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Review of a national flood risk assessment as a basis for developing a methodology for selected cross-border areas – BORIS project

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Abstract

The main aim of the project BORIS (Cross-border risk assessment for increased prevention and preparedness in Europe) is to improve preparedness and prevention in cross-border areas by developing and applying a harmonised methodology and tools for both seismic and flood risk assessment for the selected cross-border areas. Five project partners from five countries, namely, Italy, Slovenia, Austria, Montenegro, and Turkey are working on the project co-funded by European Union Civil Protection Mechanism. One of the most important project tasks that will lay the foundations for the development of the methodology is the review of national methodologies of risk assessment. Here, the focus will be on the flood risk assessment. Project partners provided the detailed description of flood risk assessment methodology in their county. More specifically, for each country, flood hazard, vulnerability, exposure elements, and impact indicators were analysed. It was found that the flood hazard assessment methodologies are in compliance with the EU Floods Directive implementation. Further, incorporation of the flood risk assessment methodology in the Union Civil Protection Mechanism was investigated. Last but not least, information on existing flood risk assessment tools was provided for each country. It was found that flood risk assessment methodologies vary from one country to another which will make the flood risk assessment in cross-border areas a demanding task.

Keywords: Flood risk assessment; BORIS project; Cross-border areas; Vulnerability; Exposure

1. INTRODUCTION

Eastern Alps including the area on the border between Italy, Slovenia, and Austria as well as the areas of South-East Europe have been subject to both earthquakes and floods in the past (e.g., Chorynski et al., 2012; Giardini et al., 2014). In these areas, the risk of floods and earthquakes may also increase due to the absence or lack of a common cross-border framework for prevention and preparedness in terms of impact of those hazards. This, in turn, points to the need to establish a harmonized cross-border methodology for flood and seismic risk assessment.

One such attempt addressing the development of a harmonized methodology and tools for seismic and flood risk assessment to improve both disaster preparedness and prevention in cross-border areas is project BORIS standing for “Cross-border risk assessment for increased prevention and preparedness in Europe”. The project is sponsored by Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO) and consists of six main work packages. Work packages are covering project management, analysis of the context and needs assessment, development of a platform for cross-border risk assessment, establishment of a shared methodology for multi-risk assessment, testing in cross-border sites, and dissemination and exploitation of the project results. Five project partners from Italy, Slovenia, Austria, Montenegro, and Turkey are actively involved in the project. Although in the scope of the project the methodology for both flood and seismic risk assessment will be developed, in this contribution only reviews of the national flood risk assessments are presented. Reviews of national flood (and seismic) risk assessment are needed as a basis for development of the cross-border methodology.

This paper summarizes the most important information from the five partner countries on the flood hazard, exposure, vulnerability and the related availability and access limitation for the data needed to develop a common methodology. Moreover, the main findings that will be used for the development of a common methodology are presented. Presented results were part of the BORIS project work package 2 on analysis of the context and needs assessment that was led by the Slovenian partner, University of Ljubljana, Faculty of Civil and Geodetic Engineering. More detailed information obtained as part of the analysis of national methodologies and data for flood risk assessment can be found in the project reports (Kern et al., 2021; Wernhart et al., 2021) published on the project website (https://www.borisproject.eu/).

2. REVIEW OF AVAILABLE DATA AND NATIONAL METHODOLOGIES FOR FLOOD RISK ASSESSMENT

One of the tasks of Work package 2 of the BORIS project was to review both the available data in each country involved in the project as well as their national methodology for flood risk assessment. According to the general definition of flood risk (Kron, 2005), which defines the main components of risk, i.e. hazard, vulnerability, and exposure, the review was divided into two parts, namely review of national flood hazard assessment and flood vulnerability and exposure review (Kern et al., 2021; Wernhart et al., 2021).

2.1 Flood hazard assessment

In Slovenia, Italy, and Austria, the flood risk assessment is based on the Floods Directive (2007/60/EC). However, Turkey and Montenegro as non-EU member states, have to a certain degree transposed the Floods Directive into national legislation, meaning also the start of activities for flood risk assessment. All project partners reviewed and reported the flood hazard assessment for the country they come from. Although the review was extensive, in this paper only some of the most important components of each national methodology for flood hazard assessment are summarized (Table 1).

One can notice that methodologies in all countries are based on a probabilistic approach. However, sets of return periods considered for determination of hazard classes vary from country to country with only one common return period, i.e. 100 years. There are also differences related to the number of hazard classes and their criteria used for defining the classes. Specifically, in Slovenia and Turkey, four hazard classes are defined, while in Italy, Austria, and Montenegro there are three hazard classes. Maps showing the spatial extent of flood hazard areas are publicly available on the websites of the competent national/regional organizations. The spatial scale of the flood hazard maps also varies between countries. Scale 1:5,000 is preferably used in Slovenia, Turkey, and Montenegro, while in Austria and Italy flood hazard are published mostly in scale 1:25,000. The country-specific methodologies are described in more detail in Kern et al. (2021) and Wernhart et al. (2021).

