BORIS

Cross **BO**rder **RIS**k assessment for increased prevention and preparedness in Europe

D3.1

Architecture of the Platform

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1. INTRODUCTION

This deliverable deals with the specifications related to the website and the WebGIS platform to be developed in the BORIS project considering updated data from previous work packages. The web-based approach was chosen to integrate the ease of use and accessibility of a web browser and the capabilities of geographic databases.

In this period the IT industry dedicated to the publication and the processing of geographic data (Geographic Information Systems, GIS) is in great expansion for what concerns both the production instruments and the publication of geographic information, especially via Internet (WebGIS). All that is possible thanks to the dissemination of instruments that can provide maps in an easy and cheap way, such as Google Maps or map data from Open Street Map.

For this reason, nowadays, the availability of tools and software solutions is particularly high, both on the side of traders and on the side of research institutions and open source development communities. In spite of that, it is important to underline that not all available products are at the right level of required technique and/or they can represent a suitable platform of development for geographic services.

It has been necessary to carry out a study activity and a selection of the IT offer concerning the GIS systems by paying particular attention to the tools developed for the use of geographic information in the web and on their publishing. Specifically, the latter should be performed according to standards that are not tied to a particular software platforms (Web Services) in order to ensure the widest availability and integration of geographic data.

In Section 2 we outline available system architectures and the one we have selected for the BORIS project. In Section 3 the software components are listed and in Section 4 a brief description of selected data exchange format is given, with best practices for the exchange of information among project partners. Section 5 is dedicated to end-user requirements.

2. PRELIMINARY RESEARCH

2.1. Research on GIS architecture

A study on the state of the art of GIS architecture and up-to date GIS has been carried out and an architectural model has been identified as a reference for the future development of the system.
The architectural adopted model is an evolution of WebGIS, known as "Spatial Data Infrastructure" (SDI). The system that EUCENTRE will develop will represent a node of it. EUCENTRE is the leader of the work package 3 and is responsible for the software development in coordination with the needs of other partners in the work package.
The main components that belong to this architecture have been identified and they are: (i) Geo Database (GD), (ii) Web Services Standards (WSS), (iii) Web Map Viewers (WMV), and (iv) Map Desktop Clients (MDC).
The system architecture provides the virtualization of computing machines that make up the system (i.e., frontend server, database server, map server, computing server).
The entire system will be provided by a VMware virtual architecture, which is set up to scale transparently, both horizontally (by adding more servers in the cluster of VMware machines) and vertically (by increasing the endowment of the available physical machines).
In addition, the partitioning of the various tasks of the system among different virtual machines allows to act precisely on each single component that could reveal itself as a bottleneck in terms of resource consumption or calculation times in the future production use.

2.2. Identification of geographic standards for data exchange

The geographic information contained in the various geographic databases will become GIS products.
We identified and adopted standards proposed by the "Open Geospatial Consortium" (OGC): the latter deals with the development and the dissemination of international standards for the publication of geographic information and geolocation services. The adopted standards for the platform are listed in Table 2.1.

Table 2.1 Adopted standards

Shortcut	Name
WFS	Web Feature Service
WMS	Web Map Service
WCS	Web Coverage Service
GML	Geographic Markup Language
CSW-ebRIM	Catalogue Service
SF/SQL	Catalogue Service

2.3. Study of libraries for Graphical User Interface (GUI) WebGIS

An important aspect of the WebGIS architecture is represented by the user interface, which is built inside a web browser and can be used by end-users.
Such task has involved a study for the identification and evaluation of java-script libraries and of GIS frameworks, which are useful to build dynamic HTML pages to be able to offer the ability to view, query, and manipulate geographic data.
The usable libraries have been two: Openlayers and JQuery, whose characteristics are summarized in Table 2.2.

