD Art. 7 Abstraction for drinking water (- Other European - National - local Also have an intrinsic vulnerability

Soil (SO)	Yes	Hazard	transmissibility, permeability, (macro)porosity (?), stone content (?), bedding/stratification, compaction surface sealing soil compaction e. g. by agriculture slack water drainage subsurface runoff/interflow flood deposits Water absorption and retention capacity from precipitation/evapotranspiration Permeability/Surface Sealing
Statistical Units + Population distribution, demography (SU-PD)	Yes	Risk	Census data (> population density etc.) and other population distribution data Statistical units like river basin districts, NUTS etc.
TransportNetwork (TN)	Yes	Risk	inland waterway (channels) Transport network assets – road, railroad, gas-pipelines, cable-road related Infrastructure affected or cut off as a result of flood event
TransportNetwork (TN)	Yes	H. Level	inland waterway (channels) Roads Railways Bridges, tunnels
Utility and governmental services (US)	Yes	Risk	Water supply Sewerage system Energy supply Cable communication networks Administration centres/infrastructure Maintenance of supply and vulnerability

Annex I

Draft list of types of floods (4th draft version from October 2010, will be further discussed on next WG F meeting in week 43)

Discussions in meetings of WG F and WG F DG and written comments from Member States on the different versions on "draft list of types of floods" made clear that it is not possible to distinguish clear between different types of flood respectivley to distinguish between "main flood types" and "sub-types". Sometimes a flooded area is affected by more than one flood type for the same event ("one flood type can cause another flood type").

As compromise the list of flood types comprises three parallel tables:

- Source of Flooding
- Mechanism of Flooding
- Characteristics of Flooding

For reporting exercises under 2007/60/EC these lists are content of reporting interface (enumeration lists), Member States are requested to pick out the relevant type(s) to deliver standardized respectively comparable information about floods and to enable COM to produce maps about flood events respectively flood types in WISE (Water Information System for Europe).

One or more options can be selected from each of the tables to describe the source, mechanism and/or characteristics of the flood.

Where the sources, mechanisms or characteristics of a flood do not correspond to the terms used in the tables, MS may select the 'Other' option (which should be the default) and provide in addition description about this "type".

Table A.1: Source of Flooding

Source	Description
Fluvial	Flooding of land by waters originating from part of a natural drainage system, including natural or modified drainage channels. This source could include flooding from rivers, streams, drainage channels, mountain torrents and ephemeral watercourses, lakes and floods arising from snow melt.
Pluvial	Flooding of land directly from rainfall water falling on, or flowing over, the land. This source could include urban storm water, rural overland flow or excess water, or overland floods arising from snowmelt.
Groundwater	Flooding of land by waters from underground rising to above the land surface. This source could include rising groundwater and underground flow from elevated surface waters.
Sea Water	Flooding of land by water from the sea, estuaries or coastal lakes. This source could include flooding from the sea (e.g., extreme tidal level and / or storm surges) or arising from wave action or tsunamis.
Artificial Water-Bearing Infrastructure	Flooding of land by water arising from artificial, water-bearing infrastructure or failure of such infrastructure. This source could include flooding arising from sewerage systems (including storm water, combined and foul sewers), water supply and wastewater treatment systems, artificial navigation canals and impoundments (e.g., dams and reservoirs).

Other	Flooding of land by water due to other sources
No Data Available	No data available on the source of flooding.

Table A.2: Mechanism of Flooding

Mechanism	**Description**
Natural Exceedance	Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands.
Defence Exceedance	Flooding of land due to floodwaters overtopping flood defences.
Defence or Infrastructural Failure	Flooding of land due to the failure of natural or artificial defences or infrastructure. This mechanism of flooding could include the breaching or collapse of a flood defence or retention structure, or the failure in operation of pumping equipment or gates.
Blockage / Restriction	Flooding of land due to a natural or artificial blockage or restriction of a conveyance channel or system. This mechanism of flooding could include the blockage of sewerage systems or due to restrictive channel structures such as bridges or culverts or arising from ice jams.
Other	Flooding of land by water due to other mechanisms
No Data Available	No data available on the mechanism of flooding.

Table A.3: Characteristics of Flooding

Characteristic	**Description**
Flash Flood	A flood that rises and falls quite rapidly with little or no advance warning, usually the result of intense rainfall over a relatively small area
Natural Flood	An onset of flooding due to significant precipitation, sometimes in combination with high sea levels, that occurs at a slower rate than a flash flood.
Spring Snow Melt Flood	Flooding due to rapid snow melt, possibly in combination with rainfall or blockage due to ice jams
Debris Flow	A flood conveying a high degree of debris.
High Velocity Flow	A flood where the floodwaters are flowing at a high velocity.
Deep Flood	A flood where the floodwaters are of significant depth.
Other	Other characteristics, or no special characteristics
No Data Available	No data available on the characteristics of flooding.

NOTES:

i) This list is prepared for the purposes of reporting types of floods giving rise to significant flood risk in an APSFR in the PFRA Reporting Sheet such that the flood mapping and flood risk management plans to be subsequently developed, where such types have been deemed to give rise to potential significant flood risk in accordance with Article 5 or 13(1), need only address the identified type of flood(s) for any given area identified under Article 5 or 13(1). The list may also be used for other aspects of the Directive.

ii) The list of flood types is prepared without prejudice to the interpretation of the Directive, in particular Article 2 and the required scope of Articles 4 and 5.

Draft list of types of consequences

Type of Consequence	**Sub-Type of Consequence / Description**
Human Health (Social)	***Human Health:*** Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment, and would include fatalities.
	Community: Adverse consequences to the community, such as detrimental impacts on local governance and public administration, emergency response, education, health and social work facilities (such as hospitals).
	Other
Environment	***Waterbody Status:*** Adverse permanent or long-term consequences ecological or chemical status of surface water bodies or chemical status of ground water bodies affected, as of concern under the WFD. Such consequences may arise from pollution from various sources (point and diffuse) or due to hydromorphological impacts of flooding.
	Protected Areas: Adverse permanent or long-term consequences to protected areas or waterbodies such as those designated under the Birds and Habitats Directives, bathing waters or drinking water abstraction points.
	Pollution Sources: Sources of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources.
	Other: Other potential permanent or long-term adverse environmental impacts, such as those on soil, biodiversity, flora and fauna, etc.
Cultural Heritage	***Cultural Assets:*** Adverse permanent or long-term consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings.
	Other
Economic	***Property:*** Adverse consequences to property, which could include homes
	Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage and communication.

	Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction and fishing.
	Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services and other sources of employment. (see note v)
	Other

NOTES:

i) One or more Types or Sub-Types of consequences can be selected to describe the adverse consequences of the flood. Reporting of Type for each significant flood under the PFRA Reporting Sheet should allow for multiple assignments from each of the tables.

ii) Where the relevant information is unavailable for a significant flood, or where the sources, mechanisms or characteristics of a flood do not correspond to the terms used in the tables, MS may select the 'Other' option (which should be the default).

iii) This list is prepared solely for the purposes of reporting Types / Sub-Types of consequences in the PFRA Reporting Sheet such that the flood risk management plans to be subsequently developed, where such consequences have been deemed to be significant in accordance with Article 4, 5 or 13(1), may focus on the identified Type / Sub-Type of consequence(s) for any given area identified under Article 5 or 13(1).

iv) The list of consequence Types / Sub-Types may include consequences that are not required to be assessed under the Directive, and is prepared without prejudice to the interpretation of the Directive, in particular the required scope of Articles 4 and 5.

v) The types of economic activities may be further specified and listed in accordance with NACE codes. To be further developed.

The use of Sub-Types of consequences in reporting on the PFRA is optional, and will be reviewed in relation to their application for flood maps and flood risk management plans.

C.2 *Landslides*

Currently a number of different landslide inventories exist in various databases and each uniquely addresses a specific purpose (for example we refer here to CSIRO *https://www.seegrid.csiro.au/twiki/bin/view/Geohazards/LandSlides*, or *http://www.landslides.usgs.gov* among others). These databases range in scale and detail, and although some similarities and a number of common themes are apparent between databases, the method in which information is organised and described varies considerably. This means information cannot readily be compared or aggregated with other sources. Furthermore, these inventories are generally only accessible to a small number of individuals and subsequently, it is possible there is significant duplication of effort among landslide researchers independently attempting to fill information gaps. Landslide inventories are fundamental for developing rigorous hazard and risk assessments.

[This is only an example of use case description, to show what it is, the link with examples of use, and what the impact is on the data model]

C.2.1 Landslide hazard mapping

Overview and involved actors

The hazard is often defined as the probability of occurrence of a potentially damaging phenomenon of a given intensity within a given area and a given period of time. To define this probability the geologist or engineer has to access datasets of climate, lithology, earthquake activity, and topography, physical, chemical, mechanical properties of rocks or soils, hydrological, hydrogeological data etc.

The objective is to develop a practical method for site prediction and movement assessment of rapid and long run-out landslides. Among various landslide types, the rapid, and long run-out landslides, especially those that occur in urbanizing areas often cause catastrophic damage to the community.

