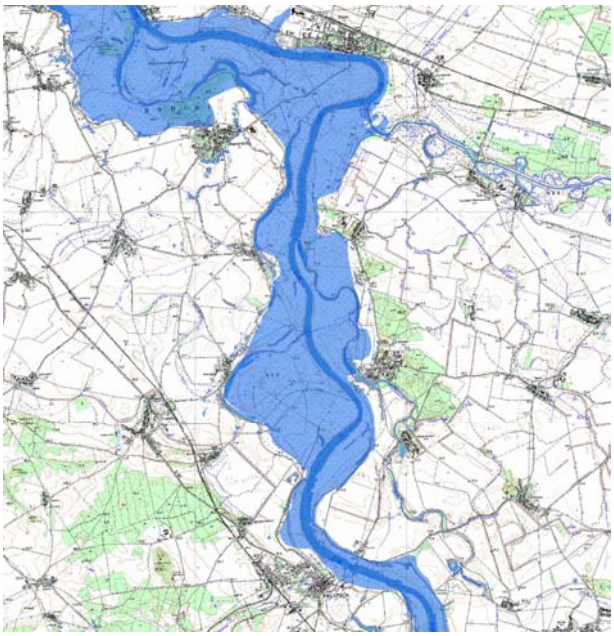
JRC Scientific and Technical Reports

Risk Mapping of Flood Hazards in New Member States

by

Róbert Jelínek, Maureen Wood and Javier Hervás



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1. INTRODUCTION

1.1 Overview: Floods and Risk Mapping

Flooding is the most common and most spatially distributed natural hazard across the world, and every year floods cause considerable damage in various parts of the world. There are many different types of flooding. The most common types are:

- River floods
- Flash floods
- Coastal floods
- Urban floods
- Ice jams

Although most flood-prone countries are mainly located in developing countries, an increasing number of events have occurred in Europe in recent years. The following list gives dates and locations of recent severe flooding events in the eastern and central European countries participating in this survey:

- July 1997 in Poland, the Czech Republic, Slovakia and Hungary
- November 1998 in Hungary and Slovenia
- March-April, July 1999 in Hungary and Romania
- April-May 2000 in Hungary and Romania
- March 2001 in Hungary and Romania, June-July 2001 in Poland
- April and August 2002 in Romania, Hungary, the Czech Republic and Slovakia
- August 2004 in Romania
- January 2005 in Estonia
- April-May 2005 in Romania and Bulgaria

Floods in Europe occur as a result of a wide range of meteorological conditions such as heavy and prolonged precipitation, storm or rapid and widespread melting of snow. Many other underlying factors also increase the potential for catastrophic floods, such as high river and stream levels, absence of proper river bank fortification, excessive felling of forests, and full reservoirs.

Flooding occurs in all eleven surveyed countries. Countries particularly at risk are those located in low-land areas, near water bodies or downstream from major dam works. The map on Figure 1 shows that flooding is considered a high risk in the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia, a medium risk in Bulgaria, Latvia and Lithuania and a low risk in Cyprus and Estonia.

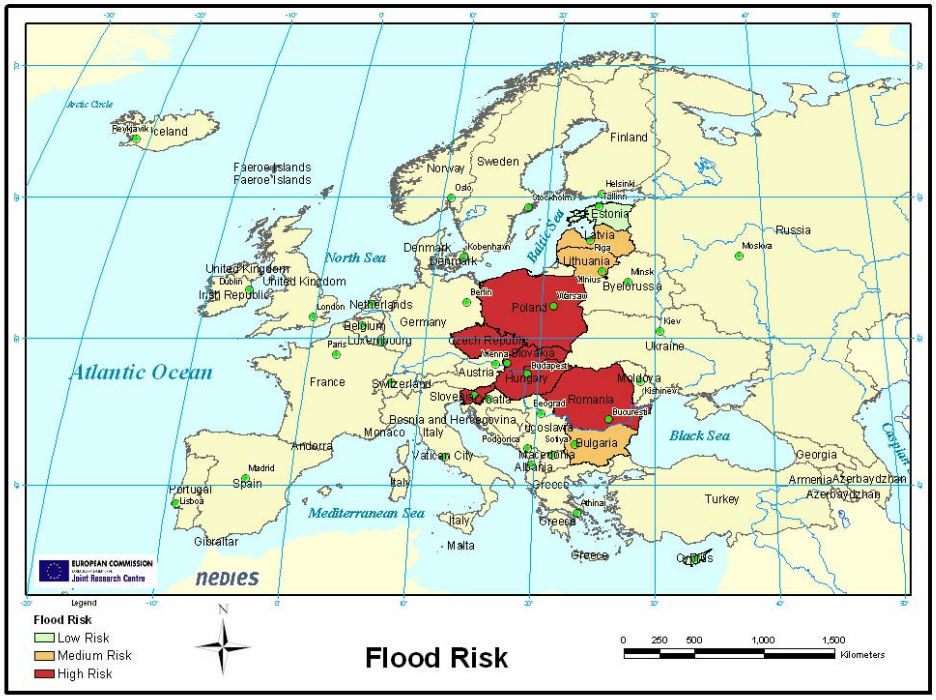

Figure 1: Risk relevance of flooding in the surveyed countries (according to national experts)

1.2 General Description of the Project

In 2003 the Joint Research Centre performed a survey of mapping practices in eleven (11) countries for eight (8) major hazards. This activity was funded as part of the project entitled "Management of Natural and Technological Risks" under the JRC Enlargement action within the Sixth Framework Programme (6FP) for Research and Technological Development (RTD). This project was a continuation of an activity supported by the JRC Enlargement action programme within the Fifth Framework Programme (5FP) RTD aimed at the 10 "PECO" countries.[1] The two activities were designed to support the efforts of new Member States and Candidate Countries in the creation of compatible regional and national central information systems for supporting authorities in the management of risks and emergency situations due to natural and technological hazards. The 6FP project was expanded to include Cyprus[2].

[1] PECO countries refer to the 10 Member States in central and Eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia). The acronym is derived from the French translation of "Central and Eastern European Countries" ("Pays de l'Europe Centrale et Occidentale").

[2] The 6FP project could also include Cyprus and Malta (although 5FP was only targeted to PECO countries). Yet for mainly practical reasons, Malta was not included in the 6FP phase of this project, although some bilateral expert exchanges on natural and technological hazards took place.

Under the 5FP project experts from the PECO countries agreed on ten priority hazards as important concerns for the region, as follows (Wood et al. 2003):

Natural hazards	**Technological Hazards**
▪ Floods	▪ Industrial installations
▪ Forest fires	▪ Transport of dangerous goods
▪ torms	▪ Contaminated lands
▪ Landslides	▪ Pipelines
▪ Earthquakes	▪ Oil-shale mining

The 6FP project aimed to investigate risk mapping practices and policy for priority hazards in these countries. The aim of this activity was to:

- Examine the existing situation, in each surveyed country for mapping of priority natural and technological hazards
- Compare methodologies used in the different countries for hazard to inform guidelines for establishing compatible national mapping systems
- Provide a basis for defining a pilot project that would test feasibility of different approaches to harmonizing aspects of mapping practices in regard to specific hazards

Moreover, it was determined that these objectives could be best fulfilled through the administration of a questionnaire on risk mapping practices and policy for priority hazards to the target countries (Di Mauro et al., 2003).

