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REPORT ON ASSESSMENT OF DATA AND INFORMATION NEEDS FOR PREPARATION OF JOINT FRMP FOR THE SAVA RIVER BASIN, IDENTIFICATION OF DATA SOURCES ON NATIONAL AND INTERNATIONAL LEVEL, FINDING DATA GAPS AND DEFINING STRATEGY HOW TO OBTAIN THE MISSING DATA

Pilot Project on Climate Change Adaptation
Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin

Contracting authority: the International Sava River Basin Commission

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ENVSEC Environment & Security

UNECE United Nations Economic Commission for Europe

INTERNATIONAL SAVA RIVER BASIN COMMISSION

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1. Introduction

The document deals with assessment of data and information needed for preparation of the Flood Risk Management Plan (hereinafter: FRMP) for the Sava River Basin. The document includes specification of data requirements for the activities defined in the Program for Development of the Flood Risk Management Plan for the Sava River Basin (hereinafter: the Program) -types of data, their quality, semantics, spatial and temporal aspects, identification of available data sources and note on data adequacy. The data assessed are: hydrological data, socio-economic data, environmental data, state of infrastructure and other data types, if relevant. The geographic data needs for the preparation of the FRMP are also considered in the context of the EU INSPIRE Directive. INSPIRE aims to create an EU spatial data infrastructure.

In the second part of the document the definition of the strategy to be used for data/information acquisition is elaborated. The alternative data and information sources are important in order to implement successfully the Program.

2. Assessment of data and information needs

2.1 Overview of data used for the Preliminary Flood Risk Assessment

According to the Article 4 of the Directive 2007/60/EC (hereinafter: EFD), the member states shall undertake a Preliminary Flood Risk Assessment (hereinafter: PFRA) based on available or readily derivable information, such as records and studies on long-term developments, in particular impacts of climate change on the occurrence of floods, to provide the assessment of potential risks.

According to the Article 6(1) of the Protocol on Flood Protection to the Framework Agreement on the Sava River Basin (hereinafter: the Protocol), the Sava River Basin (SRB) riparian countries have developed the PFRA methodologies in line with the EFD provisions. Each country has its own program and performs the PFRA according to the adopted national legislative, rules and/or directives. The overview of available data and information used for PFRA is based on countries' reports from the document "Preliminary Flood Risk Assessment in the Danube River Basins" prepared by the International Commission for Protection of the Danube River (hereinafter: the ICPDR), as a Summary Report to the EC on implementation of Articles 4, 5 and 13(1) of the EFD.

2.1.1 Slovenia

For the purpose of PFRA Slovenia developed a Hazard indication map based on analysis of past events, analysis of historic and archive data, and analysis of the past research with the following contents:

- Flood and erosion areas,
- Registered flood events with significant harm consequences,
- Common information concerning floods and erosion.

Hazard assessment was realized using hazard indication map containing data from flood events and flood models, as well as data like: maximum water levels, flood return period, type of flood, date of commencement and duration of flood (days), type/degree of adverse consequences, etc. Additional area of flood hazard was defined based on the morphology of river network and expert consideration. The data were available for fluvial floods without any indication of possible significant pluvial floods, or groundwater floods, or floods from any artificial infrastructure sewerage systems. The flood defence infrastructure was not considered.

2.1.2 Croatia

When undertaking the PFRA, the methodological approach is adjusted to the available data, and the basis for the assessment of a recipient, i.e. assessment of damage was based on the data from the CORINE Land Cover of 2006, statistics about the population and settlements from the 2001 Census[1], sites of major industrial plants and smaller settlements not visible on the CORINE Land Cover, the data base managed by Croatian Waters, and the available data about the locations of waste disposal sites. PFRA includes the following information:

- Topographic maps of the area to scale with marked boundaries corresponding basins, sub-basins with developed and planned systems, flood protection, and current state of land use;
- Description of the floods that occurred in the past in the area and of flooding processes as well as their sensitivity to change, and present or future flood transport routes.
- Description of development plans that would lead to changes in land use or retrieval of the population and distribution of economic activity, resulting in increased flood risk in the area.
- Estimates of the likelihood of future floods based on hydrological data, types of floods, the predicted impact of climate change and land use trends.
- Forecasts of future assessments on the effects of floods on human health, environment, cultural heritage and economic activity, taking into account the long-term development and climate change.
- Parts of the study area (in appropriate scale) that are potentially at risk from flooding or could be threatened by floods in the future.

2.1.3 Bosnia and Herzegovina

The principal data and information used for PFRA in Bosnia and Herzegovina are:

- characteristic river flows, water levels, reliability of data, transformation of data into hydrographs,
- accompanied relevant documentation, legislative, reports, plans.