Table 2.2 Adopted libraries

Library	Technical Characteristics	Notes
Openlayers[2]	opensource javascript library	It is widespread for the presentation of maps and geographic layers inside HTML pages while it is less suitable to build interfaces to manipulate.
JQuery[3]	opensource javascript library	General-purpose utility library for the management of DOM objects

2.4. Study of the format for updating geographic data

We performed research to identify the mechanisms and the available formats for implementing a feature to change notifications or update geographic data.
We identified two formats of data exchange. They are widespread in geographical context and they have a growing support from different programming languages and popular WebGIS frameworks.
These two formats will be implemented in the BORIS geographical portal and they are listed in Table 2.3.

Table 2.3 Data update formats

Format	Technical Characteristics	Notes
GeoRSS	XML specification that allows to provide geographic data expressed in standard GML, such as RSS feeds.	It is a good way to notify geographic data through the architecture of RSS feeds. It is widespread and used by both browser and automated interfaces.
GeoJSON	Format to encode the different geographic entities through textual data structures.	It is a format that derives from JavaScript. For this reason, it is easily integrated in graphical interfaces that use JavaScript (e.g., Openlayers).

3. SOFTWARE COMPONENTS

In the following we list the software components of the WebGIS platform that will be implemented in BORIS:

- Web Server: Apache HTTPS;
- Geographic Database: PostgreSQL with POSTGIS extension;
- Application Server: Apache Tomcat;
- Map Server: Geoserver;
- Development languages - server side: Java;

Languages - client side: Javascript, Openlayers, JQuery.
The Geoserver component will be used to display projected raster layers and vector layers that are too heavy to be rendered client-side, while all other layers will be managed with a direct communication between client-side OpenLayers library and Postgres database using the GeoJSON format, through dedicated functions developed in Java.

4. DATA EXCHANGE FORMATS

The data to be represented on the platform will be provided through the standard file formats currently used by geographic computer systems:

- CSV files for structured data
- Shapefile files for vector type geometry data
- GeoTIFF files for raster data

All the geographic information should be provided in Pseudo-Mercator (EPSG:3857) SRID; alternatively, the used SRID should be communicated together with the data allowing correct reprojection.

Text files should use UTF-8 encoding to avoid problems with different encoding representations.

5. END-USER REQUIREMENTS

BORIS stakeholders are national and local civil protection units as well as local administrations. It is a well-known fact that (end)-user requirements need to be considered already in the early stage of projects to ensure that web-applications are used by practitioners and to guarantee the sustainability of the developed web-platform after the end of projects. To tackle end-user needs and interests in the BORIS project, requirements have been collected in two steps: First, the project partners defined the potential end-users for each country and identified some user requirements (see table 5.1 and 5.2 below). The identified topics were then clustered i.e., summarized and structured according to themes and contents and connected to the proposed tabs and tools of the Web-platform:

1. Tools to preform operation of the maps
2. Building information
3. Population information
4. Infrastructure Information
5. Cross-border harmonization - visualisation of risk / impact
6. Cross-border harmonization - visualisation of hazards

In a second step, a 15-question interview guide (table 5.3) was developed to contact 21 experts from five countries (see table 5.4 for more details) were interviewed. The process of collecting user requirements allows to identify and refine the functionalities of the tools to be designed and implemented in the platform. The advantages to have information on risk made available with a user-friendly tool will facilitate mutual understanding and communication between stakeholders in confining countries and in addition to civil protection units, also first responders could benefit from the availability of the platform.

5.1 Potential end-users and user requirements defined by the project partners

Table 5.1: Identification of potential end-users in all countries and on different levels (national, regional, local)

End-user	Country	Category	Level of responsibility
Federal Ministry of Agriculture, Regions and Tourism	Austria	Government	National
Federal Ministry of the Interior (BMI) (Austrian Crisis and Disaster Management - SKKM)	Austria	Civil Protection Authority	National
Federal state Civil Protection department	Austria	Civil Protection Authority, Federal State government	Federal state /Regional
Municipalities in the case study regions	Austria	Local government	Local