The 6FP project selected eight priority hazards from the 5FP project as the subject of the questionnaire, excluding oil-shale mining and pipelines for practical reasons[3]. The survey and its main results are fully described in the document, "Risk mapping in the New Member States" (Wood & Jelinek, 2007) although this report focuses only on the flood portion of the questionnaire.

[3] In the case of oil-shale mining, interest in this hazard was not widespread and it was determined that most respondents would not have a mapping programme aimed at this activity. On the other hand, in many countries the competent authority that manages pipelines and pipeline mapping is quite distinctly apart from those that handle other technological hazards or natural hazards. Therefore, it was considered impractical to include this hazard in the survey based on the additional extra effort that might be required to gain the support and co-operation of these authorities.

1.3 Survey Methodology and Content

This section describes the survey process including the background as well as practical and technical considerations that determined its focus and approach.

Method for Soliciting and Verifying Questionnaire Responses

Survey responses were collected over the course of a 10-month period between November 2003 and July 2004. The initial survey was sent to project focal points nominated by the countries to respond to the hazard questionnaires. Each country was requested to complete a questionnaire for only those hazards that they had identified in the previous survey as priority hazards (and as mentioned, countries were allowed to modify the previous prioritization for their country if they so desired). For this reason, there is not a complete set of questionnaire responses for any one hazard. The JRC then organized a meeting in each participating country to discuss the answers to the questionnaires with the responding authorities. This meeting offered an opportunity to clarify questions and responses, gain more comprehensive information, and improve consistency between responses across hazards and respondents.

Following the meeting the questionnaire was revised and reviewed and through an iterative exchange between respondents and the JRC, the responses were finalized and accepted as complete.

Content of the Full Questionnaire

Each questionnaire encompassed eight separate sections, each one focused on a particular hazard. Moreover, the same methodology was applied for each hazard. In essence, the questionnaire aimed to identify state-of-the-art mapping practices, priorities, and similarities and differences in mapping practices for each hazard. The data identity and availability based on the questionnaire encompassing more than 35 questions grouped into six categories: flood hazard maps, flood hazard data, element at risk to floods, flood vulnerability maps and flood risk maps. Each questionnaire was divided into six sections:

- General description of hazard maps
- Data and data collection
- Identification of elements at risk
- Vulnerability mapping and classification
- Risk mapping
- Final considerations (use and accessibility)

Questions within sections were then individualized for each type of hazard.

Description of the Flood Section Questionnaire

The flood questionnaire is the subject of this report. Its contents can be summarized as follows:

General description of hazard maps

The first part of the questionnaire poses questions about the availability of official flood hazards maps (i.e., maps made by a government entity, such as a ministry, mapping agency, the army or other), as well as the availability of any other types of flood hazard maps in the surveyed countries. Standard map parameters such as coverage, scale, format, issuing authority, date of origin and the latest updates are also requested. Additionally, a question about the type of coordinate system used for flood hazard maps is included.

The second part of this section asks respondents to identify the standard components of official maps, that is, whether objects such as springs, rivers, hydrological catchments, flood hazards zones, topography, land use, water bodies are regular features of flood maps.

In the third part of this section, the respondent is asked to specify how flood hazard maps are used, degree of accessibility to such maps to the public and their availability via Internet.

The final part requests information on existing legislation covering flood mapping practices in the surveyed countries.

Data and data collection

This part of the questionnaire describes information on flood hazard data sources and related collection process. The section starts with questions in regard to reference authorities for collecting information about flood hazard sources and its related management.

The second part asks for information on official mechanisms for collecting flood hazard data. The respondents were allowed to specify the type of information collected (e.g., surface water hydrometry, ground water hydrometry) parameters and units used, and how data are collected. Furthermore, information was also requested about the area covered by the data, the time period covered, the frequency of update and whether the data are maintained in digital or paper form.

This section also asked questions about the specific way in which data are used in the surveyed countries, and the degree of accessibility of data or constraints on its use.

Identification of elements at risk

This section explores how respondents classify elements ("objects") exposed to flood hazard and the level of importance assigned to each category (from very low to very high) for the elements selected.

Vulnerability mapping and classification

The first part of this section asks about the availability of official flood vulnerability maps in the surveyed countries and how different levels and types of vulnerability are classified in the country. Respondents are also asked to indicate whether certain types of damage (e.g., to people, to property) are considered reversible (temporary) or irreversible (persistent) in the respondent country.

Risk mapping

This part of the questionnaire aims to determine whether flood risk maps are produced in the country and, if so, what the standard features of these maps are. It also seeks information on how flood risk is represented in such maps, public accessibility and how the maps are used.

Use and accessibility (final considerations)

The final part of the questionnaire describes general questions related to a harmonized approach to define risk maps and ask about potential benefit of those integrated risk maps in the surveyed countries.

2. ANALYSIS OF RESPONSES TO THE FLOOD SURVEY

As is shown in Table 1, ten out of the eleven countries identified floods as a priority hazard and completed responses to the survey[4]. Among the eight hazard surveys, this survey received the second highest response rate[5] demonstrating that flooding is a shared concern for nearly all the new Member States and Candidate Countries.

Table 1: Respondents and focal points for flood mapping questionnaire

Country	Address
Bulgaria	National Institute of Meteorology & Hydrology 66 Tsarigradsko Chaussee, Sofia 1784, Bulgaria http://www.meteo.bg
Czech Republic	Ministry of the Environment Vršovická 65, Prague 10, 100 00 Czech Republic www.env.cz
Cyprus	Water Development Department Dem. Severi Av. Nicosia, 1413 Cyprus www.moa.gov.cy
Estonia	Estonian Meteorological and Hydrological Institute Rävala 8, Tallinn, 10143 Estonia www.emhi.ee
Hungary	National Water Authority Márvány u. 1/c., Budapest, H – 1012 Hungary www.ovf.hu
Latvia	State Fire and Rescue Service Maskavas iela 5, Riga, LV – 1050 Latvia www2.112.lv
Lithuania	Civil Protection Department Pamenkalnio str. 30, Vilnius LT-2600 Lithuania www.csd.lt
Poland	Institute of Meteorology and Water Management Podlesna 61, 01-673 Poland www.imgw.pl
Romania	Ministry of Agriculture and Rural Development B-dul Carol I, Nr. 24, Sector 3, Codul Postal 020921, Oficiul Postal 37 Bucharest, Romania http://mapam.ro/
Slovakia	Slovak Hydrometeorological Institute Jeséniova 17, 833 15 Bratislava, Slovak Republic www.shmu.sk

[4] Although Slovenia representatives identified floods as a high priority hazard, they were unable to complete the flood mapping questionnaire due to a lack of resources.
[5] All participating countries completed responses to the questionnaire on industrial accidents.

Most respondents were from national water institutions or relevant authorities. In addition, survey responses should be considered in light of the following observations:

- Responses were generally very comprehensive with many useful comments, therefore, the response quality is considered very high.
- Nonetheless, some experts did not answer every question. (When relevant it has been noted in this report when one or more responses to a specific question is lacking.)
- Few respondents were able to provide complete information for the sections regarding elements at risk and vulnerability.

2.1 Flood Hazard Maps in Surveyed Countries

Data on the current status of flood hazard maps and their availability were collected and these are summarized in Table 2. The Table highlights the various flood mapping practices in all participating countries.