The goal of this use case is to deliver historical and possible occurrence of a landslide in a given area for the creation of appropriate landslide risk preparedness plans. Benefits of adopting an interoperable approach for landslide inventories Interoperability will enable landslide information to be accessed in real time by all levels of government, geotechnical professionals, emergency managers, land use planners, academics and the general public regardless of where it is hosted. It provides direct access to spatial-enabled data and allows users to simultaneously search and query the most up-to-date information available in geographically distributed databases through a single website. The search results can be displayed as reports, graphs, maps, statistics or tables, and data can be queried against background datasets, such as topography, geology and geomorphology.

Actors:

- Geological surveys to provide geological information (Geological Surveys represent the Member States)
- Engineers responsible for establishing risk maps using the geological information in combination with other data.
- Authorities for managing appropriate landslide risk preparedness plans.
- geotechnical professionals,
- emergency managers,
- land use planners,
- academics and
- the general public

Narrative description

Landslides are various types of gravitational mass movements of the Earth's surface that pose the Earth-system risk. A classification of landlides according to material type and type of movement is schematically shown in Fig. 1.

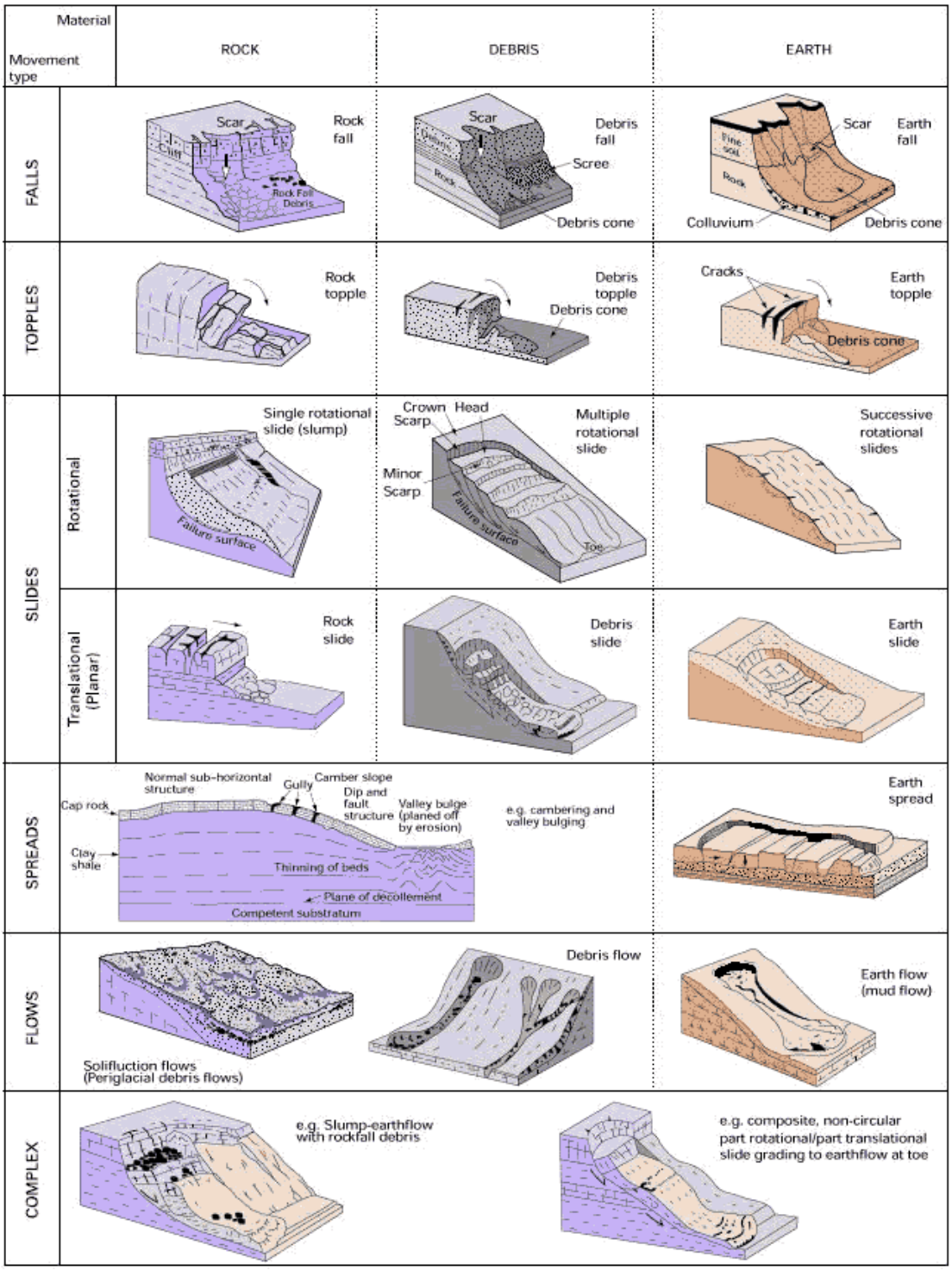


Figure 2 Classification of type of landslip (modified after Varnes, 1978 and DoE., 1990).

Falls mass detached from steep slope/cliff along surface with little or no shear displacement, descends mostly through the air by free fall, bouncing or rolling.
Topples forward rotation about a pivot point.
Rotational slides sliding outwards and downwards on one or more concave-upward failure surfaces.
Translational (planar) slides sliding on a planar failure surface running more-or less parallel to the slope.
Spreads fracturing and lateral extension of coherent rock or soil materials due to liquefaction or plastic flow of subjacent material.
Flows slow to rapid mass movements in saturated materials which advance by viscous flow, usually following initial sliding movement. Some flows may be bounded by basal and marginal shear surfaces but the dominan movement of the displaced mass is by flowage.
Complex slides slides involving two or more of the main movement types in combination.

Fig. 1 Classification of type of landslides occurring in rocks, debris or soil masses (*http://www.geonet.org.nz/landslide/glossary.html*).

‘‘Landslides’’ are a complex-disaster phenomenon triggered by earthquakes, heavy rainfall (typhoons, hurricanes), sustained rainfall, volcanic eruptions and heavy snowmelt, unregulated anthropogenic development, mining, tunneling and others (Fig. 2a). Landslides cause many deaths and injuries and great economic loss to society by destroying buildings, roads, life lines and other infrastructures; they also pose irrecoverable damage to our cultural and natural heritage. Large and small landslides occur almost every year in nearly all regions of the world. Large-scale coastal or marine landslides are known to cause tsunami waves that kill many people; an example was the 1792 UNZEN-Mayuyama landslide, which caused a devastating tsunami that resulted in 16,000 fatalities from the landslides and the tsunami in Japan. Also large-scale landslides on volcanoes can dislocate the mountain tops and trigger volcanic eruptions; such was the case for the 1980 eruption of Mount St. Helens in the USA and presumably for Mt.Bandai in Japan. Landslides also may occur without earthquakes, heavy rains, volcanic eruptions, or human activities due to progress of natural weathering; therefore, they occur almost everywhere in the world. Landslides most commonly impact residents living on and around slopes.

Landslides are a natural phenomenon which can only be effectively studied in an integrated, multidisciplinary fashion, including contribution from different natural and engineering sciences (earth and water sciences), and different social sciences. This is also the case because landslides are strongly related to cultural heritage and the environment (Fig. 2b). Landslides should be jointly managed by cooperation of different ministries and departments of government including some representing education, science and technology, construction and transportation, agriculture, forestry, and the environment, culture and vulnerable groups (the poor, aged, handicapped, or children). As landslides are highly localized phenomena it is crucial to seek the contribution of local governments or autonomous communities (Fig. 2c).

The disasters caused by landslides are of very complex nature wherever they occur around the world. Research on landslides should be integrated into a new multi-disciplinary science field of landslide study. Landslide risk preparedness is to be managed by multi-ministries.

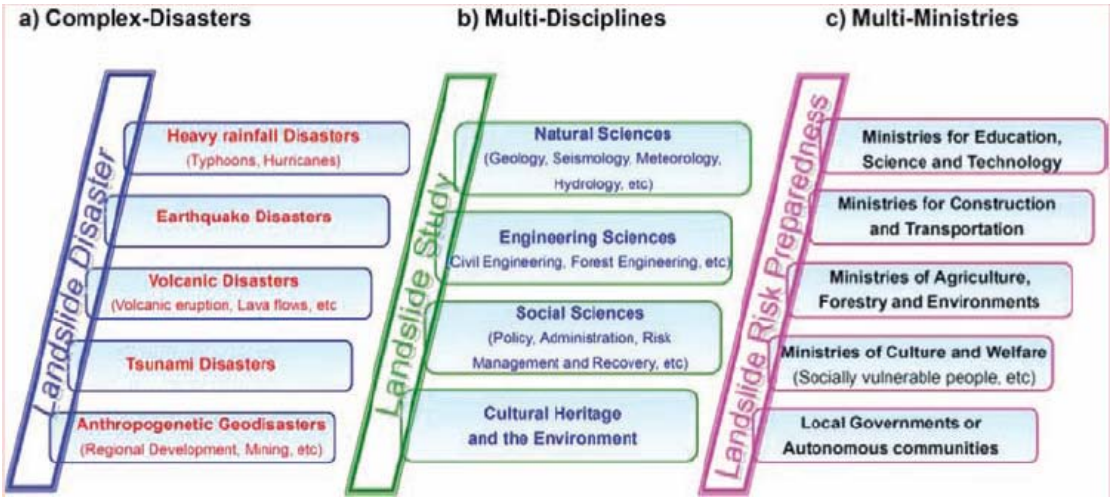


Fig. 2 Characteristics of landslide disasters

Water has a major role in triggering of landslides. Fig. 3 shows the relative contribution of various landslide triggering events factor in Italy. Heavy rainfall is the main trigger for mudflows, the deadliest and most destructive of all landslides.