Uprava Republike Slovenije za zaščito in reševanje	Slovenia	Civil Protection Authority	National
Municipalities in the case study regions (ten or more)	Slovenia	Local government	Local
Ministrstvo za okolje in prostor	Slovenia	Government	National
Friuli Venezia-Giulia civil protection	Italy	Civil Protection Authority	Regional
Regione Autonoma Friuli Venezia-Giulia	Italy	Regional Government	Regional
Italian department of civil protection	Italy	Civil Protection Authority	National
Direktorat za zaštitu i spašavanje Ministarstvo unutrašnjih poslova Crne Gore (Rescue and Protection Directorate Ministry of Interior of Montenegro)	Montenegro	Civil Protection Authority	National
Civil protection and rescue services of Municipalities in Montenegro	Montenegro	Local government	Local
Ministarstvo ekologije, prostornog planiranja i urbanizma (Ministry of Ecology, Spatial Planning and Urbanism)	Montenegro	Government	National
Ministarstvo poljoprivrede, šumarstva i vodoprivrede (Ministry of Agriculture, Forestry and Water Management)	Montenegro	Government	National
Ministry of Interior/Disaster and Emergency Management Authority (AFAD)	Turkey	Civil Protection Authority	National
Ministry of Agriculture and Forestry/General Directorate of Water Management	Turkey	Government	National
Ministry of Agriculture and Forestry/ General Directorate of Water Affairs	Turkey	Government	National
Provincial AFAD Directorates	Turkey	Local government	Local

Table 5.2: Collection of potential end-user requirements (project partners) to identified topics that can be clustered

Requirement	Details	Sub-categories
Printed Reports/Maps		Tools for operating the map
Online Help		Tools for operating the map
Limited Access/Password Protection		Tools for operating the map
Zoom in/zoom out		Tools for operating the map
Features selection from map		Tools for operating the map
Possibility to choose the administrative or geographic limit for results visualization (e.g. municipality, province, circular or square area around a point…)		Tools for operating the map
Number of temporarily/permanently unusable buildings		Building information
Number of damaged buildings of cultural heritage		Building information
Number of affected buildings in the area		Building information
Number of damaged buildings		Building information
Number of affected people in the area		Population information
Number of people requiring temporary shelter		Population information
Number of people requiring medical aid		Population information
Number of fatalities, number of outpatients, number of slightly injured people, number of severely injured people		Population information
Number of people requiring rescue from collapsed buildings		Population information
Downtime for water supply and people affected	Estimated number of days and people without regular water supply in affected area	Supply /Infrastructure information

Downtime for electricity supply and people affected	Estimated number of days and people without electricity supply in affected area	Supply /Infrastructure information
Downtime for public transport systems and infrastructure	Estimated number of days and people without public transport systems and infrastructure in affected area	Supply /Infrastructure information
Length of damaged main roads	Length in km of damaged main roads and existance of alternative roads for first response	Supply /Infrastructure information
Damaged critical infrastructures such as schools, hospitals and connection/roadway infrastructures, Industrial and commercial facilities		Supply /Infrastructure information
Possibility to calculate total results for a selected area (e.g. total losses, or number of damaged buildings, in area selected from map); for each single risk and for multi-risk		Visualisation of risk / impact
Harmonized Visualization of fragility curves		Visualisation of risk / impact
Harmonized Visualization of soil maps		Visualisation of risk / impact
Harmonized Visualization of damage maps: map of economic losses, map of homeless people, map of injured people, map of fatalities		Visualisation of risk / impact
Harmonized vizualisation of consequence/impact maps		Visualisation of risk / impact

Selection of single risk or multi-risk (seismic+flood) results visualization		Visualization of hazard information
Harmonized Vizualisation of Hazard maps		Visualization of hazard information
Possibility to view simultaneously (for comparison purposes) different damage maps according to different risks calculated with same criterion (e.g. same return period or same time frame)		Visualization of hazard / impact visualization
Possibility to combine risks (sum??) and plot superimposed maps - same criterion for calculation (e.g. same return period or same time frame)		Visualization

5.2 Results of survey on end-user requirements

The survey asked about individuals' experiences with cross-border flood and earthquake events and about their requirements towards a cross-border and multi risk web platform. The section below provides mainly the results of question 8-15, that focused on user requirements for a new Web-Tool that visualises cross-border flood and earthquake risks. The methodological approach chosen was descriptive, inspired by Mayring (2000) as the survey used open-ended questions, as they allow to gain very specific insight from experts in a particular field. The answers to each question were grouped into certain sub-categories to than summarize and in some cases underline by citations.