Types of maps

According to the survey, official flood hazard maps (maps made by a government entity, such as a ministry, a mapping agency, the army or other) are currently available in Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia. In addition, the following observations are noted:

- The Czech Republic produces official maps at a provincial level covering flood plain areas with the periodicity of floods 5, 20 and 100 years (http://mapy.vuv.cz/website/isp), as shown in Figure 2, page 20.
- Latvia indicated that it planned to approve maps created by a private company (for downstream areas of major dam works) in early 2004. Similarly, Bulgaria reported that it only has flood maps of regions affected by dam breaks on major streams.
- Flood hazard maps are not available in Cyprus; however, data related to river flows are collected.
- Romania and Slovakia indicated that they have flood warning and forecasting systems, called DESWAT and POVAPSYS (http://www.shmu.sk/) respectively, that also produce flood maps.
- Different countries use different classifications to describe the severity of floods. Usually, the criterion refers to the water level.

Table 2: Availability of flood hazard maps (Page 1 of 3)

Country	Maps Produced Format – Digital (D) or Paper (P)	Coverage/ Scale	Date Created/ Last Updates	Legal Act Foreseeing Flood Maps
Bulgaria	Official national maps: Maps of territories affected by dam breaks on major streams (P) Regional maps of flooded areas (P)	1:500,000 Not geo-referenced	Early 80s/ No updates Created sporadically for decision support purposes	No
Czech Republic	No official national maps Official maps at provincial level covering flood plains	Provincial: 1:10,000 Municipal: 1:5,000 Vulnerable areas close to dike: 1:5,000 or 10,000	Upon request	The Water Act (No. 254 dated 28. June 2001) Decree of the Ministry of the Environment No. 236 dated 10 July 2002
Cyprus	No official national maps	No	Not applicable	Not applicable
Estonia	Maps showing frequently inundated areas (P)	Not geo-referenced (manually drawn)	1960's/Updated in 1989	None
Hungary	Official national maps are produced for floodplain inundation areas of 1/100 and 1/1000-year frequency (Mostly P, some D)	National: 1:100,000 Regional: 1:50,000 Provincial: 1:50,000 Municipal:1:10,000-1:5,000	National, regional and provincial maps were created in 1977 and have not yet been updated Municipal: 1984/ updated in 2002	Act LXXIV of 1999 Act LVII of 1995
Latvia	National flood hazard map (D and P) Flood maps for territories downstream from major dam works produced by dam owner (D)	National: 1:200,000 Regional: 1:50,000 and 1:10,000 Municipal: 1:10,000	Created in 2001/ updated in 2005 First created in 2003/Update frequency undetermined Created and updated sporadically	Hydropower Dam Safety Act (Law), April 1, 2001

Table 2: Availability of flood hazard maps (Page 2 of 3)

Country	Maps Produced Format – Digital (D) or Paper (P)	Coverage/ Scale	Date Created/ Last Updates	Legal Act Foreseeing Flood Maps
Lithuania	Official national maps Yearly flood hazard maps produced by Hydrometeorology Service (P) Also, short-term daily and weekly forecasting maps such as water level monitoring maps, maps showing water volume in snow caps, weather forecast, etc, are produced on an as-needed basis (D) The Lithuanian University of Agriculture is also working to produce a flood map of the Downstream Region of the Nemunas river	National: 1:1,250,000 Regional: 1:200,000, 1:100,000, or 1:25,000 Municipal: 1:10,000	National flood hazard maps are updated annually All other maps are produced on an as-needed basis	The Civil Protection Law requires maps of potential hazard areas as part of emergency response plans
Poland	Official maps produced for regional flood areas-potentially inundated areas (some P, some D) Several maps for relatively small basins created by universities	Regional: 1:50,000, 1:25,000, or 1:10,000	First created in 2003-2004/update frequency undetermined Some of them were prepared after the flood in 1997	The Polish Water Law

Table 2: Availability of flood hazard maps (Page 3 of 3)

Country	Maps Produced Format – Digital (D) or Paper (P)	Coverage/ Scale	Date Created/ Last Updates	Legal Act Foreseeing Flood Maps
Romania	Official national map of flood-prone areas (P) County emergency response plans (P) Ministry of Defense: Detailed risk maps for flood-prone areas (D or P unknown) Local planning maps of flood-prone areas (P) Additional maps are foreseen by the DEStructive WATer (DESWAT) – Abatement and Control of Water Disasters, a national project to create an "Integrated Decisional – Informational System for Waters Emergencies", in which detailed risk maps for flood-prone areas will be created (D)	National: 1:1,000,000, 1:500,000, or 1:200,000 Regional (County): 1:50,000, or 1:25,000 Provincial and Municipal: 1:5,000 or 1:500	First created in 1990 Last updated in 2000 (targeted frequency is every 3 years)	National Land Use Planning Law, section no. 575/2001 (natural hazard areas) requires delimitation of natural hazard areas including areas potentially affected by destructive natural phenomena, such as landslides, earthquakes and floods Order of Ministry of Agriculture, Forests, Waters and Environment and Ministry of Transport, Constructions and Tourism: regarding the delimitation of the areas prone to natural risks (no. 62/N-19.0/288-1.955/1998) Hazards maps are also a component of General Urban Plans (PUGs) required at the municipal level
Slovakia	Official national maps have been created for flood-prone areas by the POVAPSYS system (the flood warning and forecasting system) (D and P) Maps also created for the "Flysch Belt" region (a highly flood-prone area) (P)	National: 1:500,000 Provincial: 1:10,000	National: 2003 Provincial: 2002	None