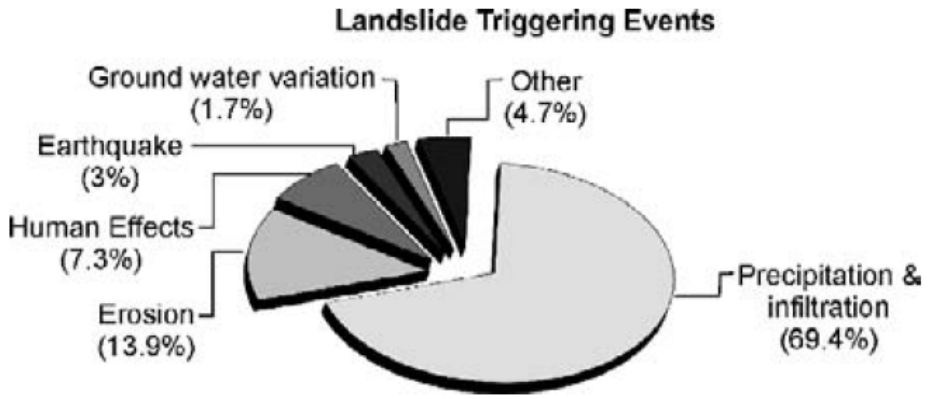


Fig. 3 Landslide triggers in Italy (CNR-GNDCI AVI Database of areas affected by landslides and floods in Italy)

The socio-economic impact of landslides is underestimated because landslides are usually not separated from other natural hazard triggers, such as extreme precipitation, earthquakes or floods. This underestimation contributes to reducing the awareness and concern of both authorities and general public about landslide risk.

Landslide inventories are fundamental for developing rigorous hazard and risk assessments. However, an agreed, systematic way of developing these inventories is presently not available, neither is there an example of 'best practise' that could be used as a guideline in EU.

Detailed description

Use case description	
Name	Landslides
Priority	High
Description	The user selects the relevant geographic area and searches for historical landslide data (time, type, magnitude, activity), geomorphological, geological, geotechnical, monitoring data etc as well as existing hazard analysis data for future landslide occurrences.
Pre-condition	Landslide data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between all relevant landslide description terms and user's terms.
Flow of events – Basic path	
Step 1	The user selects the area of interest and searches in a metadata catalogue for past landslide maps as well as hazard maps and other relevant information (i.e. geomorphological, geological-geotechnical & monitoring data, nearby activities that may trigger landslides such as mining or large excavations etc).
Step 2	The user displays the landslides historical and future hazard maps and accesses detailed information.
Step 3	The user may use his/her own models to create new hazard maps based on accessed information as above and compare model results with possible already available hazard maps.

Post-conditions	
Post-condition	The user has a set of data and predictions related to the landslide occurrence potential of the selected area.
Description	Landslide historical data from national sources.
Data provider	Each Member State

Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Natural Risk Zones (Landslides)
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Landslide GML Application schema
Documentation	INSPIRE Landslide Data Specification

Requirements from the use case

Analyzing the use case, there is a need to provide the following **objects** and **attributes**:

Geological units with:
- o their related polygons
- o lithology

Geological faults with:
- o their surfaces in 3D space
- o type of fault: normal, thrust, shear
- o attribute: active or non-active

Borehole data with:
- o geologic unit thickness and depth
- o water level
- o any other properties (physical and chemical) measured

Geotechnical data with:
- o physical, chemical and engineering data related to the geological units (from measurements: porosity, grain size, permeability, compressibility etc)

Monitoring data:
- o Type of monitoring instrumentation
- o Location of sampling measurements
- o Type and record of measurements

`Landslide past record:`
- o Activity State
- o Last Recorded Occurrence Time
- o Recurrences
- o Representative Location
- o Shape
- o Total Volume
- o Typical Movement Type

`Landslip Event:`
- o Volume
- o Causative Factor
- o Movement Type
- o Triggering Factor

`Damage Assesment Report:`
- o Reported Cost

- o Affected Entity Type
- o Number Affected
- o Report Date
- o Damage Type
- o Severity Code

This use case has some relationships with the following INSPIRE data themes:

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

TWG	Affected?	Datasets affected
1. Administrative Units (AU)	No	
2. Adresses (AD)	No	
3. Agricultural and aquacultural facilities (AF)	Yes	a. Vegetation on slope b. Anthropogenic activities (grading, land clearing)
4. Area management/restriction/regulation zones and reporting units (AM)	No	
5. Atmospheric conditions+Meteorological geographical features (AC-MF)	Yes	- Water deficit from precipitation and evapo-transpiration data - Precipitation patterns (historical + recent) - Synoptic situations
6. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	No	
7. Buildings	Yes	Landslides affect the buildings seating on the affected area hence landslide analysis is input for the constructors of buildings.
8. Cadastral Parcels (CP)	No	
9. Coordinate reference systems	No	
10. Elevation (EL)	Yes	- Slope and aspect from Digital Terrain Model (DTM) or Digital Elevation Model (DEM)
11. Energy Resources	No	
12. Environmental Monitoring Facilities (EMF)	No	
13. Geographical grid systems	No	
14. Geographical names (GN)	No	
15. Geology + Mineral resources (GE-MR)	Yes	Since Geology is concerned with the characterization of bedrock, aquifers and geomorphology, it constitutes an input for Landslide analysis of a given area.
16. Human Health and Safety (HH)	No	
17. Hydrography (HY)	No	
18. LandCover (LC)	Yes	- vegetation > enhancement of cohesion of superficial soil layers
19. LandUse (LU)	Yes	Recall the scope of LU, "…*Land use is defined as the description of land in terms or its socio-economic purpose (agricultural, residential, forestry etc.) be it past, current or future…",* hence landslide records and hazard models of a given area is of considerable importance as an input to this theme.
20. Natural Risk Zones	Yes	- UC output: Landslide hazard zones

21. Oceanographic geographical features + Sea regions (OF-SR)	No	
22. Orthoimagery (OI)	No	
23. Production and industrial facilities (PF)	Yes	May be seriously influenced by landslides
24. Protected Sites (PS)	No	
25. Soil (SO)	Yes	Recall the scope of SO, "…*Soils and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity*…". Landslide records and hazard maps require the proper characterization of soil. Also, climate change, increased susceptibility of surface soil to instability, anthropogenic activities, growing urbanization, uncontrolled land-use and increased vulnerability of population and infrastructure as a result, contribute to the growing landslide risk. According to the **European Union Strategy for Soil Protection (COM232/2006)**, landslides are one of the main eight threats to European soils.
26. Statistical Units + Population distribution, demography (SU-PD)	No	
27. TransportNetwork (TN)	Yes	- Landslides may cause damages and interruptions to traffic. - Anthropogenic activities (grading, land clearing and excavation) may affect slope stability
28. Utility and governmental services (US)	Yes	Landslides may seriously damage US

C.2.2 Landslide vulnerability assessment

Narrative description

The aim is the vulnerability assessment, considering human life, land resources, structures, infrastructure, and cultural heritage. Vulnerability is a key parameter in risk estimation. Vulnerability to natural hazards from the social science perspective has been defined by several authors. Blaikie et al. (1994), for instance, provided the following definition: "… the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of natural or man-made hazards". The main focus in this perspective is society. For this reason, such vulnerability is termed social vulnerability (e.g. Rashed and Weeks, 2003; Glade, 2003) or societal vulnerability (e.g. Lee and Jones, 2004) in the natural hazards literature. The ISSMGE Glossary of Risk Assessment Terms defines vulnerability as "The degree of loss to a given element or set of elements within the area affected by a hazard…" (*http://www.engmath.dal.ca/tc32/*). This approach to vulnerability estimation, in which vulnerability is expressed on a scale of 0 (no loss) to 1 (total loss), is referred to as "technical" or "physical", as it addresses the effects of the interaction of a damaging agent and the physical environment. An important distinction between the social and technical perspectives on vulnerability is that physical vulnerability is scenario-specific, while social vulnerability is not (Fell, 1994). Phoon (2004) provided a detailed discussion of the perspectives on vulnerability analysis.

