

Title:

A9.6-D3: HS-ERiskA Demonstrator (final release)

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Working Group:

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1. Introduction

The European Risk Atlas (ERiskA) Scenario aims at developing a cross-border flood risk management application for the Lake Constance Region which includes Swiss, Austrian and German territories. ERiskA will facilitate cross-border cooperation between the agencies responsible for disaster management in the Lake Constance Region by enabling the exchange of information on potentially flooded areas and inundation of infrastructure like roads and railways. For this purpose a number of interoperability and data harmonisation issues are addressed within the Scenario and solved by using HUMBOLDT Framework tools. The harmonisation issues, the demonstrator application as well as the experiences gained in using the HUMBOLDT Framework tools and services are documented in the form of training material accessible from the training platform at <http://www.gisig.it/humboldt/training/> . This includes step-by-step guidance on creating a data model based on INSPIRE Data Specifications, mapping between the source and target data models, creating workflows as well as using the ERiskA application .

2. General overview

2.1. The ERiskA context

The ERiskA application can be used as an add-on to existing emergency operation systems at command and control centres dealing with the different steps in the disaster management cycle (e.g. prevention, preparedness, response) in the case of floods. The handling of (spatial) data for these tasks is characterised by the following requirements:

- Heterogeneous data sources from different countries
- Integration of in-situ measurements at lake and river gauges
- Local storage of data for fast and secure access - since time is a crucial factor for the system.

Thus the ERiskA application needs to cover functionalities like providing harmonised cross-border base data for the test area, providing possibilities for selecting geospatial features interactively and selecting features according to different input parameters, integration of in-situ measurement values at gauges from different providers, recalculating measurement values as well as providing the possibility for using a desktop GIS as front-end for accessing data sources and an additional simplified web solution. For more information see “*Application Case 4: The ERiskA application: cross-border flood information*”

2.2. INSPIRE and ERiskA

The ERiskA common data model (see section 2.7) has been created taking into consideration INSPIRE Data Specifications. Following the identification of information items required for the scenario application, relevant Data Specifications were analysed for suitability.

Elements of the following INSPIRE Data Specifications were re-used:

- Hydrography
- Natural Risk Zones
- Transport Networks
- Geographical Names

The Hydrography Data Specification [INSPIRE Thematic Working Group Hydrography, 2009] aims at facilitating the interoperability of hydrographic information between EU member states. In this context,

hydrography describes sea, lakes, rivers and other waters, with their phenomena.

The spatial data theme Transport Networks [INSPIRE Thematic Working Group Transport Networks, 2009] is defined as: “Road, rail, air and water transport networks and related infrastructure. Includes links between different networks. (...)” [European Union, 2007, p.11]

The common data model was designed as an extension to the above mentioned INSPIRE Data Specifications, following the guidelines given in the INSPIRE Generic Conceptual Model document [Drafting Team Data Specifications, 2009]

2.3. The actors involved

In the ERiskA Scenario different actors are involved. These are:

(1) End users

The “*End Users*” are private persons, governmental organisations, action forces like police or fire brigade. These end users are characterized as having mostly time critical, concrete and task specific information needs, which are processed not directly by the system, but by an expert. The group of end users can be divided into two categories: “*End User Of Geodata*” (Dispatcher or decision maker) and “*End User Of Spatial Information*” (Press and further (environmental) agencies interested in the proceedings)

(2) Data integrator

The “*Data Integrator*” is responsible to collect and analyse relevant data and give derived information in different forms (verbal, reports, prepared maps) to different user groups (e.g. the “*End User*”). Data harmonisation efforts are on the “*Data Integrators*” side as well. Data are also harmonised to the same height reference.

(3) Data custodian

“*Data Custodians*” are for instance:

- Static, base data provider (land survey agencies, hydrological institutions of countries, ...)
- In-situ data provider (hydrological institutions of countries)
- Remote sensing data provider (aerial photo companies, satellite image provider, ...)

“*Data Custodians*” can also be people or institutions providing harmonised data and data adapted to given standards. The “*Data Custodian*” is in this case responsible for the creation of an information model, for the harmonisation of the available data (coming from different regions) and for the creation of web services for provision of data.