The results of the different surveys are depicted along the following identified clusters (1) Cross-border harmonization – visualisation of risk and impact, (2) Cross-border harmonization – visualisation of hazard, (3) Building Information, (4) Population Information, (5) Tools, tabs and features to operate the platform

Cross-border harmonization – visualisation of risk and impact

Impact scenarios, that show in detail the affected assets (buildings, people, infrastructure), are considered important by most of the experts to be able to compare the risk for flood and earthquake in terms of costs and human victims to allow strategic choices for a region. For the emergency phase, information is required to understand where help is needed and how to plan the routes. The respondents point out that the data must always be kept up to date to be usable. In some regions, there are already so-called lamella analyses for floods, which can be used to map a large number of scenarios. This further can increase the understanding for possible disaster szenarios and facilitates the implementation of planning with the emergency services.

Risk maps with simple coloured representation of areas with high, low, no risk were mentioned as information’s source that helps to optimize prevention and preparedness especially in cross border areas - *“It would certainly be useful to know where we should not locate our equipment, i.e., in which places the effects of earthquakes are particularly strong – building by building”*.

However, experience from past projects indicate that beside "technical data", also demographic, social, socio-economic data is necessary to plan on the local level. *"If I have to draw up an emergency plan: I also need to information about hospital beds, about the economy of the community to understand the best strategies. Knowing that a community is more industrialized … makes the response organize differently. This can help for more effective emergency planning."* In particular, the short-term impact assessments are of importance in the cross-border regions because coordinated interventions are required.

The answers to the question on additional data about risk and vulnerability underlines that further knowledge and understanding for potential damage and vulnerable assets is needed, *"In the case of floods, we have the HQ lines in advance, we know how it spreads, but we don't know where the greatest damage will occur, perhaps also in terms of economic damage. If we would have a map or analysis to guide us as to where the emergency teams need to go first, that would probably be helpful..."* Furthermore, some experts mentioned the need of fragility curves and (social) vulnerability classes for more accurate planning processes.

Cross-border harmonization – visualisation of hazard

"Maps that show for example where we need to go first, where the greatest damage is likely to occur, then that would be useful for planning and disaster response." Maps that show the exposure of buildings, strategic buildings and infrastructure, emergency areas with details on short- and long-term effects, (fatalities, injuries, homeless, economic damage), direct and indirect costs were highlighted by several experts as useful for their planning. However, it was pointed out that there are already existing maps, but that then facilitating data sharing cross-border must be the primary goal. Further interrogable risk and scenario maps e.g., for return period 475 years what is the risk in economic terms and common exposure maps between the two risks would provide new insights into the local situation.

Building Information

Half of the experts pointed out the importance of detailed information about the construction type of buildings (structural typology), the year of construction and also the number of floors. This information would be fundamental to locate vulnerable and resistant buildings to for example decide where to store emergency equipment. Further such information would make it possible to estimate damage, the amount of people at risk to better plan what kind of emergency teams need to be mobilized. To estimate the possibilities of evacuation the number of floors and the type of use (residential, commercial) is useful. Several interviewees pointed out the importance of an inventory including the location of critical infrastructure and essential supplies as for example strategic buildings.

Population Information

In addition to data about number of people living in an area (census data), particularly data on age distribution was mentioned as useful for emergency planning and in case of an event. To meet the needs of people in exposed areas more details about the gender distribution, number of disabled people and number of children are useful.