Detailed description

Use case description	
Name	Landslides
Priority	High
Description	The user selects the relevant geographic area and searches for historical landslide data, terrain, geological, geotechnical and monitoring data as well as hazard and risk analysis data for future landslide occurrences.
Pre-condition	Landslide data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a “mapping” between all relevant landslide description terms and user’s terms.
Flow of events – Basic path	
Step 1	The user selects the area of interest and searches in a metadata catalogue for past landslide maps as well as hazard maps and other relevant information (i.e. geomorphological, geological-geotechnical & monitoring data, nearby activities that may trigger landslides such as mining or large excavations etc). Also, the user searches in a metadata catalogue for elements at risk such as population, buildings and infrastructures
Step 2	The user displays the landslides historical and future hazard maps and accesses detailed information.
Step 3	The user may use his/her own models to create hazard and risk maps based on accessed information as above and compares model results with possible available hazard or risk maps.
Post-conditions	
Post-condition	The user has a set of data and predictions related to the landslide occurrence potential of the selected area.
Description	Landslide historical data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Natural Risk Zones (Landslides)
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Landslide GML Application schema
Documentation	INSPIRE Landslide Data Specification

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

TWG	Affected?	Datasets affected
29. Administrative Units (AU)	No	
30. Adresses (AD)	No	

31. Agricultural and aquacultural facilities (AF)	Yes	o Vegetation on slope o Anthropogenic activities (grading, land clearing)
32. Area management/restriction/regulation zones and reporting units (AM)	No	
33. Atmospheric conditions+Meteorological geographical features (AC-MF)	Yes	- Water deficit from precipitation and evapotranspiration data - Precipitation patterns (historical + recent) - Synoptic situations
34. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	No	
35. Buildings	Yes	Landslides affect the buildings seating on the affected area hence landslide analysis is input for the constructors of buildings.
36. Cadastral Parcels (CP)	No	
37. Coordinate reference systems	No	
38. Elevation (EL)	Yes	- Slope and aspect from DEM
39. Energy Resources	No	
40. Environmental Monitoring Facilities (EMF)	No	
41. Geographical grid systems	No	
42. Geographical names (GN)	No	
43. Geology + Mineral resources (GE-MR)	Yes	Since Geology is concerned with the characterization of bedrock, aquifers and geomorphology, it constitutes an input for Landslide analysis of a given area.
44. Human Health and Safety (HH)	No	
45. Hydrography (HY)	No	
46. LandCover (LC)	Yes	- vegetation > enhancement of cohesion of superficial soil layers
47. LandUse (LU)	Yes	Recall the scope of LU, "…*Land use is defined as the description of land in terms or its socio-economic purpose (agricultural, residential, forestry etc.) be it past, current or future…",* hence landslide records and hazard models of a given area is of considerable importance as an input to this theme.
48. Natural Risk Zones	Yes	- UC output: Landslide hazard zones
49. Oceanographic geographical features + Sea regions (OF-SR)	No	
50. Orthoimagery (OI)	No	
51. Production and industrial facilities (PF)	Yes	May be seriously influenced by landslides
52. Protected Sites (PS)	No	

53. Soil (SO)	Yes	Recall the scope of SO, "…*Soils and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity*…". Landslide records and hazard maps require the proper characterization of soil. Also, climate change, increased susceptibility of surface soil to instability, anthropogenic activities, growing urbanization, uncontrolled land-use and increased vulnerability of population and infrastructure as a result, contribute to the growing landslide risk. According to the **European Union Strategy for Soil Protection (COM232/2006)**, landslides are one of the main eight threats to European soils.
54. Statistical Units + Population distribution, demography (SU-PD)	Yes	Vulnerability of populated areas
55. TransportNetwork (TN)	Yes	- Landslides may cause damages and interruptions to traffic. - Anthropogenic activities (grading, land clearing and excavation) may affect slope stability
56. Utility and governmental services (US)	Yes	Landslides may seriously damage US

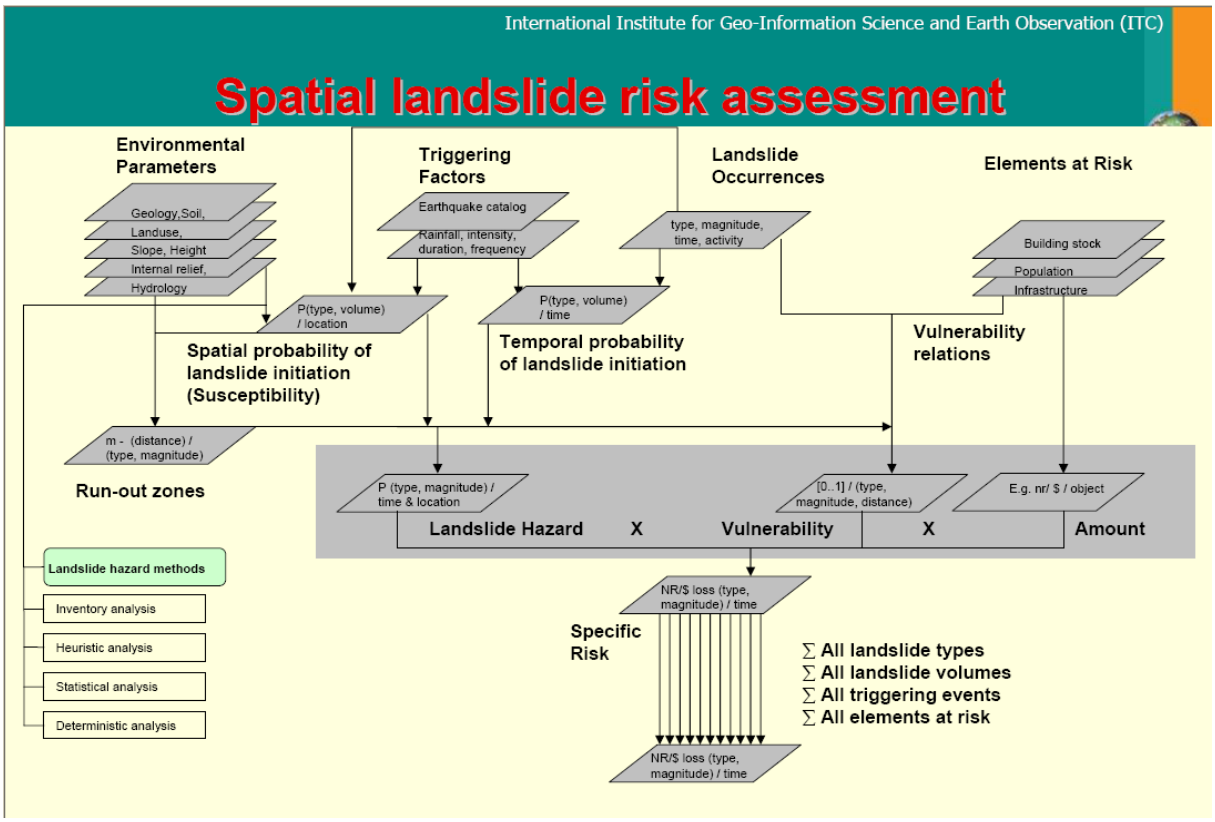
C.2.3 Landslide Risk assessment

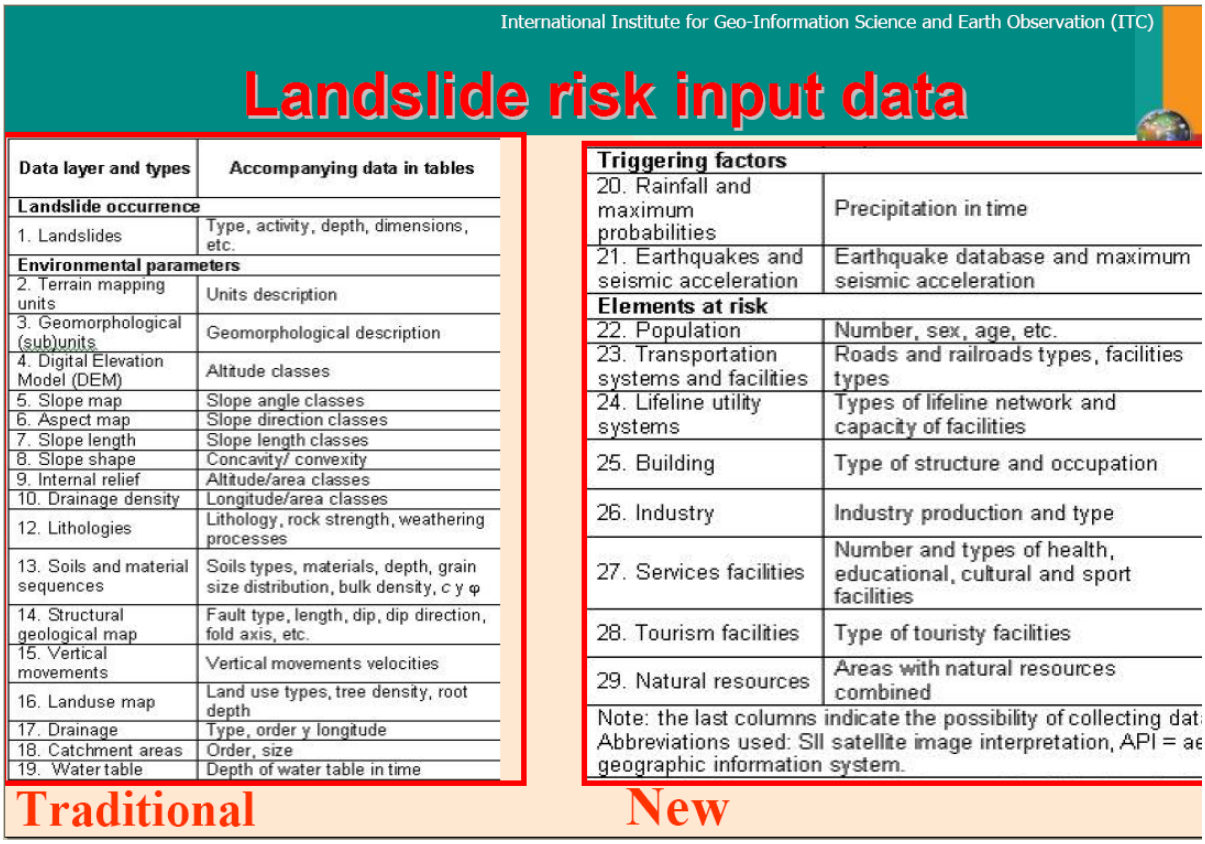
Narrative description

Risk is the measure of the probability and severity of an adverse event to life, health, property or the environment. Quantitatively, risk is the probability of an adverse event times the consequences if the event occurs, where the consequences are obtained from the elements at risk and their vulnerability. Mitigation of risk can be done by reducing the frequency (probability) of the adverse event or by reducing the vulnerability and/or exposure of the elements at risk, or even reducing both hazard and consequence.