The following information was used for defining potential significant flood risk:

- Historical flood data were collected from municipalities through a questionnaire in the

[1] The data from the 2011 Census has still not been processed, upon its publication, a revision of PFRA can be expected

first phase of the “Methodology of preliminary flood risk assessment for the Sava River Basin for watercourses of I category”. Years: 2010, some data for 2009, 2006, 2004, 2002 and 2001, and occasional data for earlier floods;
- GIS – land uses (CORINE), flood areas (historical and statistical, return period of 20, 100 and 500 years), risk assessment and vulnerability data and all other relevant information available, other types of relevant spatial data;
- Strategy for solving issues of flood protection in the Sava River Basin and a proposal for activities during high water;
- Evaluation of the current level of flood protection in the Federation of Bosnia and Herzegovina and designing improvement programs;
- Main preventive plan for flood defence, 2010;
- Water management Strategy of the Federation of Bosnia and Herzegovina, 2002;
- Federal operational flood defence plan, 2010;
- Preliminary design of flood risk assessment in Sava River basin in Federation of Bosnia and Herzegovina for I category watercourses, collecting data.

2.1.4 Serbia

The PFRA started is based on data collected using a questionnaire on floods that occurred after 1965. Data on past floods were collected from Civil Protection units at the level of municipalities and from water management companies and HMS. Only floods that caused a large-scale damage (damage which exceeds 10% of the total income of the municipality) or floods that had important social consequences were identified as significant. It is assumed that all significant past floods could occur again. For the PFRA the following digital data was used:
- GIS map 1:300.000 containing: administrative borders, relief, hydrography, cultural heritage, communications, settlements, HPPs, industrial facilities, digital terrain model;
- CORINE Land Cover 2000 (EEA);
- GIS map of indicative flood zones, containing the potential flood zones, which are the result of different hydraulic studies and the extent of past floods from post-flood analyses;
- Map of levees;
- Data on the population.

2.2 Basic data for FRMP (all activities)

This section gives detailed description of data needed for all activities within the Program and preparation of FRMP within it. Most requirements regarding the data types come directly from WFD and EFD requirements. Table 1 shows basic data described by: name, description, scale, attributes and/or classification system, data source (output from FRMP activity). The basic guidelines for data collection can be found in Handbook on good practices for flood mapping in Europe, EXCIMAP, 2007.

Table 1: Basic Data for FRMP

No.	Data name	Description	Scale	Attributes/Classification system	Data source (output from FRMP activity)
	Hydrography				
1	Sava river basin	Extent of Sava river basin (polygon)	Two scale levels: One for entire river basin One for trans-boundary areas	Name Area	National topographic maps (National PFRA, via ISRBC)
2.	Sub-basins	Extent of sub-basins larger of 1000 km2 (polygons)		Name of basin Name of sub-basin Area	National topographic maps (National PFRA, via ISRBC)
3.	Rivers	Rivers and streams (lines)		Name Length Type (order)	National topographic maps (National PFRA, via ISRBC)
4.	Lakes	Lakes (polygons)		Name Area	National topographic maps (National PFRA, via ISRBC)
5.	Channels	Channels (lines)		Name Length	National topographic maps (National PFRA, via ISRBC)
	Topography				
6.	Country borders	Extent of countries (polygons)	Two scale levels: One for entire river basin One for trans-boundary areas	-	National topographic maps (National PFRA, via ISRBC)
7.	Places	Main settlements (points)		Country Name Population	National topographic maps (National PFRA, via ISRBC)
8.	Roads	Main roads (lines)		-	National topographic maps (National PFRA, via ISRBC)
9.	General Digital elevation model	Low level details DEM (raster)		-	National topographic maps (National PFRA, via ISRBC)
10.	Topographic map	(raster)		-	National topographic maps (National PFRA, via ISRBC)
11.	Satellite/Aerial data	(raster)		-	Google/National mapping agencies
	Flood				
12.	Floods events	Occurrence of flood (points, lines, polygons)	Two scale levels: One for entire river basin One for hilly areas with limited extent	Location name Sub-basin name Extent Flood category (past /potential) Water level Date and duration Return periods Consequences Photographs	National PFRA, via ISRBC Slovenia: 1:5.000 (some areas) Croatia: 1:100.000 and 1:25.000 (Orljava, Krapina) (restricted use) Serbia: 1:25.000 (some tributaries) (see [2])
13.	Flood plains	Flooded areas (polygons)		Name of sub-basin Name of flood plain Area	National PFRA, via ISRBC Slovenia: 1:25.000 Croatia: 1:100.000 and 1:25.000 (Orljava, Krapina) Serbia: 1:100.000 BiH: 1:25.000 (internal use) (see2)
14.	Natural retention areas	(polygons)		Name of sub-basin Name of retention area Area	National PFRA, via ISRBC

[2] Questionnaires on flood mapping methodologies for the Sava Basin, ISRBC, 2007