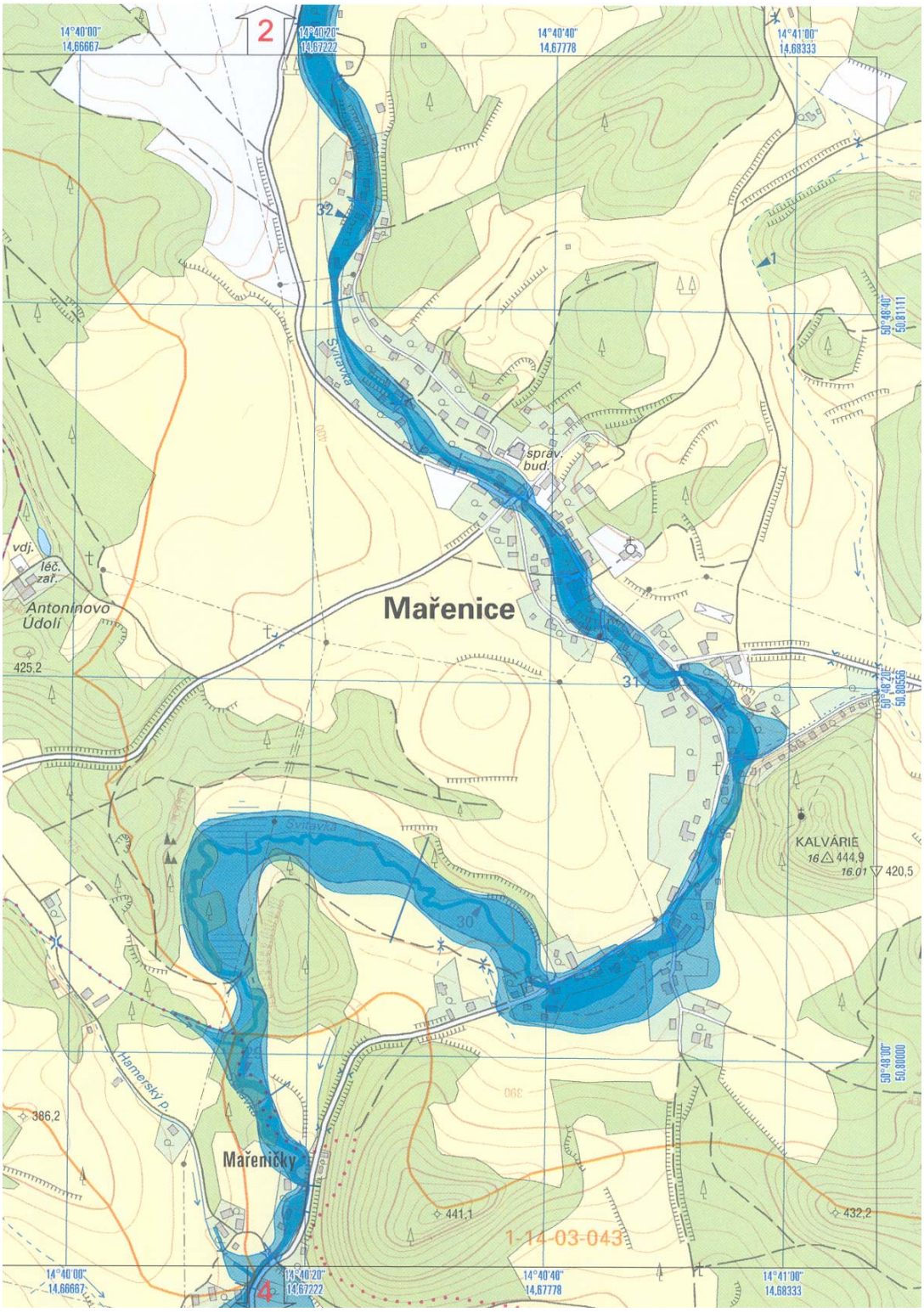

Figure 2: Map sheet of the flood plain from the Svitanka River, Czech Republic (source: The Czech Office for Surveying, Mapping and Cadastre)

Scale, coverage, projection and format of maps

- The surveyed countries are using a variety of scales for flood hazard mapping, ranging from a rather small scale of 1:1,000,000 to a large scale of 1:5,000 or even 1:500.
- All countries, except the Czech Republic, have national or regional coverage of flood hazard maps. Provincial maps are available in the Czech Republic, Hungary, Romania and Slovakia.
- The most common projection used by respondents is UTM. In many countries multiple systems are used simultaneously. Annoni et al. (2001) recommended for the member states to use the Universal Transverse Mercator (UTM) projection system and the Lambert Conformal projection (LCC) for topographic maps with scales larger than 1:500,000 and cartographic maps with scales equal 1:500,000 or less, respectively.
- Maps in paper form are available in every surveyed country, while maps in digital form are only produced in the Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.

Data created and last updated

Results indicate that the most recent floods hazards maps are available in Hungary, Latvia, Poland, Romania and Slovakia. The oldest maps in current use are from the 1960's (in Estonia) and the 1980's (in Bulgaria, last updated in 1989). In the Czech Republic, the maps are created and updated upon request, but the actual date of the most recent update was not provided.

Legislative framework

Respondents were asked to describe any legal instruments that mandate or guide official mapping of flood hazards. The responses show that a legal framework supports flood hazard mapping in the Czech Republic, Hungary, Latvia, Lithuania, Poland and Romania. These instruments generally contain guidance or requirements relative to hazard management, including data and mapping requirements, and a definition and classification system for flood-prone areas.

Representation of flood hazard areas on maps

Seven countries responded to this question. (Cyprus does not have flood maps and Bulgaria did not respond to the question.) All but Estonia indicated that contour lines are used to delineate and describe flood-prone areas. Flood areas are also depicted topographically and using historical data by most respondents (see for example Figures 3 and 4 or Table 3, page 23).