As a consequence of climate change and increase in exposure in many parts of the world, the risk associated with landslides is growing. In areas with high demographic density, protection works often cannot be built because of economic or environmental constraints, and is it not always possible to evacuate people because of societal reasons. **One needs to forecast the occurrence of landslide and the hazard and risk associated with them.** Climate change, increased susceptibility of surface soil to instability, anthropogenic activities, growing urbanization, uncontrolled land-use and increased vulnerability of population and infrastructure as a result, contribute to the growing landslide risk. According to the **European Union Strategy for Soil Protection (COM232/2006)**, landslides are one of the main eight threats to European soils. Also, as a consequence of climatic changes and potential global warming, an increase of landslide activity is expected in the future, due to increased rainfalls, changes of hydrological cycles, more extreme weather, concentrated rain within shorter periods of time, meteorological events followed by sea storms causing coastal erosion and melting of snow and of frozen soils in the Alpine regions. The growing hazard and risk, the need to protect people and property, the expected climate change and the reality for society to live with hazard and risk and the need to manage risk to set the agenda for the profession to assessing and mitigating landslide risk.

Risk assessment and communicating risk should be performed in an easily understood manner.





Data layer and types	Accompanying data in tables
Landslide occurrence	
1. Landslides	Type, activity, depth, dimensions, etc.
Environmental parameters	
2. Terrain mapping units	Units description
3. Geomorphological (sub)units	Geomorphological description
4. Digital Elevation Model (DEM)	Altitude classes
5. Slope map	Slope angle classes
6. Aspect map	Slope direction classes
7. Slope length	Slope length classes
8. Slope shape	Concavity/ convexity
9. Internal relief	Altitude/area classes
10. Drainage density	Longitude/area classes
12. Lithologies	Lithology, rock strength, weathering processes
13. Soils and material sequences	Soils types, materials, depth, grain size distribution, bulk density, *c* y φ
14. Structural geological map	Fault type, length, dip, dip direction, fold axis, etc.
15. Vertical movements	Vertical movements velocities
16. Landuse map	Land use types, tree density, root depth
17. Drainage	Type, order y longitude
18. Catchment areas	Order, size
19. Water table	Depth of water table in time

Triggering factors	
20. Rainfall and maximum probabilities	Precipitation in time
21. Earthquakes and seismic acceleration	Earthquake database and maximum seismic acceleration
Elements at risk	
22. Population	Number, sex, age, etc.
23. Transportation systems and facilities	Roads and railroads types, facilities types
24. Lifeline utility systems	Types of lifeline network and capacity of facilities
25. Building	Type of structure and occupation
26. Industry	Industry production and type
27. Services facilities	Number and types of health, educational, cultural and sport facilities
28. Tourism facilities	Type of touristy facilities
29. Natural resources	Areas with natural resources combined

Note: the last columns indicate the possibility of collecting dat
Abbreviations used: SII satellite image interpretation, API = ae
geographic information system.

Detailed description

Use case description	
Name	Landslides
Priority	High
Description	The user selects the relevant geographic area and searches for hazard and vulnerability data for future landslide occurrences.
Pre-condition	Hazard and vulnerability data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a “mapping” between all relevant landslide description terms and user’s terms.
Flow of events – Basic path	
Step 1	The user selects the area of interest and searches in a metadata catalogue for hazard maps and vulnerability data.
Step 2	The user accesses detailed information.
Step 3	The user may use his/her own models to create risk maps based on accessed information as above and compares model results with possible available risk maps.
Post-conditions	
Post-condition	The user has a set of data and predictions related to the landslide risk map of the selected area.
Description	Landslide historical data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Natural Risk Zones (Landslides)
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Landslide GML Application schema
Documentation	INSPIRE Landslide Data Specification

Relationship with other INSPIRE Themes

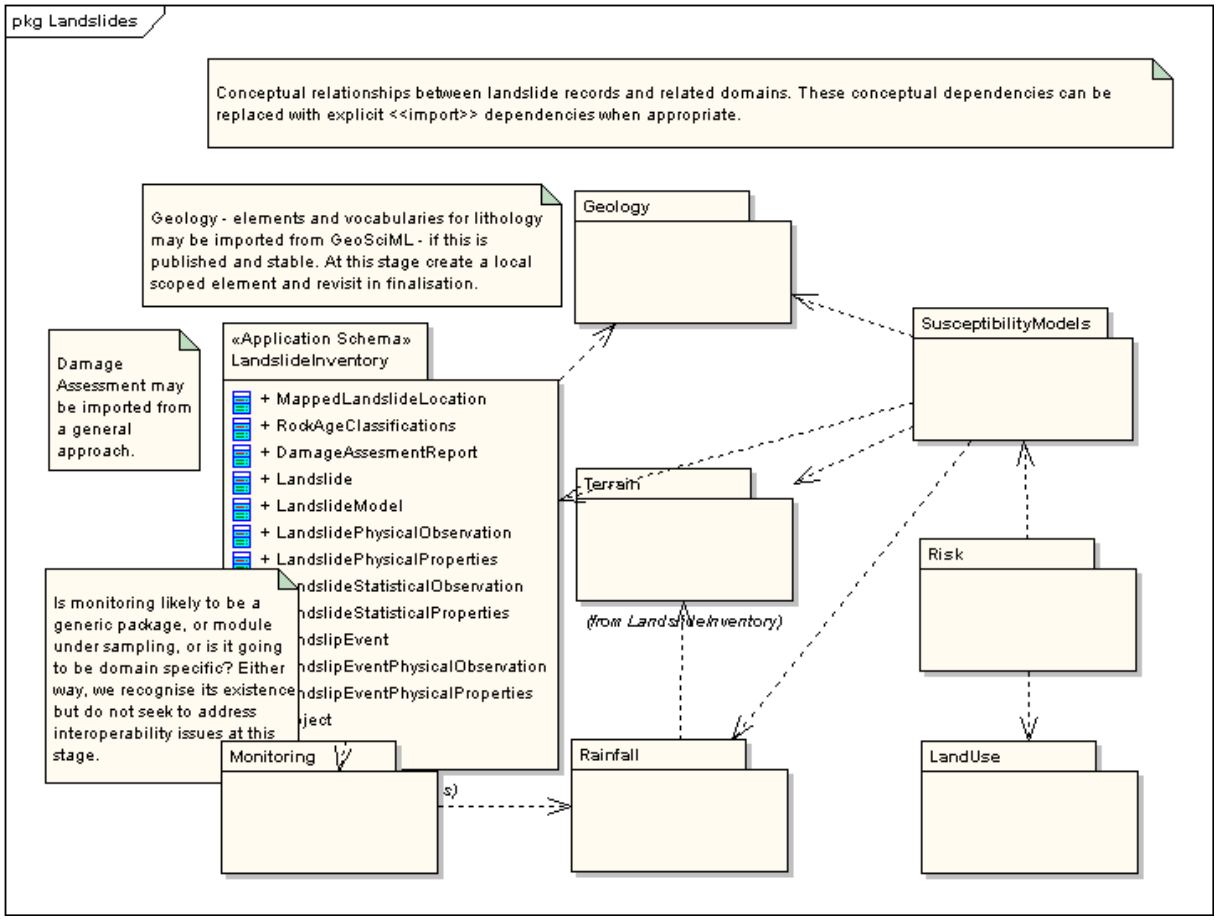
This use case has some relationships with the following INSPIRE data themes:

TWG	Affected?	Datasets affected
57. Administrative Units (AU)	No	
58. Adresses (AD)	No	
59. Agricultural and aquacultural facilities (AF)	Yes	- Vegetation on slope - Anthropogenic activities (grading, land clearing)
60. Area management/restriction/regulation zones and reporting units (AM)	No	

61. Atmospheric conditions+Meteorological geographical features (AC-MF)	Yes	- Water deficit from precipitation and evapotranspiration data - Precipitation patterns (historical + recent) - Synoptic situations
62. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	No	
63. Buildings	Yes	Landslides affect the buildings seating on the affected area hence landslide analysis is input for the constructors of buildings.
64. Cadastral Parcels (CP)	No	
65. Coordinate reference systems	No	
66. Elevation (EL)	Yes	- Slope and aspect from DEM
67. Energy Resources	No	
68. Environmental Monitoring Facilities (EMF)	No	
69. Geographical grid systems	No	
70. Geographical names (GN)	No	
71. Geology + Mineral resources (GE-MR)	Yes	Since Geology is concerned with the characterization of bedrock, aquifers and geomorphology, it constitutes an input for Landslide analysis of a given area.
72. Human Health and Safety (HH)	No	
73. Hydrography (HY)	No	
74. LandCover (LC)	Yes	- vegetation > enhancement of cohesion of superficial soil layers
75. LandUse (LU)	Yes	Recall the scope of LU, "…*Land use is defined as the description of land in terms or its socio-economic purpose (agricultural, residential, forestry etc.) be it past, current or future…",* hence landslide records and hazard models of a given area is of considerable importance as an input to this theme.
76. Natural Risk Zones	Yes	- UC output: Landslide hazard zones
77. Oceanographic geographical features + Sea regions (OF-SR)	No	
78. Orthoimagery (OI)	No	
79. Production and industrial facilities (PF)	Yes	May be seriously influenced by landslides
80. Protected Sites (PS)	No	