2.4. Selected Use case for the ERiskA demonstrator

The main use case for the demonstrator development, which is also presented in the training section, is “information exchange”. The following steps describe this use case:

- Exchange of information on potentially flooded areas and resulting inundation of infrastructure (roads, railway) between the command and control centre (“End User Of Geodata”) and end users (“End User Of Spatial Information”) of other agencies or the public is necessary.
- The “End User Of Spatial Information” requests information if roads or railways in his area of interest are inundated.
- The “End User Of Geodata” selects a gauge relevant for the area of interest and requests the current water level at this gauge. The ERiskA application consults the different gauge provider web services and loads the corresponding precalculated flooded area extent feature. This flood extent is overlaid and can be used for further analysis. The information on flooded infrastructure is delivered to the “End User Of Geodata” in a geographical map representation.
- The “End User Of Geodata” delivers the information either as a map or he calls the “End User Of Spatial Information”.

The existence of harmonised cross-border base data sets is a precondition for this use case. For a detailed description of the use cases please refer to deliverable A9.6-D2 ERiskA Demonstrator Draft release (document no. 1011)

2.5. The characteristics of the data used in ERiskA

The following information items are required for the ERiskA application:

- **Road**
(location and characteristics of roads; also used for intersection with flood areas)
- **Railway**
(location and characteristics of railways; also used for intersection with flood areas)
- **Watercourse and Standing Water**
(location and characteristics of watercourses & standing waters; also used for choosing relevant gauges)
- **Gauge**
(location and characteristics of gauges; also used for symbolising warning levels at gauge)
- **Flood Area**
(location, extent and characteristics of flooded areas derived from modelling, pre-calculated at certain intervals; also used for intersection with roads and railways to determine whether they are passable or not)
- **Water Level Measurement**
(current and forecasted water levels at a certain gauge provided by in-situ sensors; used for selecting the appropriate flood area extent feature corresponding to the current water level and for determination of current warning level)

The following data sources can be used as additional information in the ERiskA application for instance:

- **Discharge Measurement**
- **Warning Level**
- **Warning Level Classification**

- **Elevation**
- **Aerial Image**
- **Topographic Map**

For more information please refer to „Application Case 4: The ERiskA application: cross-border flood information“

2.6. The data harmonisation needs

The following data harmonisation requirements have been identified for ERiskA:

2.6.1. Data formats

The different countries/states in the ERiskA Scenario also use different GIS data formats like:

- ESRI Shapefile
- ESRI ARC/INFO-Coverage
- Geomedia Access (derived from pre-processed data)
- Geomedia Warehouses for provision of data

2.6.2. Spatial reference systems

All countries in the lake Constance region use different coordinate systems, dates and elevation levels:

- **Coordinate systems**
 - Baden-Württemberg (Germany): EPSG 31467
 - Bavaria (Germany): EPSG 31468
 - Vorarlberg (Austria): EPSG 31254
 - Switzerland: EPSG 21781
- **Datum**
 - Baden-Württemberg (Germany): DHDN / 3-degree Gauss-Krueger Zone 3
 - Bavaria (Germany): DHDN / 3-degree Gauss-Krueger Zone 4
 - Vorarlberg (Austria): MGI Ferro / Austria GK West
 - Switzerland: CH1903 / LV03
- **Different elevation levels and reference surfaces**
 - Germany: Normal-orthometrical height - Amsterdam (North sea)
 - Austria: Normal-orthometrical height - Triest (Adria, Mediterranean sea)
 - Switzerland: Normal-orthometrical height - Marseille (Mediterranean sea)