15.	Manmade flood defence structures	Dikes, weirs, dams, pump stations (lines, points)		Name of sub-basin Name of defence structure Type	National PFRA, via ISRBC
16.	Conveyance routes for the significant past floods	(lines)			National PFRA, via ISRBC
17.	Areas of a potential significant flood risk (APSFR)	(polygons)		Name of sub-basin Area Type of flood Type of potential consequences	National PFRA, via ISRBC
18.	Trans-boundary flood areas	Transboundary flood areas (polygons)		Name of sub-basin Area Type of flood Type of potential consequences Trans-boundary countries	National PFRA, via ISRBC
	Economic activities				
19.	Land use	Areas of same land use (polygons)	Two scale levels: One for entire river basin One for trans-boundary areas	Land use types Area Economic activity category	National land-use maps, statistics, cadastre National PFRA, via ISRBC
20.	Long term development	Planned economic activities (points, lines, polygons)		Future land use types Area Economic activity category	National development strategies and plans National PFRA, via ISRBC
	Population				
21.	Population	Distribution of population (people per territorial unit) (polygons, raster)	Two scale levels: One for entire river basin One for trans-boundary areas	Country Territorial unit ID Area of unit Number of inhabitants	National population and territorial units registers National PFRA, via ISRBC
	Climate change influence				
22.	New Flood scenarios	New flooded areas caused by climate changes (polygons)	Two scale levels: One for entire river basin One for hilly areas with limited extent	Name of scenario Name of sub-basin Name of flood plain Area	Pilot project on climate change adaptation: Building the link between Flood Risk Management planning and climate change assessment in the Sava River Basin, ISRBC

2.3 Data for Flood maps

This section gives detailed description of data needed for all mapping activities within the Program and the preparation of FRMP for the Sava River Basin. Data addressed herein are related to the Flood hazard maps, Vulnerability maps and Risk maps. Most requirements regarding the data types come directly from WFD and EFD requirements. Table 1 shows basic data described by: name, description, scale, attributes and/or classification system, data source

(output from FRMP activity). The basic guidelines for data collection can be found in Handbook on good practices for flood mapping in Europe, EXCIMAP, 2007.

Table 2: Data for Flood maps

No.	Data name	Description	Scale	Attributes/Classification system	Data source (output from FRMP activity)
	Flood scenarios/hazard				
23.	Water drainage network	Detailed data with hydrological and geomorphological characteristics of rivers	Two scale levels: One for entire river basin One for trans-boundary areas	Name Type/order Length	National water executive agencies and Ministries ISRBC
24.	Cross section and longitudinal profiles for rivers	Detailed data showing river geometry with blocked obstructions (e.g. bridges).	Typically two to three cross sections per km and a set of cross sections at each major hydraulic structure location.	Cross-section No. Lateral and elevation coordinates for each terrain point Roughness coefficients Reach lengths between adjacent cross-sections Left and right bank station Channel contraction and expansion coefficients Blocked obstructions (areas in the cross-section through which no flow can occur, e.g. bridge or culvert)	National water executive agencies and Ministries Serbia: Sava river cross section (Plovput) Croatia: Sava river cross section (Croatian Waters, VPB)
25.	Digital elevation model	High level detailed DEM (raster)	Min. horizontal requirements: 10 m*10 m Min. vertical requirements: 0.5 m (Ref. 3, Handbook)	-	National mapping agencies
26.	Manmade flood defence structures	Dikes, weirs, dams, reservoirs, retentions	-	Location Cross sections Construction drawings	National water executive agencies and Ministries
27.	Hydrology	Basic elements of water regime (precipitation, flow, runoff and evaporation)	Maps of gauge stations with adequate data 1:25,000. Preferably time series are needed	Gage location Precipitation Flow Evaporation Runoff	National water executive agencies and Ministries Croatia: gage records, Croatian Waters (several studies, 2000.-2005) BIH: gage records, precipitation/runoff, MAFWM and RDV (studies for some tributaries, 1987.-2007), Serbia: : gage records, Institute Jaroslav Cerni (one study, 2007) Slovenia: gage records, precipitation/runoff, IzVRS, (studies for Sava some tributaries, 1984.-2004),

					(see [3] and [4])
28.	Flood scenarios -medium probability (Q_{100}) -high probability for transboundary areas (e.g. Q_{20}, Q_{50}) - low probability (e.g. Q_{300}, Q_{500},, Q_{1000},)	Flood scenario includes the following: Flood extent (intersection of flood level with terrain) Water depths (difference between flood level and the terrain) Water level (level of inundation) Flow velocity (optional) Flow direction (optional) Propagation of flood (optional)	Flood depth map: 1:5,000 -1:25,000 Flow velocity map (highly local information): 1.000 – 5.000 Flood propagation (cover large areas): 25.000-100.000	Classification of flow depth, e.g. below 0,5; 0,5-1; 1-2; 2-4; above 4 m) Flow velocity in m/s (shown as vectors showing speed and direction) Flood propagation shown in discrete steps of 24 hours, or in days	Results of the following activities: Slovenia: HEC-2; HEC-RAS (some Sava Tributaries) Croatia: HEC-2, Mike11, HEC-RAS, KORSIM (Sava river), Mike11, HEC-RAS, KORSIM (some Sava tributaries), Croatian waters Serbia: Jaroslav Cerni Institute models, HEC and partly HEC-RAS, Mike 11 (Sava river), Jaroslav Cerni Institute BIH: DUFLOW and partly HEC-RAS and MIKE11 (Sava river), DUFLOW, Mike 11 and 12, HEC-RAS (some Sava tributaries) MAFWM RS–RDV (see 3) Georeferenced HEC-RAS Model of the Sava, The Sava River Modelling, U.S. Army Corps of Engineers, study 2011, ISRBC
29.	Flood hazard areas	Flood hazard class areas: high, moderate and low (polygons, raster) Overlying the maximum velocity map on the maximum water depth maps.	Two scale levels: One for entire river basin One for local levels	Country Name of sub-basin Area Flood extent according to probability classes, According to past events Flood depth Flow velocity Flood propagation Degree of danger Flood hazard class (high, moderate, low)	National water executive agencies and Ministries Slovenia: high, medium and low
	Vulnerability				
30.	Population	Distribution of population (people per territorial unit) (polygons, raster) Population density over 500 inhabitants per square kilometre defines expected density for urban areas in SRB. For low populated areas it is expected to have less than 100 inhabitants per square kilometre.	Two scale levels: One for entire river basin One for trans-boundary areas	Country Territorial unit ID Area of unit Number of inhabitants Vulnerability class Vulnerability classification: 1. high vulnerability : > 500 inhabitants per km^2 2. moderate vulnerability: 100 - 500 inhabitants per km^2 3. low vulnerability : < 100 inhabitants per km^2	National population and territorial units registers National PFRA, via ISRBC