Table 1. Basic information for flood hazard assessment at national level in five countries involved in the BORIS project

Country	Intensity parameter	Return periods	Scenario considered	Spatial scale	Data type	Projection	Source of each data layer
Slovenia	discharge (Q), water level (G), water velocity (v), product of water velocity and water depth (where v > 1 m/s at Q100)	10 years, 100 years, 500 years	Four hazard classes: low, medium, high, other	Flood hazard maps in 1:1000 or 1: 5,000 scale (preferred)	vector SHP	EPSG: 3794 or 3912	Ministry of the Environment and Spatial Planning
Italy	water level (m), water velocity (m/s)	30 years, 100 years, 300	three hazard classes: low, medium, high	Flood hazard maps 1:25,000	vector SHP	EPSG: 3035	Ministry of Environment - Hydrological Districts (Unit of Management)

		years					
Austria	water level (m), flow velocity (m/s), flood extension, product of water velocity and water depth	30 years, 100 years, 300 years	high (30 years), medium (100 years), low (300 years = extreme event)	Flood hazard maps in 1:25,000, in some cases 1: 5,000 or more detailed	vector SHP	EPSG: 3035	Ministry of Agriculture, Regions and Tourism (BMLRT)
Turkey	discharge (Q), water level (m), water velocity (m/s), product of water velocity and water depth	5 years, 10 years, 50 years, 100 years, 500 years	four classes: very high, high, medium, low	Flood hazard maps in 1: 1,000 scale (preferred) or 1:5,000	vector, raster	ITRF96 TM 3	Ministry of Environment and Urban, General Directorate of Meteorology, Directorate of Water Affairs
Montenegro	discharge (Q), water level (m), water velocity (m/s)	10 years, 100 years, 500 years	Three hazard classes: high (10 years), medium (100 years), low (500 years)	Flood hazard maps in 1:5,000 scale or larger scale	Digital and analogue	EPSG:3857	Water administration, Institute of hydrometeorology and seismology, Ministry of agriculture, Forestry and Water management, Ministry of the Interior

2.2 Flood vulnerability and exposure

Related to the review of flood vulnerability and exposure, project partners provided information about vulnerability classes, impact indicators, exposure elements, data layers and data types used in the assessment, spatial scales, sources of data layers, and legal framework and/or restrictions of data accessibility and data use. Here, we gathered only the most essential information needed to develop a common and shared methodology in cross-border areas (Table 2).

Analysis of shared information by five countries revealed that vulnerability and exposure elements are similar resulting from a common basis for national flood risk assessment, i.e. Floods Directive. Floods Directive requires assessment of flood risk in terms of impacts on human health, environment, cultural heritage, and economic activities. Still, there are differences between countries in how flood risk classes are determined. For example, in Slovenia, flood risk assessment is made based on the classification of damage potential according to the exposure of damage elements in the flood hazard areas. In Italy, in current methodology, risk is expressed in relative terms with a number between zero and one. More specifically, zero represents case with no risk, while one means the maximum vulnerability of the exposed element.

For the analysed countries, the impact indicators can be grouped into four to eight categories (Table 2). For Slovenia, Italy, Austria, and Turkey, the categories of people's health, economic activities, cultural heritage, and environment are common. In Slovenia, there are two additional categories, namely social infrastructure and infrastructure. Social infrastructure represents an additional category also in Turkey. On the other side, Montenegro that is still at an early stage of Floods Directive's implementation, has defined four classes related to the people's health, while the other four classes are economy, environment, cultural heritage, and disruption of everyday life.

The review revealed also differences between countries in terms of the spatial resolution of flood risk. For example, in Slovenia, for the flood risk raster matrix with a spatial resolution of 75x75 m is used, whereas in Austria the spatial resolution is 125x125 m.

***Table 2**. Basic information about f*lood vulnerability *and* exposure assessment data *for five countries involved in the BORIS project*