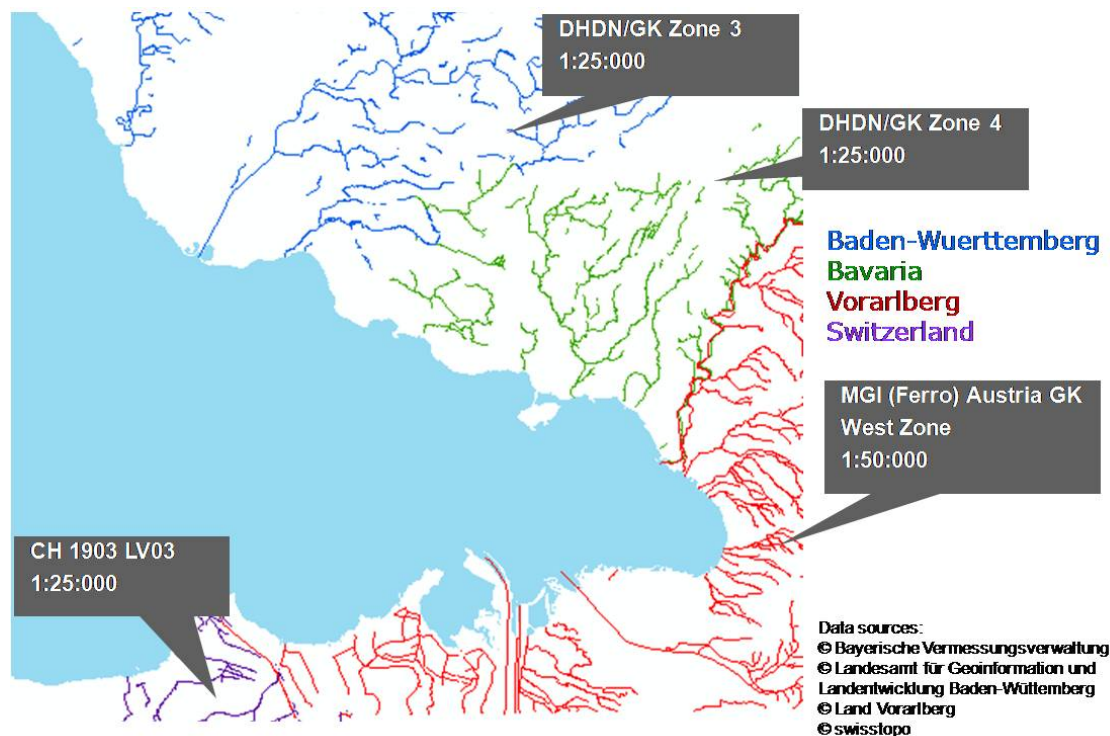


Figure 1: Different spatial reference systems and scales in the Lake Constance Region (river data)

2.6.3. Conceptual schemas (data models)

An important source of heterogeneities lies in the different data models or conceptual schemas of the data. To overcome these heterogeneities, a common data model has to be developed (see section 2.7) and mappings of the source data models to that target data model must be defined (see Figure 2). This mapping has to be formalised in a machine readable way, e.g. using the HUMBOLDT Alignment Editor (HALE). Based on this, the transformation of the source data into the target model can be executed, e.g. using the Conceptual Schema Translation Service (CST) of the HUMBOLDT Framework. For more information please refer to “*Application Case 1: Creating the ERiskA common data model*”, “*Application Case 2: Using the HUMBOLDT Alignment Editor (HALE) to define mappings between source data models and ERiskA common data model*” and “*Application Case 3: Creating an executing a data harmonisation workflow using the HUMBOLDT Framework*” of the ERiskA training material on the e-Learning Platform.