[3] Hydrology, hydraulic and mapping summary sheet, ISRBC, 2008
[4] Hydrology report for the Sava River Basin analysis (HRSRBA), ISRBC, 2009

31.	Protected areas – nature	Protected areas – nature (polygons) Only polygons > 100 ha Categorisation of the protected areas is developed in accordance with definition of protected areas by International Union for Conservation of Nature and Natural Resources. Special attention should be paid to potentially affected protected areas identified in Annex IV(1)(i), (iii) and (v) to Directive 2000/60/EC.	Two scale levels: One for entire river basin One for trans-boundary areas	Country Protected area name Protected area type Area Vulnerability class 1. high– strictly where human visitation and impacts are rigorously controlled 2. moderate - cantered on particular natural feature, fragments of ecosystems or habitats 3. low - cultural landscapes altered by humans, natural areas where biodiversity conservation is linked with sustainable use	Protected areas in the Sava River Basin ver.3, 2011, Study with GIS database, ISRBC Thematic databases and maps of Relevant Institutions, Natura 2000
32.	Cultural heritage	Cultural heritage includes tangible culture such as buildings, monuments, landscapes, books, works of art, and artefacts, etc. It also comprises the museums and similar facilities that store cultural heritage. (points, lines, polygons)	Two scale levels: One for entire river basin One for trans-boundary areas	Country Protected heritage name Protected heritage type Area Vulnerability class Vulnerability classification: 1. high - World heritage (UNESCO) or high national importance 2. moderate - national or regional importance 3. low - local importance	Thematic databases and maps of Relevant Institutions
33.	Economic activities	Areas showing economic activities (polygons) This criterion is related to economic activities and their importance to economy: national, regional or local. The criterion has high level of abstraction. Therefore each riparian country has to define particular type of activities through land use categorisation and estimate importance to the economy. For trans-boundary areas a special attention should be paid to avoid eventual discrepancy in judgement.	Two scale levels: One for entire river basin One for trans-boundary areas	Country Land use type Type of economic activity Area Vulnerability class Vulnerability classification: 1. high - areas with importance to national economy 2. moderate - areas with importance to regional economy 3. low - areas either without any importance or with importance to local economy	National land-use maps, statistics, cadastre. National PFRA, via ISRBC
34.	Special structures and objects	Structures and objects essential for functioning of society and economy (water supply systems, energy networks, telecommunication systems, mayor roads and railroads, etc.). Structures and objects that could cause pollution are	Two scale levels: One for entire river basin One for trans-boundary areas	Country Special structure name Special structure type Area (length) Vulnerability class Vulnerability classification:	National land-use maps, statistics, cadastre. Thematic databases and maps of utility companies (National Electricity, Water supply, …)

		usually dumpsites, water treatment plants, industrial objects, quarries, etc. (points, lines, polygons)		1. high vulnerability - structures and objects having national or transnational extent influence 2. moderate vulnerability - structures and objects having regional influence 3. low vulnerability - structures and objects having local influence.	
35.	Vulnerability areas	Vulnerability areas: high, moderate and low (polygons, raster) Each vulnerability criteria has to be categorized into three classes of vulnerability: high, moderate and low. The final vulnerability class is the maximum value of the criteria classes.	Two scale levels: One for entire river basin One for trans-boundary areas	Country Name of sub-basin Area Population (criterion 1) vulnerability class Economy (criterion 2) vulnerability class Special structures and objects (criterion 3) vulnerability class Protected areas – nature (criterion 4) vulnerability class Cultural heritage (criterion 5) vulnerability class Final vulnerability class	Unavailable (all Sava countries)
	Flood risk				
36.	Flood risk areas	Flood risk areas (polygons, raster)	Two scale levels: One for entire river basin One for trans-boundary areas	Country Name of sub-basin Area Assets at risk Flood vulnerability – final Flood vulnerability - criterions Probable damage Probable loss (per unit time)	Unavailable (all Sava countries)

2.4 Flood conveyance routes and areas

Definition of areas and conveyance routes that could retain floodwater (this particularly concerns transboundary areas) as a part of integral FRMP. Basically, the data are digital elevation model as described in Item 25, Table 2 and drawings that could be attached as an attribute to a particular object.