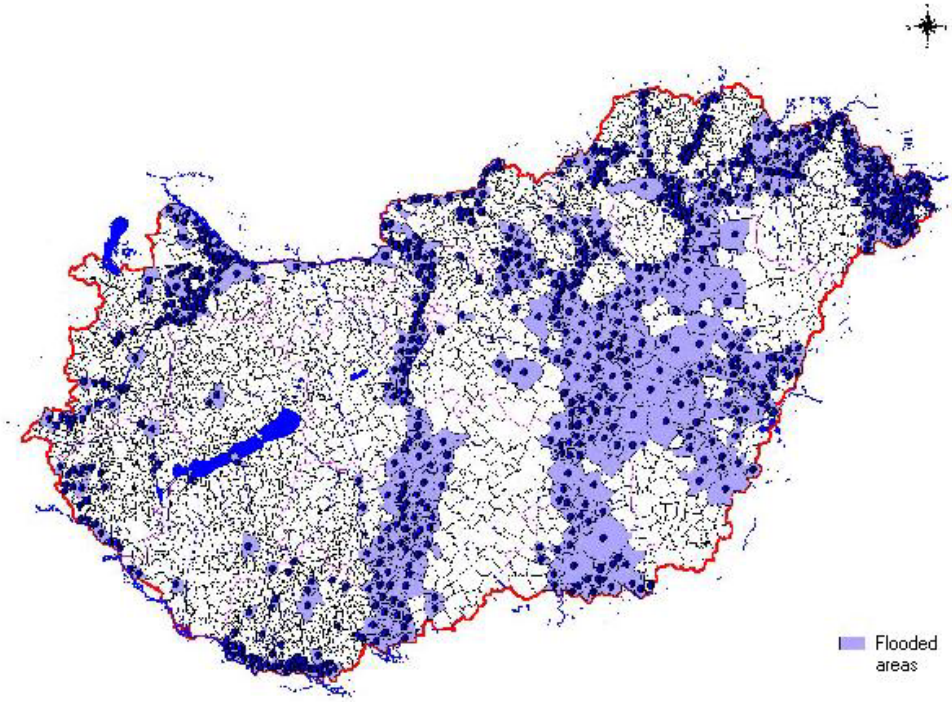

Figure 3: Areas exposed to flood risk in Hungary

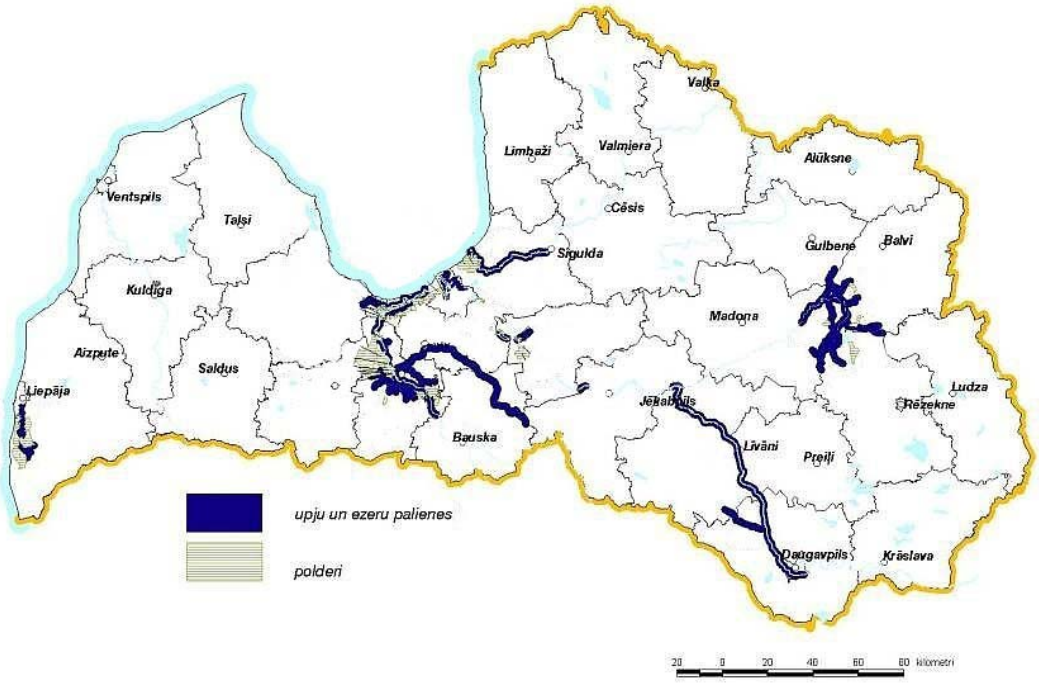

Figure 4: Flood hazard territories in Latvia

Table 3: Representation of flood-prone areas on maps

A topographical map showing rivers, lake shores and sea coasts (only flood hazard sources)	CZ, LT, PL, RO, SK
Contours of frequency and magnitude (e.g., water levels) describing the flood hazard potential	CZ, HU, LV, PL, RO, SK
Areas where historical flood events have occurred	CZ, EST, LT, PL, RO, SK
Other	EST (manually), LV, PL, RO

Map features or symbols and background information on flood hazard maps

Eight out of ten countries responded comprehensively to this question. Standard mapping features for flood hazards were cited by the following countries: the Czech Republic, Hungary, Lithuania, Romania and Slovakia. Their descriptions supplemented with background information on flood hazard maps are summarized in Table 4.

Table 4: Map features and background information used in flood hazard maps

Country	Standard Flood Map Features or Symbols
Bulgaria	Topography, land use (only forests, orchards, vineyards and young forests), water bodies (rivers, lakes, reservoirs and canals), administrative boundaries (state boundaries only), population (divided into 6 classes), roads, railways
Czech Republic	**Flood-related:** Springs, rivers, flood hazard zones, hydrological catchments, hydrological catchments, hydrological catchment names, water bodies, **Background:** Administrative boundaries, significant buildings, land use, protected areas, place names, topography, administrative boundaries, population, roads, railways
Cyprus	None
Estonia	Hydrological catchments
Hungary	**Flood-related:** Dike keeper's house, defense section center, gauging station, gated sluice, pumping station, port, river barrage, administrative boundaries, rivers, drainage and irrigation canals, flood embankments, confinement dikes, summer dikes, flood hazard zones – flood beds, open flood plains, protected flood plain, contour line of settlements, hydrological catchments, hydrological catchment names, name of watercourses, stationing of the rivers, embankments and canals, water bodies **Background:** Paved roads, railways, protected forest belts, place names, topography (only the contours of the flood plain of 1 % and 0,1 % probability and the flood plain islands), administrative boundaries
Latvia	Topography **Flood-related:** hydrological catchments , water bodies, **Background:** administrative boundaries, roads, railways
Lithuania	**Flood-related:** Water level measurements, rivers, hydrological catchments, flood hazard zones, flood levels, hydrological catchments, hydrological catchment names, topography, water bodies **Background:** Small urban settlements, administrative boundaries, place names, land use, administrative boundaries, roads, railways, hazardous establishments (for higher scale maps only)
Poland	**Flood-related:** Springs, rivers, river names, dikes, hydrological catchments, hydrological catchment names, flood hazard zones, water bodies (in preparation) **Background:** Administrative boundaries, land use, place names
Romania	**Flood-related:** Springs, gauging stations, flow measurements, rivers, hydrological catchments (large scale maps only), hydrological catchment names, flood hazard zones, flood wave movement, water bodies **Background:** Administrative boundaries, place names, legend text, administrative boundaries, population (perimeter of inhabited areas), **Large scale maps only:** Water bodies, land use, topography, population size, roads, railways Also attached to the map is a complete list of the administrative territorial units (municipalities, communes) by counties, located in the flood or ice-blocking area, including at each administrative unit the description of the flood type (such as: due to overflowing of a water course; due to torrential flow from the slopes; or both)
Slovakia	**Flood-related:** Springs, water gauging stations, rivers, precipitation and runoff levels, hydrological catchments, hydrological catchment names, hydrological numbering of catchments, flood hazard zones, hydrological models, flood index, river names, slope movement, lithology, slope deformation, water bodies, **Background:** Administrative boundaries, land use, place names, types of buildings, topography, population, roads, railways

A few observations about flood mapping in the different countries are highlighted below:

- Typical map features or symbols include points such as the location of springs, lines (mainly rivers and administrative boundaries), polygons (hydrological catchments, flood hazard zones and land use), text (names) and color-coded zones to depict boundaries of different zones (administrative, flood, population or other).
- Almost all respondents reported that administrative boundaries, land use, roads, railways and place names are included as standard background information in nearly all countries responding to this question. Topography is a standard feature of half the countries and population information is standard for three countries. (In addition, these features are standard for larger scale maps in Romania).
- The background information is generally similar across countries, consisting of topography, land use, hydrological catchments, water bodies, administrative boundaries, roads and railways.
- Hungary, Lithuania, Romania and Slovakia indicated that flood hazard maps tended to contain detailed information related to flooding potential, particularly on high scale maps.
- Lithuania and Romania noted that the level of detail could vary depending on the scale of the map. For example, small scale maps in Romania will not show the transportation infrastructure or topography.

Most respondents depicted population size on their flood hazard maps, although it was not always clear as to how the information was classified and displayed (for example, color-coded and classed by population size, or color-coding for inhabited areas, depiction of actual buildings from areal photos, or text indicating exact population).

Use of flood hazard maps and their degree of accessibility

Seven of the ten countries responded comprehensively to this question. (Cyprus and Estonia have no specific use for flood maps because flooding does not represent a high risk for the population or economy.)

As shown in Table 5, information from flood hazard maps is used to support mapping needs of civil protection services, scientific research, and military planning, and as a visual aid for communicating about hazards to the public through the media. The following observations are highlighted:

- Only one country, Lithuania, indicated that the public was allowed direct access to flood hazard maps (as opposed to other types of maps, such as emergency planning maps, that contain flood hazard information).
- Access to official maps at national level in the majority of countries is controlled and provided selectively to local and regional authorities for various decisions and mapping needs (e.g., land-use planning, emergency planning, etc).
- Regarding the accessibility of flood hazard maps, the surveyed countries can be categorized into two groups. In Bulgaria, the Czech Republic, Hungary and Romania, flood hazard maps are restricted, that is, not generally accessible to the public. While in Latvia, Poland and Slovakia, these maps are generally available for public access, however restricted for some purposes.