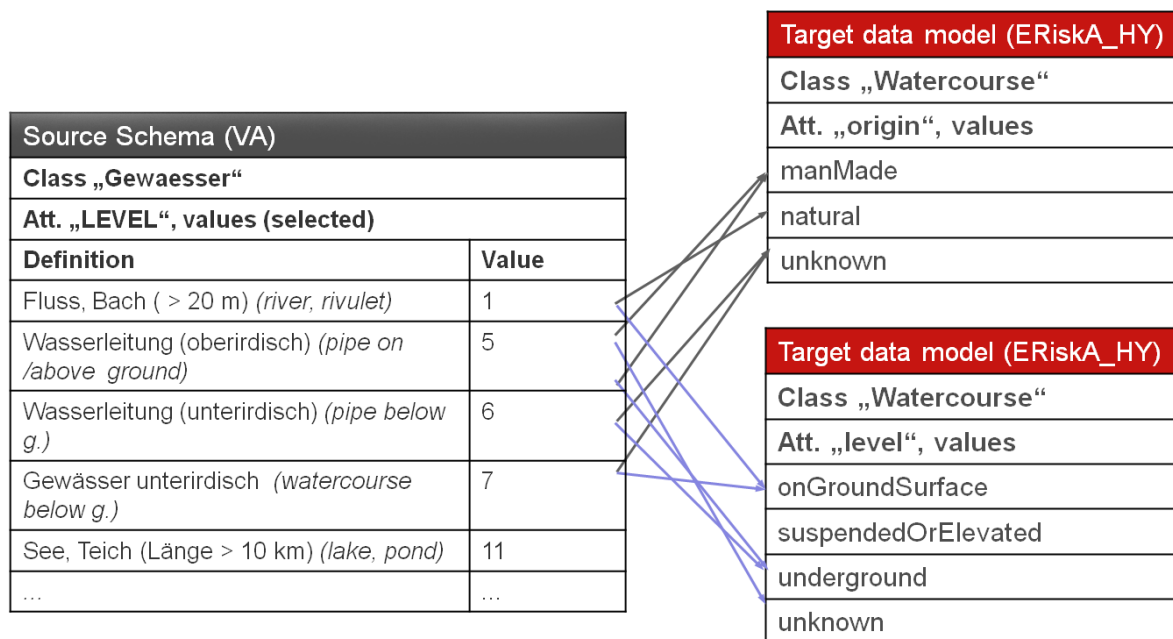


Figure 2: Example of mapping attribute values of source schema (Vorarlberg) to ERiskA target schema (based on INSPIRE data specification Hydrography)

2.6.4. Classification schemas (e.g. Warning Levels)

The classification schemas for flood warning levels differ considerably across the states / countries in the Lake Constance region:

(1) Baden-Württemberg: 4 levels based on models and 8 levels based on water levels

Catchment areas <200km²: For rivers with small catchment areas, a flood early warning system different than the usual level based flood early warning systems must be used due to insufficient accuracy of the meteorological precipitation forecasts, and the fast runoff-response of the catchment.

Through a combined use of meteorological and hydrological models, a flood warning map can be created that classifies the flood hazard for small basins in different warning levels [LUBW, 2010]:

- Level 1, no flood risk (<2-year flood)
- Level 2 medium flood risk (≥ 2-year flood)
- Level 3 high flood risk (≥ 10-year flood)
- Level 4 very high flood risk (≥ 50-year flood)

Catchment areas >200km²: The flood report service (Hochwassermeldedienst) is based on the water level measurements at gauges maintained by Baden-Württemberg, the Federal Republic of Germany, the state of Bavaria, the French Republic and on the reports of the German Weather Service (DWD) in Stuttgart.

The German Weather Service (DWD) reports unusually rapid snow departure and extraordinary rainfall that can cause flood hazards [UVM, 2004].

The warning levels for Catchment areas >200km² are classified in the following way [LUBW, 2010]:

- (red): latest water level measurement ≥ 100-year flood
- (pink): latest water level measurement ≥ 50-year flood
- (pink-yellow): latest water level measurement ≥ 20-year flood

- (yellow): latest water level measurement \geq 10-year flood
- (light green): latest water level measurement \geq 2-year flood
- (dark green): latest water level measurement $<$ 2-year flood
- (dark blue): latest water level measurement $<$ mean water
- (light/ dark blue): latest water level measurement $<$ low water

(2) Bavaria: 4 levels based on hazard potential

In Bavaria, four different levels according to a flood's hazard potential are distinguished. The warning levels do not depend on a specific gauge measurement value, but on the dimensions of the flood and the damage caused by it (see Figure 3) [LfU, 2010]:

- Level 1: Minor overflowing at some places.
- Level 2: Agricultural and forestry land flooded or light traffic obstruction on main roads.
- Level 3: Flooding of some built parcels or flooded basements, regional transport links closed or sporadically operations of water- or dam-maintenance-forces.
- Level 4: Large-scale flooding of built-up areas or operations of water or dam-maintenance-forces on a large scale required..