2.5 Flood defence emergency situations and mutual assistance

The Program states that spatial data and information should be a part of integrated Sava GIS, managed by the ISRBC. Furthermore, HMIFFWS (Hydrometeorological Information and Flood Forecasting/Warning System) should be central information source during all emergency management phases. Evacuation routes on transboundary areas should be identified and

plans/maps disseminated to the local communities. In order to obtain plans and maps for crisis management and rescue services, the most of the above mentioned data and information (Tables 1 and 2) are needed. Other data that could be added are related to some facilities related to the rescuing operation itself. For example, the crucial data for planning the scale of response and resources needed are: population density and expected number of endangered people, evacuation routes, temporary refuge centres and available hospitals. Critical structures that could cause pollution or environmental damages as a result of flooding or structures that are critical for functioning of either rescue operations or the society also play crucial role. In addition, emergency maps may include a range of different information, such as:

- Flood extent maps for likely return periods, linked to different flood forecasting and warning systems;
- Locations where actions at operational level should be taken to mitigate flood impact (flood defence structures like gates, channels, retentions);
- Vulnerability map (e.g. houses of people requiring assistance during evacuation).

2.6 Other activities defined by the Program

2.6.1 Public participation and consultation

Considering transboundary areas, the information sharing and consultations should be performed through the ISBRC. Relevant data and information should be developed at local scale and adjusted to the local societal needs. Essential data, like flood extent, possible impact derived from the hazard, endangered critical structures, should be mapped in a simple way, understandable for the citizen. Global scales and strategic information are usually not required for public consultations on particular areas.

2.6.2 Flood forecasting, warning and alarm system

The main data source for flood forecasting, warning and alarm system will be the planned HMIFFWS (Hydrometeorological Information and Flood Forecasting/Warning System). Furthermore, the Program proposes simulations of different scenarios in case of the predicted potential flooding, resulting in flooding characteristics (water depth, flow velocity, flood extent), which are input information for the preparation of evacuation plans. Input data for the simulations are mainly the same as for the mapping procedure described in Table 2, as well as the common data described in Table 1.

2.6.3 Information exchange

The data and information exchange will be performed through ISRBC using the already developed tools: HMIFFWS, web-based hydrometeorological data module and Sava GIS. The most important types of data that are expected to be exchanged on daily/monthly bases are: meteorological and hydrological data, analyses and information important for flood protection, especially the timely forecast of high waters, various basic spatial data.

2.7 Common requirements on GIS data

As defined by the Program common geo-reference system for Sava River Basin should be selected and official transformation from national to the selected system should be defined.

2.7.1 Common geo-reference system for Sava River Basin

European commission has recommended the following[5]:

- ETRS89 as geodetic datum (underlying ellipsoid GRS80);
- expressing and storing positions, as far as possible, in ETRS89 ellipsoidal coordinates;
- EVRF2000 for expressing practical heights (gravity-related);
- ETRS – LAEA (Lambert Azimuthal Equal Area) coordinate reference system, for statistical analysis and display;
- ETRS-LCC (Lambert Conic Conformal) coordinate reference system, for conformal pan European mapping at scales smaller or equal to 1:500.000;
- ETRS-TMzn (Transverse Mercator) coordinate reference systems, for conformal pan-European mapping at scales larger than 1:500.000.

Accordingly to the above recommendations, FRMP geographic data should be stored in ETRS89 ellipsoidal coordinates. As FRMP requires maps in scales from 5.000-500.000, the ETRS-TMzn (Transverse Mercator) coordinate reference systems should be used. ETRS-TMzn is a series of zones (6 degrees wide in longitude) and SRB area is covered by two zones: ETRS-TM33 and ETRS-TM34 (having border at 18 degrees east). National elevation standards should be referenced to EVRF2000 height reference system. Pan-European and national coordinate reference systems descriptions and transformation parameters one can find at www.crs-geo.eu.

2.7.2 Metadata

FRMP geographic data should contain at least the following metadata:

- standard meta-data (dates, responsable organisation, etc.),
- coordinate reference system, height reference system.

2.7.3 INSPIRE themes and FRMP geographic data

The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe. The Directive addresses 34 spatial data themes needed for environmental applications, with key components specified through technical implementing rules. In addition to providing a basis for the interoperability of spatial data in INSPIRE, the data specification development framework and the thematic data

[5] Map projections for Europe, JRC, 2001

specifications can be reused in other environments at local, regional, national and global level, such as ISRBC.
Regarding FRMP geographic data needs, one should consider the INSPIRE spatial data theme *Hydrography* [6]as a framework for mapping, reporting and modelling purposes. This data specification is provided as a basic framework for the ISRBC and the Sava countries for the preparation of the FRMP to be adopted and extended according to their needs. The institutions participating in the process of the development of the FRMP for the Sava River Basin have different responsibilities and this will influence the kind of data they collect and manage and use.

Short description of the INSPIRE spatial data theme Hydrography follows.

The Hydrography theme is divided into three separate application schemas, roughly corresponding to spatial objects needed to satisfy the three main Use Cases:

- Physical Waters (primarily for mapping purposes),
- Network model (primarily for spatial analysis and modelling),
- Management and Reporting units (primarily for WFD reporting).