Tools, tabs and features to operate the platform

Tools to zoom to a specific area and features to pan, drop-down, as also the possibility to query a point or export data in different formats are mentioned as necessary. According to the experts these features can be refined by:

- a list to choose, the country of interest (one or more), the time range of interest, single risk or multi-risk,
- possibility to easily load webservice and information from Copernicus,
- address inquiry and coordinate information.

One respondent suggested that slider tools can be added to set the data range values dynamically and concluded that visualization tools such as histograms, bar charts, pie charts etc. might be helpful in terms of interpretation. The possibility to overlay or different hazards and the visualisation of multi hazards for one region seemed for all experts quite new. One expert stated that it *"would be handy to have a tab containing data on historic floods…"*. Layers showing the results differentiated by type of risk (flood, earthquake, multi-hazard) and component (hazard, vulnerability, exposure) were mentioned by a range of survey participants. To sum up they were all interested in the visualisation of exposed people, exposed buildings, exposed infrastructure exposed important suppliers.

To conclude, the experts were all interested in the visualisation of exposed people, exposed buildings, exposed infrastructure and key suppliers, with pointing out the importance of keeping the data easy to understand and up-to-date. Few had yet experienced the mapping of multi-risk information.

Table 5.3: Development of 15 questions to contact end-users about their requirements (survey guideline)

ID	Question
1	What were your first thoughts when you learned about our project, what do you think this project could bring to your daily work?
2	Have you ever dealt with natural hazard events that had a transboundary impact?
3	If yes, could you give a short recap what went well and what have could been better?
4	Can you provide examples where hazard and risk information across national borders would be useful?
5	Are you aware of any projects, initiatives, or meetings for cross-border risk coordination?
6	Can you provide examples where multi risk information would be useful?
7	What kind of data / information / Web Tools about flood and earthquake risk do you use currently within your planning process?
8	What information's on flood risks - especially in cross border areas - are necessary to optimize prevention and preparedness?
9	What information's on earthquakes - especially in cross border areas - are necessary to optimize prevention and preparedness?
10	What maps would you need?
11	What tools to perform operations of the map (Zoom, pan,…) would you like to have in a hazard and risk Web-Tool?

12	What Tabs that give access to layers and tools for querying the database would like to have in a hazard and risk Web-Tool?
13	What additional data/information on risk and vulnerability would you need?
14	What additional information about the population is useful?
15	What kind of information about buildings and infrastructure is useful?

Table 5.4: Participants distribution of end-user survey

Country	Number of survey		m/f
Austria	4	• Department of the Provincial Government of Styria A14 Protective Water Management & Unit Member of the permanent River Mur commission AUT/SLO • Government of Styria Department 14, Hydrography and Flood Forecasting Unit • Federal civil protection union of Styria, emergency and disasters • Provincial fire brigade superintendent (Styria)	2/2
Italy	3	• Italian Department of Civil Protection, seismic prevention, coordination and monitoring of interventions • responsible of the civil protection office by the Municipality of Gorizia • Italian Department of Civil Protection	1/2
Slovenia	2	• Ministry of Environment and Spatial Planning of the Republic of Slovenia • Slovenian Water Agency	1/1
Montenegro	6	• Head of the Department for Civil Protection and Disaster Risk Reduction, Rescue and Protection Directorate • Advisor II of division on disaster risk reduction • Independent advisor in Rescue and Protection Directorate • Director of National water administration of Montenegro • Head of Hydrological Analyses Department • Head of Department for Water Management	1/5
Turkey	6	• Head of Earthquake Department of AFAD • Geological Engineer /GIS expert • Civil Engineer- Provincial AFAD Directorate in Turkey/ Iran Border • Deputy manager of Planning and Risk Mitigation Section / Lack of awareness of citizens and the lack of sensitivity of institutions and organizations.	6/0
All	21		11/10

6. LIST OF REFERENCES

Open Geospatial Consortium - https://www.ogc.org/

OpenLayers library - https://openlayers.org/

JQuery library - https://jquery.com/

PostgreSQL database - https://www.postgresql.org/

Apache Tomcat application server - http://tomcat.apache.org/

Geoserver - http://geoserver.org/

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