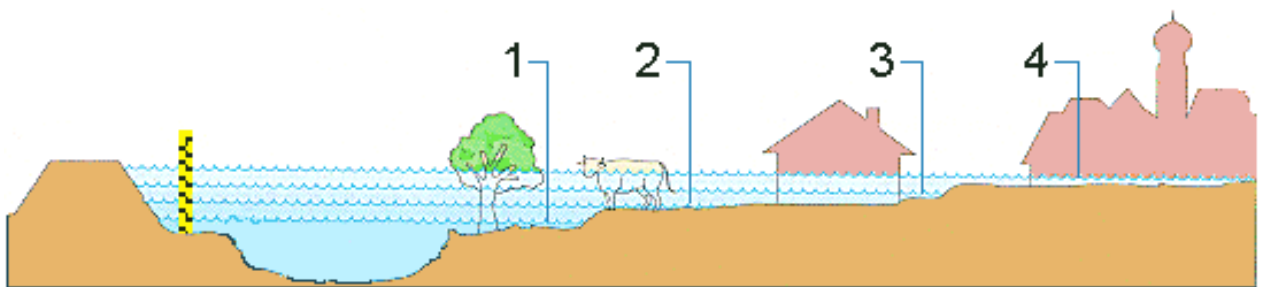


Figure 3: Four different warning levels in Bavaria [LfU 2010]

(3) Vorarlberg: 3 levels based on water level measurement at gauges

The Federal Water Engineering Administration offers hazard zone maps including the following information [BMLFUW, 2006]:

- Areas at risk from flooding in case of a discharge value reaching the 30-year probability of occurrence
- Areas at risk to be flooded in case of a discharge value reaching the 100-year probability of occurrence
- Area of risk that could be affected by exceeding of an flood design event (up to HQ300) or in case of a failure of a dam etc. (residual risk area).

(4) Switzerland: 7 levels based on percentage of long-standing monthly average discharge

Maximum runoff of the last 24 hours compared with estimates of extreme values [BAFU, 2010]:

- Level 1: black: $<$ HQ2
- Level 2: dark blue: HQ2 – HQ5
- Level 3: light blue: HQ5 – HQ10
- Level 4: green: HQ10 – HQ20
- Level 5: yellow: HQ20 – HQ50

- Level 6: orange: HQ50 – HQ100
- Level 7: red: > HQ100

These different classifications show the challenge of harmonisation across borders. Due to the different foundations of each methodology, harmonisation could not be fully achieved in this scenario. Further research is needed here.

2.6.5. Terminology

Although the countries around the Lake Constance share the same language, terminology used e.g. for the hydrology / flood / warning level information items differs considerably amongst the regions in the test area.

2.6.6. Metadata profiles

At the time of writing this document metadata in a standardised way only exist for parts of Swiss and Austrian base datasets (transport networks and watercourses). Metadata elements needed for the ERiskA application were investigated and published via a Catalogue service in the INSPIRE Metadata format.

2.6.7. Scale / resolution

As shown in Figure 1 different scales are used across the countries/states, e.g. for watercourses data:

- 1:25.000 (Germany, Switzerland)
- 1:50.000 (Austria)

2.6.8. Spatial consistency of data

As shown in figure 4, geometrical inconsistency exists in semantically equal objects across-borders. The reasons are different spatial reference systems as well as different scales at which the data was captured or according to which the data was generalised.