The Physical Waters application schema primarily is for creating base maps relating to hydrography. The selection of feature classes in this package is based on both the requirements for mapping of specific objects, as well as the need for distinction between certain objects from a modelling point of view. As a result certain 'real world' features are combined in a single class when there was found to be no need of distinction from either a mapping, or modelling point of view. The following groups of objects can be distinguished:

- Physical water objects that form part of the hydrological network such as watercourses, standing water, wetlands etc,
- Objects delineating the physical water objects (shore, land-water boundary),
- Areas where the water is collected (River Basin / Drainage Basin),
- Hydrographic points of interest. Points that influence the flow of water in the network and appear on maps but are not artificial objects (e.g. falls, springs and seeps etc),
- Manmade objects. All objects that are important to specify on the map and have a relation to the water network (e.g. embankment, locks, sluices, dams and weirs).

[6] D2.8.I.8 INSPIRE Data Specification on Hydrography – Guidelines, 2009

Figure 1 - Some elements of the physical waters and related objects6

The Application schema Network model is for modelling. Additional information (e.g. closed network, certain attributes) is needed that is not necessarily needed for a background map. This additional information, as well as the network model itself, is therefore contained in a separate application schema that can be regarded as an extension to the physical waters. If only a network model is available at the data provider, it is possible to describe the network without directly referring to physical objects. For this reason, spatial objects in both the network model and the physical waters application schemas contain their own geometries.

Figure 2 - Elements of the network model6

Reporting units are not part of the Annex I theme Hydrography, but belong to Annex III, Area management/restriction/regulation zones and reporting units. Since there is an important relation between the physical waters and water related reporting units, the water bodies for the WFD have been included in this data specification.

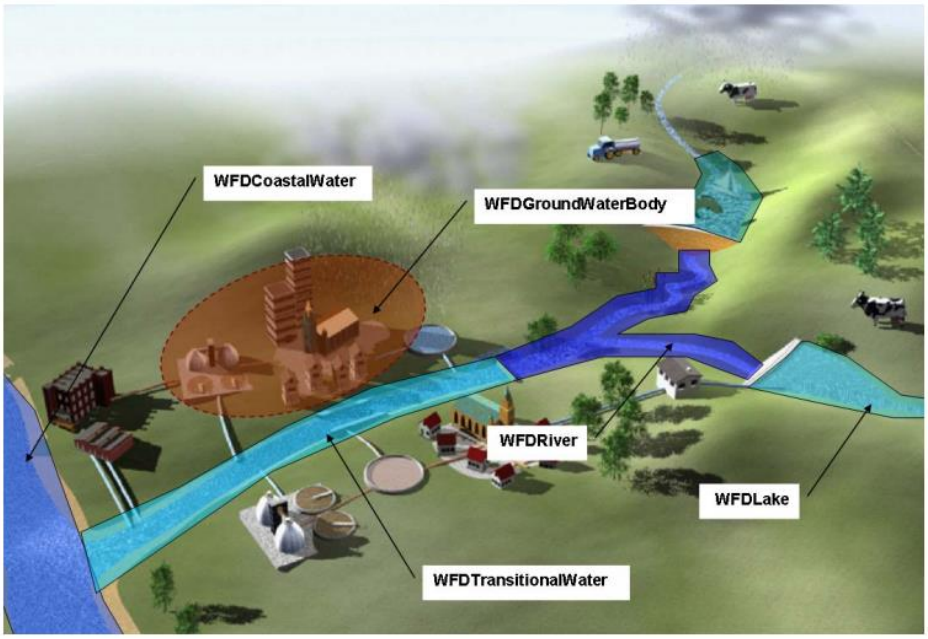

Figure 3 - Elements of reporting6

3. Strategy for obtaining the missing data

The proposed strategy is based on the principle that data could be obtained from various open sources. The main direction of the strategy is to use standard modelling methods for the hydrological data like: regression and correlation analysis, regional analyses achievements, methods of interpolation and extrapolation, rainfall-runoff models and methods of homogenization for data that is recognised as time series e.g. hydrological, climatological, hydrogeological (groundwater characteristics) and some environmental and social data. For all data related to land use, or economic data related to vulnerability analysis, the CORINE classification is suggested. CORINE classification is also recommended by the Handbook on good practices for flood mapping in Europe, EXCIMAP, 2007. It is recommended to use medium size level, i.e. 100x100m for a grid cell (corresponds to the scale 1:100.000, 1mmx1mm area). The whole procedure of data collection from alternative sources was demonstrated for the Initial flood vulnerability assessment in the Sava River Basin, Task 4 of this Pilot project. Tables 3 and 4 describe data availability and strategy how to obtain the missing basic data for preparation of the FRMP and the data for flood mapping.

However, the more time and money consuming methods could be also used, like screening the archives and old maps, obtaining data from stakeholders or local residents, or adequate spatial data collection methods (for ex. airborne or satellite, GPS technology).