Table 5: Use of flood hazard maps and their degree of accessibility

Use of Flood Map	BG	CZ	CY	EST	H	LV	LT	PL	RO	SK
Targeted Information Communication to the Public	-	R	-	-	R	P	P	R	R	O
Targeted Information Communication amongst Decision-makers	-	R	-	-	R	P	P	R	R	R
Land Use/Spatial Planning	-	R	-	-	R	P	P	P	R	P
Emergency Response Plans for Civil Protection	R	O	-	-	R	P	P	P	R	R
Targeted Allocation of Resources	-	R	-	-	R	-	ns	P	R	-
Scientific Research	-	R	-	-	R	R	P	P	R	P
Military Purposes	-	R	-	-	R	-	R	O	R	-
Visualisation of Information only	-	R	-	-	P	-	R	O	R	P

Legend: P- public, R-restricted, O- other, ”-“ - no data provided, ns- not specified

2.2 Flood Hazard Data

Flooding generally depends on daily weather conditions, such as precipitation and temperature in the regions. The most important parameters controlling flooding are rainfall intensity and duration. Therefore, flood prediction and planning efforts at a minimum require data on surface and ground water hydrometry, climatology and meteorology. Those data are usually acquired from an automatic monitoring system or sometimes manually.

According to the survey, all of the surveyed countries have an official mechanism for collecting flood hazard data. These data are summarized in Table 6.

Table 6: Flood hazard data collected by each country (Page 1 of 2)

Country	Surface Water Hydrometry (Collection Method)	Groundwater Hydrometry (Collection Method)	Climatology & Meteorology (Collection Method)	Soil (Collection Method)	Format Area Coverage Geo-reference Metadata/Standard
Bulgaria	Water level, Discharge (Automatic/manual)	Groundwater depth, Groundwater discharge (Manual only)	Precipitation, Temperature, Pressure, Solar radiation, Evapotranspiration (Automatic/manual)	Soil moisture deficit, Permeability (Manual only)	Format: Digital & paper Coverage: National Geo-referenced: Yes Metadata: Not used
Czech Republic	Water level, Discharge (Automatic/manual)	Groundwater depth, Groundwater discharge (Automatic/manual)	Precipitation, Temperature, Pressure, Solar radiation, Evapotranspiration (Automatic/manual/other)	Soil moisture deficit (Other)	Format: Digital & paper Coverage: National Geo-referenced: Yes Metadata: Used
Cyprus	Water level, Discharge (Automatic/manual)	Groundwater depth (Manual only)	Precipitation, Temperature, Pressure, Solar radiation, Evapotranspiration (Automatic/manual)	No	Format: Digital & paper Coverage: National Geo-referenced: Yes Metadata: Not used
Estonia	Water level (Automatic only)	None	Precipitation, Temperature, Pressure (Automatic only)	Soil moisture deficit (no data)	Format: Digital & paper Coverage: National Geo-referenced: Yes Metadata: Not used
Hungary	Water level, Discharge, Water quality (Automatic/manual)	Groundwater depth, Groundwater discharge, Water quality (Automatic/manual)	Precipitation, Temperature, Pressure, Solar radiation, Evapotranspiration (Automatic/manual)	Soil moisture deficit, Permeability (Automatic/manual)	Format: Digital Coverage: All levels Geo-referenced: Yes Metadata: Not used

Table 6: Flood hazard collected by each country (Page 2 of 2)

Country	Surface Water Hydrometry (Collection Method)	Groundwater Hydrometry (Collection method)	Climatology & Meteorology (Collection Method)	Soil (Collection Method)	Format Area Coverage Geo-reference Metadata/Standard
Latvia	Water level, Discharge, Ice thickness, Ice phenomena, Water temperature (Automatic/manual)	No	Precipitation, Temperature, Pressure (Automatic/manual)	No	Format: Digital & paper Coverage: NationalGeo-referenced: Yes Metadata: Used
Lithuania	Water level (Manual only)	Groundwater depth (no data)	Precipitation, Temperature, Pressure, Solar radiation (no data)	Soil moisture deficit, Permeability (no data)	Format: Paper Coverage: NationalGeo-referenced: Yes Metadata: Not used
Poland	Water level, Discharge (Automatic/manual/other)	Groundwater depth (Manual only)	Precipitation, Temperature, Pressure, Solar radiation (Automatic/manual/other)	No	Format: Digital & paper Coverage: National Geo-ref: Yes Metadata: Not used
Romania	Water level, Discharge, Temperature, Precipitation (Automatic only)	Groundwater flow Velocity, Groundwater depth, Temperature, pH, Dissolved oxygen (no data)	Precipitation, Temperature, Pressure, Solar radiation, Air relative Humidity, Wind speed, Snow depth, Snow density, Water equivalent of the snow layer (Automatic/manual/other)	Soil temperature (Automatic/manual)	Format: Digital & paper Coverage: All levels Geo-referenced: No Metadata: Not used
Slovakia	Water level, Discharge (Automatic/manual)	Groundwater depth, Spring yield (Automatic/manual)	Precipitation, Temperature, Pressure, Solar radiation, Evapotranspiration (Automatic/manual)	None	Format: Digital & paper Coverage: National, Regional Geo-referenced: Yes Metadata: Used

Surface water hydrometry

Most countries collect information on water level and discharge (Estonia and Lithuania excepted). Automatic collection methods supplemented with manual measurements are generally applied in most of the countries, except Lithuania (manual measurement only).

Ground water hydrometry

Ground water depth and ground water discharge are the most frequently collected parameters of ground water in the surveyed countries. The measurements are most often performed manually, although in the Czech Republic, Hungary and Slovakia automatic monitoring system is also used. Estonia and Latvia do not measure ground water hydrometry regularly.

Climatology and Meteorology

Results show that a number of different parameters are collected in the surveyed countries. The majority of countries take regular measurements of precipitation, temperature, pressure, solar radiation and evapotranspiration. Manual and automatic methods of measurement are used.

Soil

Bulgaria, the Czech Republic, Estonia, Hungary, Lithuania and Romania regularly collect data on soil. Five of these countries measure the soil moisture deficit; three of them also measure permeability.

Additional observations

- All the surveyed countries collect hazard data in both digital and paper format with the exception of Lithuania (paper only) and Hungary (digital only).
- In all of the surveyed countries flood data are collected for the entire country.
- All of the countries have geo-referenced information on flood hazards with associated metadata (except Romania), which are standardly used in the Czech Republic, Latvia and Slovakia. The advantage of using a metadata standard is that data sets will interoperate with other sets that use the same standard.

Use of flood hazard data

Flood hazard data have a specific use in all of the surveyed countries with the exception of Estonia (which has had only very small floods over the last few decades). All of the countries except Estonia use hazard data to assist in targeted communications among decision-makers. All countries but Estonia and Cyprus use the data for emergency response planning for civil protection and scientific research. The flood hazard data in Poland are usually available for regional and local authorities responsible for public communication;

however some data are also available for public access. Complete responses to questions relating to how flood hazard data are used in the surveyed countries are summarized in Table 7.

Table 7: Use of flood hazard data

Use of Flood Map	BG	CZ	CY	EST	H	LV	LT	PL	RO	SK
Targeted Communication to the Public	P	R	-	-	P	P	P	O(R)	R	-
Targeted Communication amongst Decision-Makers	R	R	P	-	P	R	P	O(R)	R	ns
Land Use/Spatial Planning	-	-	PR	-	P	-	P	O(P)	R	P
Emergency Response Plans	R	P	-	-	R	R	P	O(P)	R	R
Targeted Allocation of Resources	R	-	-	-	R	-	-	O(P)	R	P
Scientific Research	-	R	-	-	P	P	P	O(P)	R	ns
Military Purposes	-	O	-	-	R	R	R	O	R	
Visualisation of Information only	P	P	-	-	-	-	-	O	R	R

Legend: P- public, R-restricted, O- other, ns- not specified, "-" - no data provided

Experts were also asked if available information is sufficient for defining a national flood hazard map. Positive answers were obtained from Bulgaria, the Czech Republic, Estonia, Latvia, Poland, Romania and Slovakia. The Cypriot experts stated that more accurate topographical information is needed. Hungarian experts indicated that their flood maps were outdated and that the maps do not contain any important and detailed information on flood impacts.