81. Soil (SO)	Yes	Recall the scope of SO, "…*Soils and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity*…". Landslide records and hazard maps require the proper characterization of soil. Also, climate change, increased susceptibility of surface soil to instability, anthropogenic activities, growing urbanization, uncontrolled land-use and increased vulnerability of population and infrastructure as a result, contribute to the growing landslide risk. According to the **European Union Strategy for Soil Protection (COM232/2006)**, landslides are one of the main eight threats to European soils.
82. Statistical Units + Population distribution, demography (SU-PD)	Yes	Populated areas at risk.
83. TransportNetwork (TN)	Yes	- Landslides may cause damages and interruptions to traffic. - Anthropogenic activities (grading, land clearing and excavation) may affect slope stability
84. Utility and governmental services (US)	Yes	Landslides may seriously damage US

APPENDIX



UML Diagram: Landslides related to other themes. https://www.seegrid.csiro.au/twiki/bin/view/Geohazards/LandSlides

References

http://www.ukgeohazards.info/pages/eng_geol/landslide_geohazard/eng_geol_landslides_classification.htm

http://geology.com/usgs/landslides/

https://www.seegrid.csiro.au/twiki/bin/view/Geohazards/LandSlides

Blaikie, P., Cannon, T., Davis, I., Wisner, B., 1994. At Risk: Natural Hazards, People's Vulnerability, and Disasters. Routledge, New York.
Lee, E.M., Jones, K.C., 2004. Landslide Risk Assessment. Thomas Telford, London.
Phoon, K.-K., 2004. Risk and vulnerability for geohazards — vulnerability in relation to risk management of natural hazards. ICG Report 2004-2-3, Oslo.
Rashed, T., Weeks, J., 2003. Assessing vulnerability to earthquake hazards through spatial multicriteria analysis of urban areas. International Journal of Geographic
Information Science 17 (6), 547–576.
Fell, R., 1994. Landslide risk assessment and acceptable risk. Canadian Geotechnical Journal 31, 261–272.

C.3 *Forest fires*

Introduction

Forest fires are a major concern especially for southern Member States of the EU. As reported by the European Forest Fire Information System (EFFIS) an average of 70 000 fires take place every year burning more than half a million hectares in Europe. Although no clear trend regarding the areas burnt by forest fires could be detected in the last decades, fire events show increased intensity and impacts with a high number of fatalities and large economic losses. To address the increasing risks of forest fires, forest fire management has been improved in an integrated way. Thereby, a particular focus is being placed on forest fire prevention measures.

Specific forest fire policies exist in most EU Member States, but a harmonisation of these policies at the European level has not yet been achieved. At EU level a first regulation on forest fire prevention was issued in 1992. Since there several European initiatives have taken place. The European Commission has developed since 1998 the European Forest Fire Information System (EFFIS) which includes a module for forecasting and assessing the risks of forest fire at European level. The EFFIS[19] established by the Joint Research Centre and the Directorate General for Environment, is the EU focal point for information on forest fires addressing fire prevention, fire fighting and post fire evaluations. The wide range of available data and models covers among others fire danger forecast, fire emission and fire damage assessment, post-fire vegetation recovery.

In the last years the Commission put forest fires higher on the political agenda, focusing not only on fire fighting but also on prevention and adapting forest management to climate change. In these fields, preparatory work on two Council conclusions was carried out, the Commission adopted the Green Paper on forest protection and information and the European Parliament took initiatives in forest fire prevention. Furthermore the Commission supported the setting-up of the EU Forest Fires Tactical Reserve (EUFFTR), which aims at stepping up Member States cooperation to reinforce the overall EU fire-fighting capacity.

[19] http://effis.jrc.ec.europa.eu/

Template to describe use cases

This template is from D2.6 Methodology for the Development of Data Specifications. The D2.6 contains the common methodology for the development of data specifications for the INSPIRE Annex spatial data themes. Document D2.6 facilitates the process of creating harmonised data specifications for the INSPIRE themes and it is intended to assist the facilitators, editors and experts who get involved in the development of data specifications for Annex themes.

In D2.6 there are 3 parts to describe a use case:

- Overview and involved actors (UML diagram)
- Narrative description (text)
- Detailed and structured description (template below)

Detailed and structured description

Use case description	
Name	
Priority	
Description	
Pre-condition	
Flow of events – Basic path	
Step 1	
Step ..	
Flow of events – Alternative path	
Post-conditions	
Post-condition	
Data source: *name*	
Description	
Data provider	
Geographic scope	
Thematic scope	
Scale, resolution	
Delivery	
Documentation	

Overview and involved actors

There is lack of consensus in the literature on the meaning of the term "forest fire risk". Allgöwer et al. (2003) identified two main approaches to this term. First, the "wildland fire community" has defined fire risk by looking at the chances of having a fire event. For instance, FAO[20] defines forest fire risk as "the probability of fire initiation due to the presence and activity of a causative agent". This approach neglect the outcome (damage potential) of a possible fire event (Allgöwer et al., 2003; Chuvieco et al., 2010). Second, the "structural fire community" has implemented a fire risk approach that is more in line with the approach followed in other natural hazards, where risk is a function of probability of occurrence and consequence. In this document we follow the second approach because of its comprehensiveness and the inclusion of the two main components of forest fire risk: fire danger and vulnerability. Within this approach fire risk is the probability of a fire to happen and its consequences, fire danger considers the potential that a fire ignites and propagates, and vulnerability relates to the potential damages caused by the fire. It is noteworthy that the term exposure is not common in the forest fire literature. Figure 1 shows the framework adopted in this document and the interlinks between the factors of forest fire risk.

In addition to the general conceptual framework, there are several perspectives from which forest fire risk assessments can be addressed. From the time-scale of the factors included in the assessment, fire risk can be classified into long-term and short term (San-Miguel-Ayanz et al., 2003). Long-term indices are based on variables that change relatively little in the short to medium term (e.g. topography, fuel). This type of assessment is useful for supporting management procedures such as long-term sustainable land management, rural planning, fire prevention and preparation of fire fighting strategies. Short term fire risk indices are based on variables that change nearly continuously over time, such as weather conditions. They are usually operationally implemented for early warning and preparedness support.

This use case describes the process for setting up the geographic data relevant for assessing forest fires risk (Figure 2). The modelling aspects behind fire danger, vulnerability or risk are out of the scope of the use cases in this document.

[20] http://www.fao.org/forestry/firemanagement/13530/en/

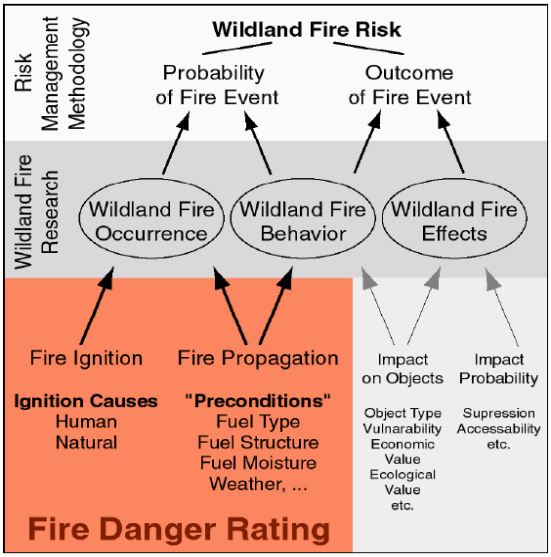


Figure 1: Forest fire risk analysis framework. Source: Allgöwer et al. (2003).

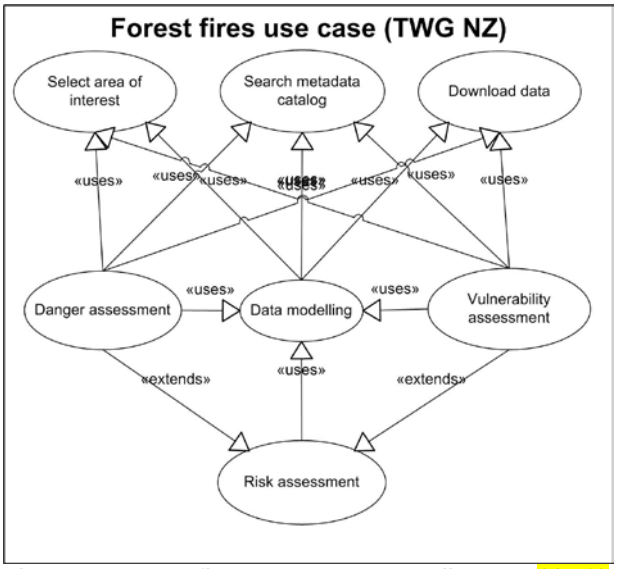


Figure 2: Forest fires use case UML diagram (draft).