Table 3: Obtaining Missing Basic Data for preparation of the FRMP

No.	Data name	Description	Scale	Data availability (at the moment)	Strategy for obtaining missing data
	Hydrography				
1	Sava river basin	Extent of Sava river basin (polygon)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: YES	-
2.	Sub-basins	Extent of sub-basins larger of 1000 km2 (polygons)		National level: YES ISRBC: YES	-
3.	Rivers	Rivers and streams (lines)		National level: YES ISRBC: YES	-
4.	Lakes	Lakes (polygons)		National level: YES ISRBC: NO	Alternative data source: WMS national topographic layers ESRI data
5.	Channels	Channels (lines)		National level: YES ISRBC: NO	Alternative data source: WMS national topographic layers ESRI data
	Topography				
6.	Country borders	Extent of countries (polygons)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: YES	-
7.	Places	Main settlements (points)		National level: YES ISRBC: YES	-
8.	Roads	Main roads (lines)		National level: YES ISRBC: NO	Alternative data source: WMS national topographic layers ESRI data
9.	General Digital elevation model	Low level details DEM (raster)		National level: YES ISRBC: YES	-
10.	Topographic map	(raster)		National level: YES ISRBC: YES	-
11.	Satellite/Aerial data	(raster)		National level: YES ISRBC: NO	Alternative data source: WMS national topographic layers Google Earth, Bing Maps
	Flood				
12.	Floods events	Occurrence of flood (points, lines, polygons)	Two scale levels: One for entire river basin One for hilly areas with limited extent	National level: YES ISRBC: PARTLY	-
13.	Flood plains	Flooded areas (polygons)		National level: YES ISRBC: PARTLY	-
14.	Natural retention areas	(polygons)		National level: YES ISRBC: PARTLY	-
15.	Manmade flood defence structures	Dikes, weirs, dams, pump stations (lines, points)		National level: YES ISRBC: PARTLY	-
16.	Conveyance routes for the significant past floods	(lines)		National level: YES (Slovenia) PARTLY (Croatia, BIH, Serbia) ISRBC: PARTLY	-
17.	Areas of a potential significant flood risk (APSFR)	(polygons)		National level: YES (Slovenia) PARTLY (Croatia, BIH, Serbia) ISRBC: PARTLY	-
18.	Transboundary flood areas	Cross border flood areas (polygons)		National level: YES (Slovenia) PARTLY (Croatia, BIH, Serbia) ISRBC: PARTLY	-
	Economic activities				
19.	Land use	Areas of same land use (polygons)		National level: YES ISRBC: NO	Alternative data source: CORINE 2006

			Two scale levels: One for entire river basin One for transboundary areas		
20.	Long term development	Planned economic activities (points, lines, polygons)		National level: YES ISRBC: NO	-
	Population				
21.	Population	Distribution of population (people per territorial unit) (polygons, raster)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: NO	Alternative data source: Global Rural-Urban Mapping Project, Version 1 (GRUMPv1): Population Density Grid, Center for International Earth Science Information Network (CIESIN), Columbia University; International Food Policy Research Institute (IFPRI); The World Bank; and Centro Internacional de Agricultura Tropical (CIAT). 2004. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw [date of download: December 2011] Given in: Pilot Project on Climate Change Adaptation Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin, 2012, Study with GIS database, ISRBC
	Climate change influence				
22.	New Flood scenarios	New flooded areas caused by climate changes (polygons)	Two scale levels: One for entire river basin One for hilly areas with limited extent	National level: NO ISRBC: NO	-

Table 4: Obtaining Missing Data for Flood mapping

No.	Data name	Description	Scale	Data availability (at the moment)	Strategy for obtaining missing data
	Flood scenarios/hazard				
23.	Water drainage network	Detailed data with hydrological and geomorphological characteristics of rivers	Two scale levels: One for entire river basin One for transboundary areas	National level: PARTLY ISRBC: PARTLY	Alternative data source: Global hydrological database (HydroSHEDS), developed by the Conservation Science Program of World Wildlife Fund (WWF) in partnership with the USGS, CIAT, The Nature Conservancy (TNC), and the Center for Environmental Systems Research (CESR), available from the http://www.worldwildlife.org/hydrosheds [date of download: December 2011] Given in: Pilot Project on Climate Change Adaptation Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin, 2012, Study with GIS database, ISRBC
24.	Cross section and longitudinal profiles for rivers	Detailed data showing river geometry with blocked obstructions (e.g. bridges).	Typically two to three cross sections per km and a set of three cross sections at each major hydraulic point.	National level: PARTLY ISRBC: PARTLY	
25.	Digital elevation model	High level details DEM (raster)	Min. horizontal requirements: 10 m*10 m Min. vertical requirements: 0.5 m (Ref. 3 Handbook)	National level: PARTLY ISRBC: NO	Possible tools/methods to generate DEMs of the required accuracy: • LiDAR (corrected for top of trees and objects) • SAR and variations (IFSAR, GeoSAR, AIRSAR) • orto-maps, DTM derived from digital satellite images (SPOT 5; multispectral res 10 m, panchromatic res 3-DTM/DEM derived from aerial digital ortophotos (terrain pixel size: 0,5-2,0 m; vert. res. 0,3-0,5 m • DEMs derived from the vectorized contour lines of 1:10 000 scaled digital map segments (terrain pixel size: 0,85-2,0 m; contour lines available in 1.0 m resolution, on flat territories also the median 0.5 m contour lines, interim terrain surfaces to be determined by non-linear interpolation
26.	Manmade flood defence structures	Dikes, weirs, dams, reservoirs, retentions	-	National level: PARTLY ISRBC: PARTLY	
27.	Hydrology	Basic elements of water regime (precipitation, flow, runoff and evaporation)	Maps of gauge stations with adequate data 1:25,000	National level: PARTLY ISRBC: PARTLY	**Application of regression and correlation analysis, regional analyses achievements, methods of interpolation and extrapolation, rainfall-runoff models and methods of homogenization for data that is recognised as time series e.g.**