Official flood hazard maps in the surveyed countries are usually created by representative national authorities. Universities, research institutes and professional organisation may also produce other types of flood hazard maps through various research projects.

Flood hazard data are completely restricted in Romania and generally open to the public in Latvia. In other countries, the data are available to the public with some restrictions.

2.3 Flood Vulnerability Maps

Respondents were asked to identify objects considered important vulnerable elements for flood hazards. In general, interpretation of responses does not distinguish between importance of the element (to the economy, to society) or exposure. They are simply an indication of how such objects are prioritised for mapping and also other prevention and response activities in relation to floods.

Hungary, Romania and Slovakia indicated that they have an official classification system identifying types of objects considered potentially vulnerable to flood hazards. The Hungarian and Romanian systems are generally described in Table 8 below. Slovakia did not provide any details of their classification system and thus are not included in the table..

Table 8: Official classification of vulnerable objects in Hungary and Romania

Country	Classification of Vulnerable Objects
Hungary	Population affected, sensitive infrastructure (water supply, elderly homes, hospitals, schools, kindergarten, emergency services), estimated value of properties at risk (housing, businesses, estimated value of daily production in the flood plain basin or cassette), cultural heritage, ecological effect and cost/benefit ratio
Romania	Population (represented by the number of fatalities, injured, homeless if applicable), infrastructure, economical units affected and the environment (represented by the damages and economic losses and costs). Vulnerable objects are further categorized as direct or indirect losses and classified according to number of casualties, homelessness, value of damages, and cause of damage. (Law for Civil Defence against Disasters, no. 124/1995)

Level of importance of the elements at risk exposed to flood hazards

Respondents were also asked to indicate how various categories of typically vulnerable objects are prioritised for flood risk management in their countries, on a scale of very low to very high. Their answers to this question are summarized in Table 9.

Table 9: Level of importance of the elements at risk exposed to flood hazards

Country	Humans as Indivi-duals	Humans as Social Targets	Infrastruc ture	Cultural Heritage	Private Property	Natural Resour-ces	Ecology
Bulgaria	VH	H	H	H	M	M	H
Czech Republic	VH	VH	M	M	H	L	VL
Cyprus	M	L	M	L	M	VL	L
Estonia	VL	VL	L	VL	L	L	M
Hungary	VH	VH	VH	VH	H	H	H
Latvia	L	L	H	L	H		L
Lithuania	VL / L	L	L	VL	L / M	L	L
Poland							
Romania	VH	VH	VH	H	M	VH	VH
Slovakia	VH	VH	H	H	M	M	M

Legend: VH: Very high; **H**: High; **M**: Medium; **L**: Low; **VL**: Very low

As shown in Table 9, humans as individuals, humans as social targets, infrastructure and cultural heritage are ranked as elements at high or very high risk when exposed to flooding by at least four out of eight countries. Two countries, Lithuania and Estonia, give low or very low ranking to almost all the elements listed, except for the category of ecology in Estonia. The reasons for a consistently low ranking of all elements in these countries is not given but could conceivably result from the flood prone areas being located in conservation or otherwise low density population areas.

Figure 5 is a graphical presentation of the results shown in Table 9. This figure clearly highlights the differences in how various countries view flood risk. Hungary and Romania have identified the most objects as at very high risk to floods among the surveyed countries. The other countries with very high risk relevance to floods are Bulgaria, Slovakia and the Czech Republic.

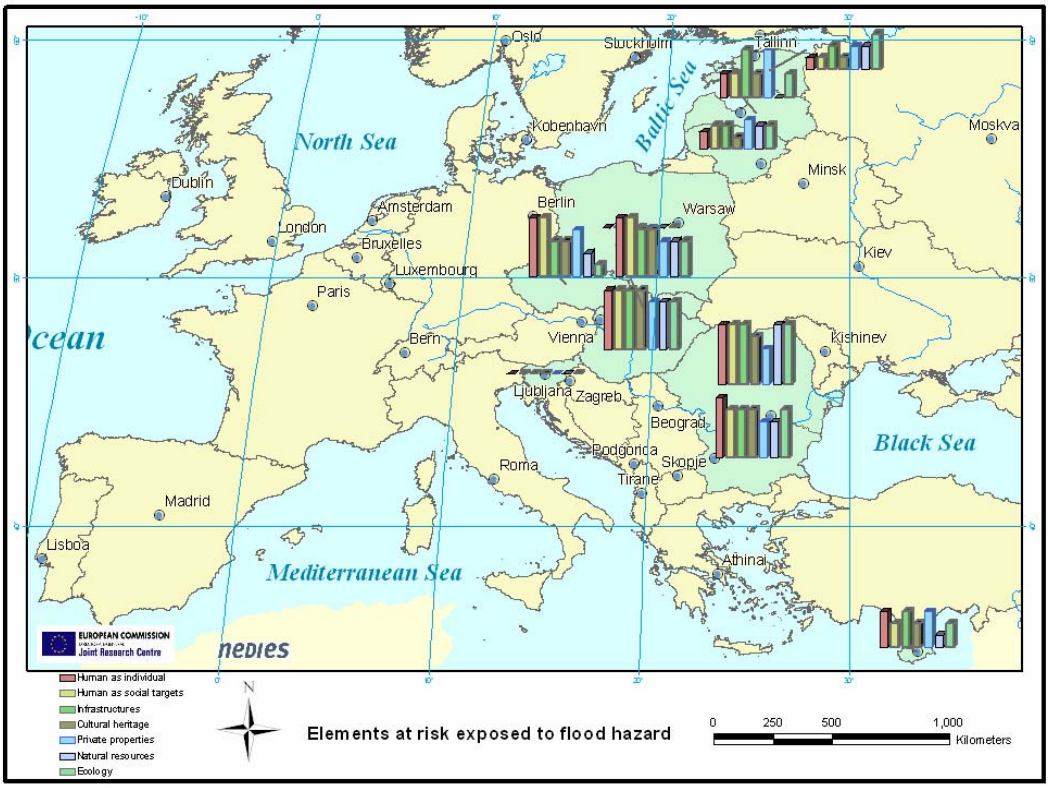

Figure 5: Elements at risk from flood hazards[6]

This survey did not explore the reasons for various rankings, but a plausible explanation could be high geographic exposure to flooding in these countries. For example, the Hungarian respondent indicated that, in Hungary, about 51.6 % of the total territory is affected by flooding. According to this expert, Hungary has the highest percentage of its territory marked as a flood hazard, followed by Bulgaria, Slovakia and the Czech Republic, where floods are also a significant hazard. Perhaps it could also be assumed, judging by the rankings, that Cyprus, Estonia, Latvia and Lithuania have much lower exposure.

From the surveyed countries only Slovakia has an official flood vulnerability map. Unfortunately, Slovakia did not provide any additional comments or reference related to help characterize the contents and coverage of this map.

[6] As indicated by surveyed countries. To facilitate graphic display, the risk rankings by country of elements exposed to flood hazards were quantified based on their category of risk, i.e., very high = 100, high, = 80, medium = 60, low = 40, and very low = 20.