C.3.1 Forest fires danger mapping

Narrative description

Forest fire danger can be defined as the probability that a fire with a given intensity ignites and propagates. Hence fire danger is a function of ignition danger and propagation danger. The two main causes of ignition i.e. human and natural, and the moisture content of plants are considered for assessing ignition danger. Propagation danger is dealt with assessing fire spread potential, which is the result of fuel properties and amount, terrain characteristics and weather conditions. The mentioned approach is well addressed for short-term systems. Long-term risk assessments would need to incorporate climatic data for assessing the long-term spatial-temporal setting that facilitates ignition and propagation.

Most short-term fire early warning systems assess fire danger using numerical indices not producing a probability *per se*. An example of this approach is the Fire Weather Index (FWI) system from the Canadian Forest Service[21]. The Canadian FWI consists of six components that account for the effects of fuel moisture and wind on fire behaviour. This is the approach adopted in EFFIS fire danger module. Short term fire danger rating systems are included in Figure 1 under the "Fire Danger Rating" box. These indices are commonly used by forest services and civil protection services in charge of fire prevention and fighting.

For assessing ignition danger several georreferenced datasets can be used (depending on the model):

- Forest fire occurrence (human and natural) georreferenced time-series
- Fuel moisture content - moisture content of vegetation (live and dead components): usually from remotely sensed imagery
- Infrastructure (transport networks, electric lines, hotels, camp sites, etc)
- Land use/land cover, urban/wildland interface
- Population density and/or other relevant census data
- Lighting occurrence
- Climate or bio-climate datasets
- Terrain (DEM)
- Meteorological datasets (temperature, relative humidity, wind, rain)

For assessing propagation danger several georreferenced datasets can be used (depending on the model):

- Fuel types
- Fuel moisture content (live and dead component)
- Meteorological datasets (temperature, relative humidity, wind, rain)
- Terrain (DEM)
- Forest fire mitigative measures (e.g. fire breaks)

This use case describes the main data needed for preparing forest fire danger maps either for short-term or long-term assessments. Notice that this is a live document resulting from a wide literature review and attempts to be as comprehensive as possible. However it could be the case that some specific approaches or methods are not included here.

Detailed description

Use case description	
Name	Accessing data to assess forest fire danger
Priority	

[21] http://cwfis.cfs.nrcan.gc.ca/background/summary/fwi

Description	The user selects a geographic area and a search for relevant forest fire danger data is conducted
Pre-condition	Relevant forest fire danger data is available for the selected area
Flow of events – Basic path	
Step 1	The user selects the area of interest and searches in a metadata catalogue for relevant data (topography, meteorological, climatic, fuel, vegetation…)
Step 2	The user accesses the requested data and downloads it
Step 3	When needed, downloaded data is processed to obtain derived information (fuel type from vegetation or aspect from DEM, for instance)
Step 4	The user matches original and derived data to produce danger zones
Flow of events – Alternative path	
Post-conditions	
Post-condition	Forest fire danger zones map is achieved
Description	
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Natural Risk Zones (Forest fires)
Scale, resolution	Scale relevant to the application: from local/regional to continental (tbd)
Delivery	
Documentation	

Requirements from the use case

The analysis of the use case indicates that it would be necessary to provide, at least, the following objects and attributes:

Forest fires occurrence (georreferenced time-series) and causes (human and natural)
- Number of fires
- Burnt area

Fuel data
- Fuel moisture content - moisture content of vegetation (live and dead components)
- Fuel types

Topographic data from DEM
- Slope and aspect

Infrastructure and land use/cover
- Transport networks, electric lines, hotels, camp sites, etc
- Land use/land cover, urban/wildland interface
- Population density and census data

Climate and meteorological datasets
- Lighting occurrence
- Climate datasets (temperature, relative humidity, wind, rain) or bio-climate dataset
- Meteorological datasets (temperature, relative humidity, wind, rain)

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

TWG	Affected?	Datasets affected
85. Administrative Units (AU)	Yes	- Boundaries (geographical units)
86. Adresses (AD)	No	

TWG	Affected?	Datasets affected
87. Agricultural and aquacultural facilities (AF)	Yes	- Agriculture as a causal factor
88. Area management/restriction/regulation zones and reporting units (AM)	No	
89. Atmospheric conditions+Meteorological geographical features (AC-MF)	Yes	- Wind: speeds, directions, wind fields - Temperature - Relative humidity - Rain
90. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	Yes	- bio-climate
91. Buildings	No	
92. Cadastral Parcels (CP)	No	
93. Coordinate reference systems	No	
94. Elevation (EL)	Yes	- Slope and aspect from DEM
95. Energy Resources	No	
96. Environmental Monitoring Facilities (EMF)	No	
97. Geographical grid systems	No	
98. Geographical names (GN)	No	
99. Geology + Mineral resources (GE-MR)	No	
100. Human Health and Safety (HH)	No	
101. Hydrography (HY)	No	
102. LandCover (LC)	Yes	- vegetation > fuel models > flammability / combustibility
103. LandUse (LU)	Yes	- Forest, urban areas, urban/wildland interface
104. Natural Risk Zones	Yes	- UC output: Forest fires danger zones
105. Oceanographic geographical features + Sea regions (OF-SR)	No	
106. Orthoimagery (OI)	No	
107. Production and industrial facilities (PF)	Yes	- As a causal factor
108. Protected Sites (PS)	No	
109. Soil (SO)	No	
110. Statistical Units + Population distribution, demography (SU-PD)	Yes	- As a causal factor
111. TransportNetwork (TN)	Yes	- As a causal factor
112. Utility and governmental services (US)	Yes	- As a causal factor

C.3.2 Forest fire vulnerability mapping

Narrative description

Forest fire vulnerability is a notion referring to potential fire damage and impact. Hence, within the approach adopted in this use case, the vulnerability factor assesses potential damage and impact caused by the fire. For example, negative effects of fire have been classified in Chuvieco et al. (2010) in three main aspects:

- Socio-economic values (properties, wood resources, recreational value, carbon stocks, etc)
- Environmental degradation potential (soil erosion, vegetation conditions/vulnerability), and
- Landscape value (uniqueness, conservation status, legal protection, etc).

This use case describes how these datasets can be accessed so that a vulnerability map could be derived from them.

Detailed description

Use case description	
Name	Accessing data to assess vulnerability to forest fires
Priority	
Description	The user selects a geographic area and a search for relevant vulnerability data is conducted
Pre-condition	Relevant vulnerability data is available for the selected area
Flow of events – Basic path	
Step 1	The user selects the area of interest and searches in a metadata catalogue for relevant data
Step 2	The user accesses the requested data and downloads it
Step 3	When needed, downloaded data is reclassified to obtain derived information
Step 4	The user matches original and derived data to produce a vulnerability zones map
Post-conditions	
Post-condition	Forest fires vulnerability map is achieved
Description	
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Natural Risk Zones (forest fires)
Scale, resolution	Scale relevant to the application: from local/regional to continental (tbd)
Delivery	
Documentation	

Requirements from the use case

The analysis of this use case shows that many datasets used for vulnerability mapping are the result of external models to the forest fire risk assessment. For instance, soil erosion potential is usually implemented using the Universal Soil Loss Equation (ULSE) approach. Tangible resources are usually evaluated using direct methods such as market price (e.g. wood resources). And intangible resources (recreational value) are usually evaluated using indirect methods such as travel-cost methods or contingency value methods. Therefore, considering the large number of methods and models usually involved in the implementation of forest fire vulnerability maps, in this section we provide a non-comprehensive general overview of the main datasets used in some operational systems (e.g. Chuvieco et al., 2010):

Economic values

- Properties (value of properties)
- Infrastructures and its value (buildings, housing, transport networks, distribution networks, utilities, land use, other infrastructures)
- Wood resources (market value per ha)
- Recreational value of forested areas (economic value per ha/year)
- Carbon stocks (market value)

- Etc

Environmental degradation potential (index)
- Soil erosion (e.g. ULSE approach)
- Vegetation conditions/vulnerability
- Etc

Landscape value (economic value e.g. Euro/ha/year from indirect valuation methods)
- Uniqueness
- Conservation status
- Legal protection
- Etc

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

TWG	Affected?	Datasets affected
1. Administrative Units (AU)	Yes	- Boundaries (geographical units)
2. Adresses (AD)	No	
3. Agricultural and aquacultural facilities (AF)	Yes	- Economic value of agriculture classes
4. Area management/restriction/regulation zones and reporting units (AM)	No	
5. Atmospheric conditions+Meteorological geographical features (AC-MF)	No	
6. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	Yes	- Could be one of the inputs in the landscape value assessment
7. Buildings	Yes	- Economic value of assets
8. Cadastral Parcels (CP)	No	
9. Coordinate reference systems	No	
10. Elevation (EL)	No	- DEM e.g. USLE
11. Energy Resources	No	
12. Environmental Monitoring Facilities (EMF)	No	
13. Geographical grid systems	No	
14. Geographical names (GN)	No	
15. Geology + Mineral resources (GE-MR)	No	
16. Human Health and Safety (HH)	?	
17. Hydrography (HY)	No	
18. LandCover (LC)	Yes	- Vegetation type, canopy cover
19. LandUse (LU)	Yes	- Land use classes: urban areas, agriculture, forested areas, etc. for several purposes.
20. Natural Risk Zones	Yes	- UC output: Forest fires vulnerability zones
21. Oceanographic geographical features + Sea regions (OF-SR)	No	
22. Orthoimagery (OI)	No	