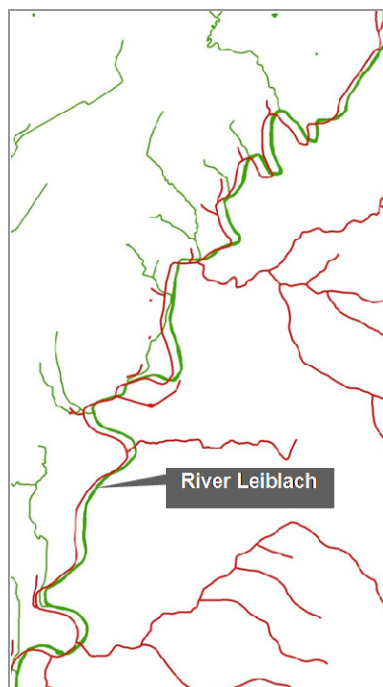


Figure 4: Spatial inconsistency in the watercourse dataset in the test area

2.7. The scenario data modelling work

The first phase in data modelling work was to identify information items necessary for the ERiskA use cases as well as analysing and documenting available datasets. Based on this thorough information analysis the ERiskA common data model was created based on INSPIRE Data Specifications. This was done following the guidelines for extensions to INSPIRE application schemas given in the INSPIRE Generic Conceptual Model document [Drafting Team Data Specifications, 2009, Fichtinger et al., 2010]. The data models were designed using UML and GML application schemas were derived from the UML model. Figure 5 contains a subset from the UML data model created for the HUMBOLDT ERiskA Scenario. It illustrates, how feature types of the INSPIRE application schemas “Hydrography – Physical Waters” and “Natural Risk Zones” were re-used for the ERiskA feature types Gauge and FloodArea. The data modelling work is described in detail in “Application Case 1: Creating the ERiskA common data model” of the ERiskA training material on the e-Learning Platform.

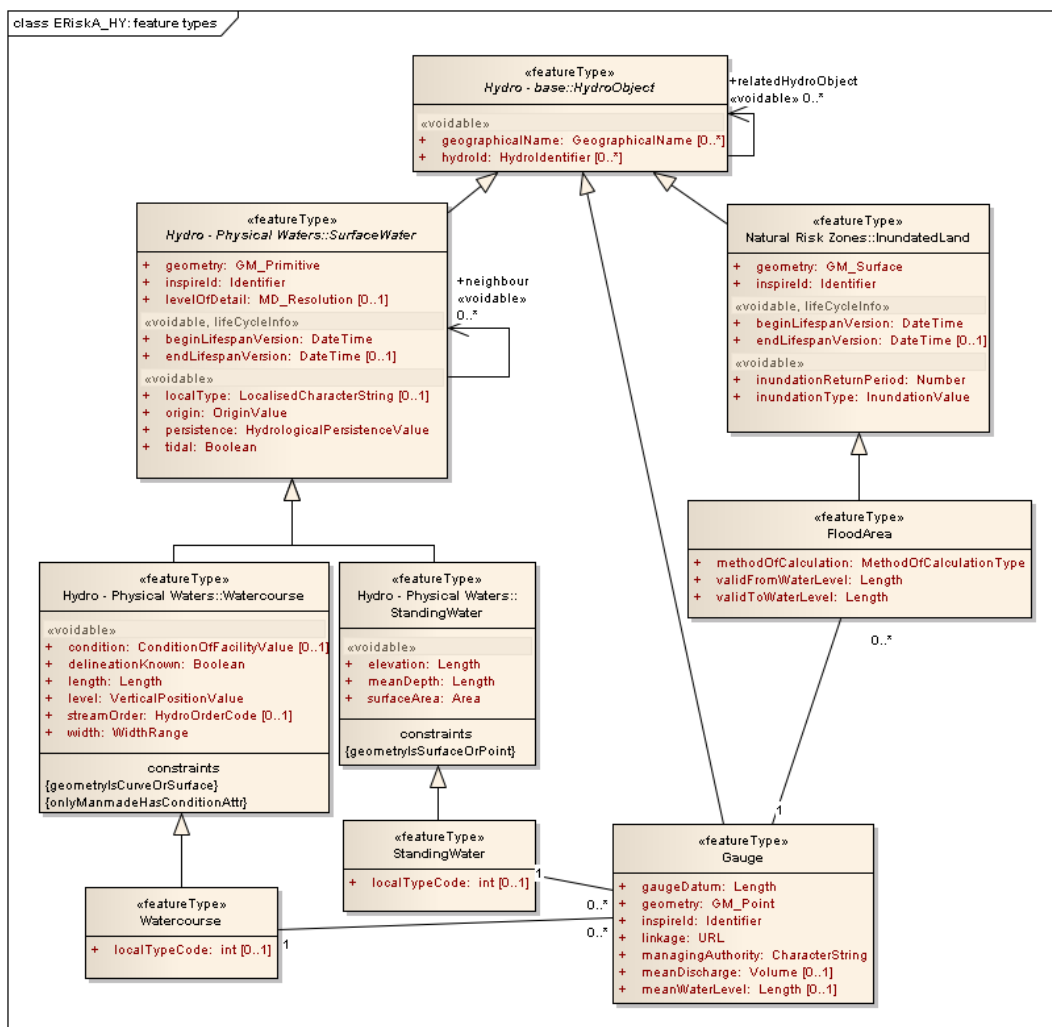
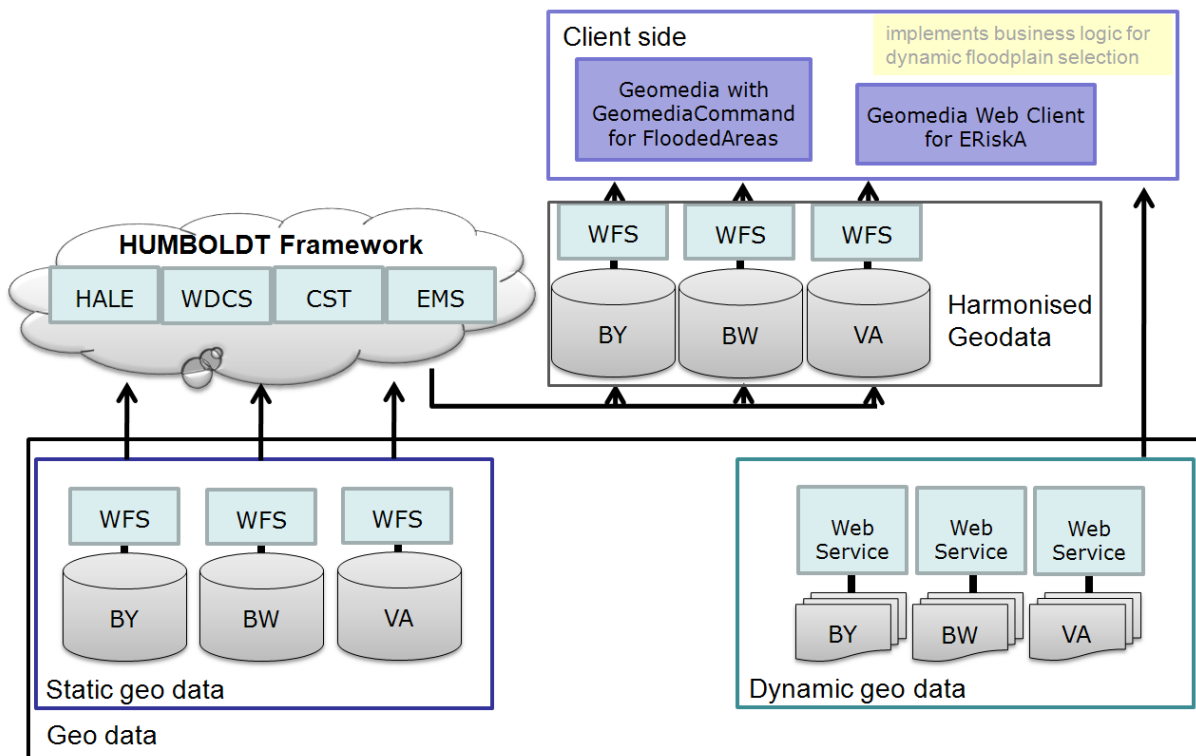


Figure 5: Subset of the ERiskA common data model

3 System Architecture



Focusing on the client – the most visible part of the ERiskA demonstrator – two development paths targeted at different user groups were chosen:

(1) The desktop-based solution

The desktop-based solution uses Intergraph Geomeia as GIS platform to provide commands for accessing the harmonised data by requesting the WFS interface of the mediator service or the pre-harmonised datasets for each country/state in a WFS as well as commands for executing the ERiskA business logic. Two additional commands were developed by Intergraph that can easily be installed along with Geomeia Professional. The advantage is the full GIS functionality of Geomeia that can be used for further analysis after the user has requested the flood extent by selecting the gauge of interest. Overlay and intersection with other data sources like topographic maps, aerial images and other WMS and WFS is possible in this way. This version is intended for professional users at command and control centres.

(2) The web-based simplified solution

The web solution of ERiskA aims at users who want quick information about gauge water level values and flood extents that can occur at this water level. This user is not necessarily interested in further analysis using additional data sources or advanced GIS processes. The harmonised data sources available to the users in the web client were previously selected and set up by an administrator.

For further information on the ERiskA Demonstrator please refer to "Application Case 4: The ERiskA application: cross-border flood information" of the ERiskA training material on the e-Learning Platform.

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