					hydrological, climatological, hydrogeological (groundwater characteristics).
28.	Flood scenarios -medium probability (100) -high probability for transboundary areas (e.g. 20,50)	Flood scenario includes the following: Flood extent (intersection of flood level with terrain) Water depths (difference between flood level and the terrain) Water level (level of inundation) Flow velocity (optional) Flow direction (optional) Propagation of flood (optional)	Flood depth map: 1:5,000 -1:25,000 Flow velocity map (highly local information): 1.000 – 5.000 Flood propagation (cover large areas): 25.000-100.000	National level: PARTLY ISRBC: PARTLY	
29.	Flood hazard areas	Flood hazard class areas: high, moderate and low (polygons, raster) Overlying the maximum velocity map on the maximum water depth maps.	Two scale levels: One for entire river basin One for local levels	National level: PARTLY ISRBC: NO	
	Vulnerability				
30.	Population	Distribution of population (people per territorial unit) (polygons, raster)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: NO	Alternative data source: Global Rural-Urban Mapping Project, Version 1 (GRUMPv1): Population Density Grid, Center for International Earth Science Information Network (CIESIN), Columbia University; International Food Policy Research Institute (IFPRI); The World Bank; and Centro Internacional de Agricultura Tropical (CIAT). 2004. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw [date of download: December 2011] Given in: Pilot Project on Climate Change Adaptation Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin, 2012, Study with GIS database, ISRBC
31.	Protected areas – nature	Protected areas – nature (polygons) Only polygons > 100 ha	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: YES	One possible vulnerability classification is given in: Pilot Project on Climate Change Adaptation Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin, 2012, Study with GIS

					database, ISRBC.
32.	Cultural heritage	Cultural heritage includes tangible culture such as buildings, monuments, landscapes, books, works of art, and artefacts, etc. It also comprises the museums and similar facilities that store cultural heritage. (points, lines, polygons)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: NO	Slovenia: "Ocena poplavnega škodnega potenciala nepremične kulturne dediščine" (2011)
33.	Economic activities	Areas showing economic activities (polygons)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: NO	Alternative data source: CORINE 2000 From the CORINE land cover, the economic activities are recognized and corresponding level of vulnerability attached e.g: Bare rocks: no vulnerability; Land principally occupied by agriculture, with significant areas of natural veg: low vulnerability; Fruit trees and berry plantations: moderate vulnerability; Continuous urban fabric: high vulnerability. Given in: Pilot Project on Climate Change Adaptation Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin, 2012, Study with GIS database, ISRBC
34.	Special structures and objects	Structures and objects essential for functioning of society and economy (water supply systems, energy networks, telecommunication systems, mayor roads and railroads, etc.). Structures and objects that could cause pollution are usually dumpsites, water treatment plants, quarries, etc. (points, lines, polygons)	Two scale levels: One for entire river basin One for transboundary areas	National level: YES ISRBC: NO	Alternative data source: CORINE 2000 From the CORINE land cover, the structures and objects are recognized and corresponding level of vulnerability attached e.g: Mixed forest: no vulnerability; Construction sites: moderate vulnerability; Airports: high vulnerability. Given in: Pilot Project on Climate Change Adaptation Building the Link between Flood Risk Management Planning and Climate Change Assessment in the Sava River Basin, 2012, Study with GIS database, ISRBC
35.	Vulnerability areas	Vulnerability areas: high, moderate and low (polygons, raster)	Two scale levels: One for entire river basin One for transboundary areas	National level: NO ISRBC: NO	-
	Flood risk				
36.	Flood risk areas	Flood risk areas (polygons, raster)		National level: NO ISRBC: NO	-

			Two scale levels: One for entire river basin One for transboundary areas		

4. References

1. EU Flood Directive (2007), Official Journal of the European Union, 2007/60/EC
2. EU Water Framework Directive (2000), Official Journal of the European Union, 2000/60/EC
3. Ocena poplavnega škodnega potenciala nepremične kulturne dediščine (2011), Zavod za varstvo kulturne dediščine Slovenije, Ministrstvo za kulturo, Direktorat za kulturno dediščino, INDOK center, Inštitut za vode Republike Slovenije
4. Pravilnik o metodologiji za določanje območij, ogroženih zaradi poplav in z njimi povezane erozije celinskih voda in morja, ter o načinu razvrščanja zemljišč v razrede ogroženosti (2007), Uradni list RS, št. 60/2007
5. Preliminary Flood Risk Assessment in the Danube River Basins (2012), ICPDR
6. Sava River Basin Analysis Report (2009), ISRBC