Classification of damages

Only three countries, Cyprus, Latvia and Romania, indicated that potential damage resulting from floods was officially classified as reversible or irreversible, as shown in Table 10.

Table 10: Classification of damages as reversible and irreversible in Cyprus, Latvia and Romania

Country	Reversible Damage	Irreversible
Cyprus	**Human**: Injury, acute health effects, epidemic, economic loss **Infrastructure:** Severe damage, loss of functionality, economic loss, public service interruption **Cultural heritage:** Economic loss, accessibility **Private property:** Economic loss, loss of functionality **Natural resources:** Economic loss	**Human:** Death, disability **Infrastructure:** Destruction, uneconomical recovery **Cultural heritage:** Cultural loss, economic loss **Private property:** Economic loss **Natural resources:** Loss of resource
Latvia	**Human**: Injury, economic loss **Infrastructure:** Severe damage, loss of functionality, economic loss, public service interruption **Cultural heritage:** Economic loss **Private property:** Loss of functionality **Natural resources:** Resources **Ecology**: Biodiversity	**Private property:** Economic loss
Romania	**Human**: Injury, acute health effects, epidemic, economic loss **Infrastructure:** Severe damage, loss of functionality, economic loss, public service interruption **Cultural heritage:** Economic loss, accessibility **Private property:** Economic loss, loss of functionality **Natural resources:** Economic loss, loss of resource **Ecology:** Loss of biodiversity	**Human:** Death **Ecology:** Loss of biodiversity

2.4 Flood Risk Maps

None of the surveyed countries reported having flood risk maps (as in 2004). However, the majority expressed their intention to create flood risk maps within the next three to five years. It was agreed among all respondents that a harmonized approach or standardized definition of risk maps could be of assistance in their efforts. For example, a commonly accepted methodology, harmonized symbols and compatible features could serve as a basis for comparing different flood prevention projects.

3. CONCLUSIONS AND RECOMMENDATIONS

Conclusions and key findings from responses to this survey can be summarized as follows:

- **Floods are considered as a moderate to high hazard for all but two countries surveyed.** Notably, ten out of eleven countries (all except Slovenia) provided information on flood mapping. The Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia, consider themselves to be at high risk from flooding. Bulgaria, Latvia and Lithuania perceive flooding as a medium risk and in Cyprus and Estonia it is considered a low level risk. Moreover, floods have transboundary implications and some important river basins that cross boundaries include the Danube River, the Elbe River and the Vistula River.
- **Official flood hazard maps are currently available in six countries** (Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia). Other countries (Bulgaria, Czech Republic, and Estonia) only map specific areas such as flood plains or areas downstream from major dam works. Cyprus is not aware of the existence of any flood maps.
- **Most official maps are in paper form**, although Hungary, Latvia, Lithuania, Poland and Romania reported that certain maps are in digital form.
- **At least half of the countries have maps reflecting the flood situation in the last five years** (Estonia, Lithuania, Hungary, Romania, Poland, Slovakia and possibly the Czech Republic), whereas various maps in Estonia and Bulgaria are at least ten years old.
- **Six countries have legislation that mandates or strongly influences the production of flood maps** (Czech Republic, Hungary, Latvia, Lithuania, Poland and Romania).
- **Flood hazard maps are generally available for public access in three countries** (Latvia, Poland and Slovakia); and four countries reported restricted access in Bulgaria, the Czech Republic, Hungary and Romania.
- **Standard features of maps vary widely from country to country; however, several common elements can be identified**. Moreover, how the information is classified and depicted may sometimes differ substantially. Typical map features or symbols include points such as the location of springs, lines (mainly rivers and administrative boundaries), polygons (hydrological catchments, flood hazard zones and land use), text (names) and colour-coded zones to depict boundaries of different zones (administrative, flood, population or other). Almost all respondents reported that administrative boundaries, land use, roads, railways and place names are included as standard background information. For larger scale maps, topography and population are sometimes included.
- **All of the surveyed countries have national authorities responsible for collecting data relevant to flood hazards.** In general, all countries are collecting data on surface and ground water hydrometry, climatology and meteorology. Several countries are additionally collecting some data on soil.
- **A common set of parameters is generally measured in most countries to monitor changes in surface water hydrometry and climate and weather conditions.** Data collected to measure ground water and soil changes varied more widely from country to country.

- **Flood hazard data are available to the public (with some restrictions) in the majority of countries** (Bulgaria, the Czech Republic, Cyprus, Hungary, Latvia, Lithuania, Poland and Slovakia).
- **Romania and Slovakia have their own flood warning and forecasting systems that are substantial sources of flood data and related information.**
- **Hungary, Romania and Slovakia are the only countries reporting an official classification of elements considered at risk from exposure to flood hazards.**
- **Several respondents ranked humans as individuals, humans as social targets, infrastructure and cultural heritage as elements at high or very high risk when exposed to flooding.** Two countries, Lithuania and Estonia, give low or very low ranking to almost all the elements listed. It is possible that the rankings correlate with perceptions about how the vulnerability of the country to flood hazards, but this is a question that has not yet been further explored.
- **Only Slovakia indicated that it has an official flood vulnerability map.** No details on the main features characterizing this map were provided so it is not possible to evaluate this information any further.
- **Only three countries reported having an official classification of potential damages as reversible or irreversible.**
- **None of the surveyed countries is currently producing flood risk maps but most countries would like to do so in the next three to five years.**

Based on these conclusions, the following recommendations can be offered:

- **Floods are an important risk in the new Member States and Candidate Countries and represent an opportunity to design and implement new tools for managing these hazards**. Areas of opportunity include:
    - Transformation of maps into digital form is an important step forward for facilitating data exchange.
    - The establishment of minimum features, standards and data for preparing digital flood maps to facilitate data exchange and use of standardised formats.
- **Moreover, for harmonisation to take place, the way in which flood maps and flooded areas are defined is an area that should be explored.** For example, for the purposes of integrity and interoperability between the countries, it will be necessary to agree on the use of the same standards such as symbols and projections. Data parameters, software and other practical issues would also need to be considered.
- **The experience and knowledge of the surveyed countries should be regarded as a valuable resource in European efforts to advance flood hazard and risk mapping techniques**. Several countries have considerable resources and expertise devoted to flood mapping and flood monitoring.
- **There is potentially a strong opportunity for collaboration to develop a common methodology for flood vulnerability and flood risk mapping.** The surveyed countries are not producing flood vulnerability and flood risk maps; however, they recognise that these types of maps could be valuable tools.
- **It could be valuable to examine different flood hazard mapping practices in transborder regions** of surveyed countries and make comparisons.

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Abstract

In 2003 the Joint Research Centre conducted a survey of mapping practices in eleven (11) new Member States (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) for eight (8) major natural and technological hazards such as floods, forest fires, storms, landslides, earthquakes, industrial installations, transport of dangerous goods and contaminated lands. This activity was funded as part of the project entitled "Management of Natural and Technological Risks".

One fundamental project objective was to examine the existing situation in each of the surveyed countries, and compare different mapping methodologies in order to define guidelines for establishing compatible risk mapping systems, in particular multi-hazard risk mapping. This report describes the results of the flood section of the risk mapping activity. Responses to the survey provide important information about the current status of flood hazards and risk mapping in different countries and advantages and obstacles to developing a common methodology for multi-hazard risk mapping including this hazard in each country.

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