TWG	Affected?	Datasets affected
23. Production and industrial facilities (PF)	Yes	- With regards to adverse consequences for economic activities - With regards to economic capacity at risk – asset maps
24. Protected Sites (PS)	Yes	- Cultural heritage - Protected areas as defined under article 6 and article 7 2000/60/EC respectively article 6 2007/60/EC - Natura 2000 - Other protected areas
25. Soil (SO)	Yes	- parent material (e.g. USLE)
26. Statistical Units + Population distribution, demography (SU-PD)	Yes	- Census data: population density and other population data
27. TransportNetwork (TN)	Yes	- Transport network assets – road, railroad, gas-pipelines, etc - Infrastructure affected as result of forest fires
28. Utility and governmental services (US)	Yes	- Water supply - Sewerage system - Energy supply - Cable communication networks - Administration centres/infrastructure - Maintenance of supply and vulnerability

C.3.3 Forest fire risk mapping

Narrative description

Forest fire risk is a function of probability of occurrence and consequence. Hence fire risk is the outcome of the assessment as shown in Figure 1. The integration of the fire danger factor (ignition and propagation potential) and the vulnerability factor (potential damage) may follow different approaches/methods and thus the resulting risk map can be represented using different configurations. The ideal model would follow a probabilistic approach in which for each place the probability of occurrence and severity of the fire is related with the potential consequence of fire. However, the large amount of data and techniques needed for implementing a probabilistic approach limits their operational implementation. Therefore often forest fire risk is represented in a qualitative scale from low or very low to high or very high fire risk.

The implementation of this use case follows the results of the previous use cases on fire danger and vulnerability. Hence we show briefly how fire danger and vulnerability data is accessed for implementing forest fires risk.

Detailed description

Use case description	
Name	Accessing data to assess forest fires risk
Priority	
Description	The user selects a geographic area and searches for fire danger and fire vulnerability maps, then integrates the maps in an forest fire risk map
Pre-condition	Danger and vulnerability maps are available for the selected area
Flow of events – Basic path	
Step 1	The user selects the area of interest and searches in a metadata catalogue fire danger and fire vulnerability maps
Step 2	The user defines methods for integrating danger and vulnerability maps into a forest fire risk map
Step 3	The user produces a forest fires risk map (short or long-term)
Post-conditions	
Post-condition	A forest fires risk map is produced
Description	
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Natural Risk Zones (forest fires)
Scale, resolution	Scale relevant to the application: from local/regional to continental (tbd)
Delivery	
Documentation	

Requirements from the use case

The analysis of the use case shows that there is a need to provide the following objects and attributes for forest fire risk assessment:

- Forest fire danger
- Forest fires vulnerability

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

TWG	Affected?	Datasets affected
1. Administrative Units (AU)	No	
2. Adresses (AD)	No	
3. Agricultural and aquacultural facilities (AF)	No	
4. Area management/restriction/regulation zones and reporting units (AM)	No	
5. Atmospheric conditions+Meteorological geographical features (AC-MF)	No	
6. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	No	
7. Buildings	No	
8. Cadastral Parcels (CP)	No	
9. Coordinate reference systems	No	
10. Elevation (EL)	No	
11. Energy Resources	No	
12. Environmental Monitoring Facilities (EMF)	No	
13. Geographical grid systems	No	
14. Geographical names (GN)	No	
15. Geology + Mineral resources (GE-MR)	No	
16. Human Health and Safety (HH)	Yes	- Design and planning of fire protection infrastructure
17. Hydrography (HY)	No	
18. LandCover (LC)	No	
19. LandUse (LU)	No	
20. Natural Risk Zones	Yes	- Forest fire danger zones - Forest fires vulnerability
21. Oceanographic geographical features + Sea regions (OF-SR)	No	
22. Orthoimagery (OI)	No	
23. Production and industrial facilities (PF)	No	
24. Protected Sites (PS)	No	
25. Soil (SO)	No	
26. Statistical Units + Population distribution, demography (SU-PD)	No	
27. TransportNetwork (TN)	No	
28. Utility and governmental services (US)	Yes	- Forest fire protection infrastructure

References

Allgöwer, B., Carlson, J.D. and van Wagtendonk, J.W., 2003. Introduction to Fire Danger Rating and Remote Sensing — Will Remote Sensing Enhance Wildland Fire Danger Rating? In: E. Chuvieco (Editor), Wildland fire danger estimation and mapping - The Role of Remote Sensing Data. Series in Remote Sensing. World Scientific Publishing, Singapore, pp. 1-19.

Chuvieco, E. et al., 2010. Development of a framework for fire risk assessment using remote sensing and geographic information system technologies. Ecological Modelling, 221(1): 46-58.

FAO, 1986. Wildland Fire Management Terminology. FAO Forestry Paper n. 70, p. 257.

San-Miguel-Ayanz, J. et al., 2003. Current methods to assess fire danger potential. In: E. Chuvieco (Editor), Wildland fire danger estimation and mapping - The Role of Remote Sensing Data. Series in Remote Sensing. World Scientific Publishing, Singapore, pp. 22-61.

C.4 *Earthquake insurance*

Narrative description

The building Code of European countries prepared a special earthquake Hazard map for the purpose of seismically resilient civil engineering and construction. An extensive study could be found in http://eurocodes.jrc.ec.europa.eu/doc/EUR23563EN.pdf:
“A review of the seismic hazard zonation in national building codes in the context of Eurocode 8”

In this map, places with the key parameter- awaited maximal level of earthquake– peak ground acceleration in a given interval - is projected as an area of equal seismic hazard. The territory (of Bulgaria) is presented as set of multi-polygons, where each multi-polygon correspond to some specific interval of peak ground acceleration/ awaited level of seismic reaction.

The Insurance implementation of this earthquake risk map is based on the following:

- The reality is that a substantial number of existing dwellings (in some areas – more than 50%) are “pre code”, i.e. are not resistant to potential maximal local seismic impact
- less than 20% of dwellings comply with the latest building code i.e. are constructed to be resistant to maximal awaited seismic phenomena for their territory.

The general insurance practice uses different tariffs for insurance premium calculation depending on the location of the insured building/property in the different zones of the earthquake hazard map from the building Code. The more strong seismic motion is awaited – more high insurance premium is calculated. In addition, other key parameters, related to seismic resilience, such as Building material and Building height are also considered.

There is an unofficial exception for new buildings of less than 20 years (the new building code) for which the smallest seismic level tariff is applied indifferently of their location

Detailed description

Use case description	
Name	Accessing data to assess potential earthquake damage
Priority	Medium
Description	The user selects a geographic area and search for relevant data on earthquake hazard. After that the user searches for relevant construction related data on buildings, Installations or any assets to be insured
Pre-condition	Relevant earthquake hazard data is available for the selected area, et least in the volume available from (doc 1)
Flow of events - Basic path	

Step 1	The user selects the area of interest and searches in a metadata catalogues for the relevant data (Hazard , assets specific parameters)
Step 2	The user accesses the relevant data and downloads the necessary portion on the target object of interest
Step 3	The user calculates the risk coefficient and determines the risk premium for the requested risk cover
Description	
Data provider	Each member State
Geographic scope	All EU Member States
Thematic scope	
Scale, resolution	Scale relevant to the application, requiring at least any village position in the earthquake hazard map
Delivery	
Documentation	

Requirements from the use case

Anayzing the use case , there is a need to provide the following objects and attributes

Earthquake hazard map
- hazard repeating perioad (50, 475, 1000 years)
- awaited peak ground acceleration
- Information on earth faults if any (for utility infrastructure, transport infrastructure)

Buildings, Production and industrial facilities
- Type of construction (material)
- Year of construction (applied anti-seismic Code)
- height of construction

Utility infrastructure
- type of infrastructure (e.g. pipeline, underground cable etc)
-Type of construction (material)
- Year of construction (applied anti-seismic Code)
- height of construction

Relationship with other INSPIRE Themes

TWG	Affected?	Datasets affected
1. Administrative Units (AU)	No	
2. Adresses (AD)	No	
3. Agricultural and aquacultural facilities (AF)	No	
4. Area management/restriction/regulation zones and reporting units (AM)	No	
5. Atmospheric conditions+Meteorological geographical features (AC-MF)	No	
6. Bio-geographical regions + Habitats and biotopes + Species distribution (BR-HB-SD)	No	
7. Buildings	Yes	Assets at risk :buildings parameters
8. Cadastral Parcels (CP)	No	
9. Coordinate reference systems	No	
10. Elevation (EL)		
11. Energy Resources	No	
12. Environmental Monitoring Facilities (EMF)	No	
13. Geographical grid systems	No	
14. Geographical names (GN)	No	

15. Geology + Mineral resources (GE-MR)	No	
16. Human Health and Safety (HH)	No	
17. Hydrography (HY)	No	
18. LandCover (LC)	No	
19. LandUse (LU)	No	
20. Natural Risk Zones	Yes	- UC output: Seismic hazard zones
21. Oceanographic geographical features + Sea regions (OF-SR)	No	
22. Orthoimagery (OI)	No	
23. Production and industrial facilities (PF)	Yes	Assets at risk :buildings parameters
24. Protected Sites (PS)	No	
25. Soil (SO)	No	
26. Statistical Units + Population distribution, demography (SU-PD)	No	
27. TransportNetwork (TN)	Yes	Assets at risk :buildings parameters, utility parameters
28. Utility and governmental services (US)	Yes	Assets at risk: utility parameters