Country	Vulnerability classes	Impact indicators	Exposure elements

Slovenia	very low, low, medium, high (continuous/discretized scale adapted by using different weights for impact indicators)	1) People's health, 2) Social infrastructure, 3) Cultural heritage, 4) Environment, 5) Economic activities, 6) Infrastructure	1) People health: location and number of exposed people; 2) Social infrastructure: hospitals, schools, firefighters, civil protection facilities etc.; 3) Cultural heritage (state/local importance, museums, archives, libraries etc.); 4) Environment (large-scale pollution facilities: IED, SEVESO and IPPC directive, industrial and municipal landfill areas, wastewater treatment plants etc.); areas under environmental or other protection status: NATURA 2000, water protection areas); 5) Economic activities: type, number and characteristics of economic and non-economic activities; 6) Infrastructure: municipal infrastructure (roads, railways, water supply systems, sewage systems, electric power systems, gas pipelines etc.)
Italy	Vulnerability is set equal to 1 for all the exposed elements	1) People, 2) Economic activities, 3) Environment, 4) Cultural heritage	1) Population: number of people living the flood area calculated as a percentage of the total population living in the census tract; 2) Economic activities: buildings, agriculture, natural and semi-natural environments, infrastructures and strategic structures; 3, 4) Environmental and cultural-archaeological heritage
Austria	Flood risk map - impacts	1) People's health, 2) Environment, 3) Cultural heritage, 4) Economic activities	1) Population (>100, 76–100, 51–75, 26–50, 1–25, no affected persons) per raster cell (census track data used); 2) Land use (settlement-related uses, agriculture, forestry and grassland, Water, transport infrastructure); 3) Protected areas (Water conservation area, UNESCO World Heritage Site, NATURA 2000 area, National Park); 4) Infrastructure (contaminated site, industry, swimming water, railway station, hospitals, schools, kindergarten, senior residence)
Turkey	very low, low, medium, high, very high	1) People's health, 2) Social infrastructure, 3) Cultural heritage, 4) Environment, 5) Economic activities	1) People's health: location and number of exposed people district based; 2) Social infrastructure: hospitals, schools, firefighters, civil protection facilities, mosques, bus stations etc.; 3) Cultural heritage (museums, ancient cities, libraries etc.); 4) Environment (large-scale pollution facilities: industrial and municipal areas, wastewater treatment plants, parks, woodlands, water protection areas); 5) Economic activities: industrial and municipal facilities, transformers, bazaars, gas stations, high ways, bridges, railways,(number and characteristics of economic and non-economic activities)
Montenegro	Vulnerability classes are not defined numerically, only presented in a descriptive manner for each of the scenarios	1) Casualties, 2) Severely injured/ Hospitalized/ Threatened, 3) Endangered people basic needs, 4) Number of people to be evacuated, 5) Total economic impact, 6) Environmental impact ,7) Disrupted everyday life, 8) Loss of cultural heritage.	1) Casualties: number of fatal outcomes; 2) Severely injured/hospitalized/threatened: water pollution; poor sanitary and hygienic conditions may lead to epidemic outbreak; overflowing cesspits may lead to germ infestation; 3) Endangered people basic needs: employees could not go to work, children to schools and kindergartens, inability to receive health care …; 4) Number of people to be evacuated: number of interventions carried out by Civil protection service 5) Total economic impact: damage to individual properties, devastation of agricultural land, damage to family houses…; 6) Environmental impact: increase of water levels in rivers and groundwater which leads to their pollution due to wastewater spills, removal and damage of agricultural land; 7) Disrupted everyday life: interruptions in water supply, interruptions and difficult functioning of traffic infrastructure …; 8) Loss of cultural heritage

3. CONCLUSIONS

Based on the reviews presented in the paper and more details provided in the project deliverables, the project partners identified opportunities and possible limitations in the use of data to develop a methodology for flood risk assessment in cross-border areas. One of the most important findings is that in the analysed countries majority of the data that are needed for flood exposure and vulnerability and consequently for flood risk evaluation have different GDPR restrictions. Their collection and use are determined by different national legislations. Moreover, the authority for the latter have different ministries and other governmental services within individual countries under consideration. Therefore, the project partners agreed that it would be the most optimal and appropriate to use an individual municipality as the basic spatial unit for development of the methodology for cross-border flood risk assessment. The project partners have already identified the cross-border areas exposed to floods and/or seismic risk. Border areas between Slovenia and Italy and between Slovenia and Austria will be used in the following work packages of the BORIS project as case studies for the development and testing of the methodology.

4. REFERENCES

Chorynski, A., Pinskwar, I., Kron, W., Brakenridge, G.B. and Kundzewicz, Z.W. (2012), “Catalogue of Large Floods in Europe in the 20th Century”, in Kundzewicz, Z.W. (Ed.), Changes in Flood Risk in Europe, IAHS, pp. 27–54.

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks

Giardini, D., Woessner, J. and L., D. (2014), “Mapping Europe’s Seismic Hazard”, EOS, Vol. 95 No. 29, pp. 261–262.

Kern, H., Resch, C., Wernhart, S., Pignone, F., Rebora, N., Polese, M., Borzi, B., et al. (2021), Comparison of National Risk Assessments. Delivarable 2.1, available at: https://www.borisproject.eu/.

Kron, W. (2005), “Flood risk = Hazard • Values • Vulnerability”, Water International, Vol. 30 No. 1, pp. 58–68.

Wernhart, S., Lenhardt, W., Weginger, S., Pignone, F., Rebora, N., Polese, M., Borzi, B., et al. (2021), Data Availability and Needs for Large Scale and Cross-Border Risk Assessment, Obstacles, and Solutions. Delivarable 2.2, available at: https://www.borisproject.eu/.