



REPORT ON ALREADY COMPLETED OR ONGOING ACTIVITIES AND THEIR FINDINGS REGARDING FLOOD RISK MANAGEMENT PLANNING IN THE SAVA RIVER BASIN

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

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Table of Contents

1. Introduction	1
2. An overview of activities in the Sava River Basin and related Danube River Basin initiatives.....	1
2.1 Flood Risk Management (FRM) planning in the Sava River Basin	1
2.2 National activities of the Sava countries	4
2.2.1 Republic of Slovenia	4
2.2.1.1 Background information	4
2.2.1.2 FRM related activities.....	6
2.2.2 Republic of Croatia	7
2.2.2.1 Background Information	7
2.2.2.2 FRM related activities.....	7
2.2.3 Bosnia and Herzegovina	8
2.2.3.1 Background information	8
2.2.3.2 FRM related activities.....	8
2.2.4 Republic of Serbia	9
2.2.4.1 Background information	9
2.2.4.2 FRM related activities.....	10
2.3 Danube River Basin initiatives, primarily lead by the ICPDR with possible impact on the Sava River Basin	10
3. Overview of recent EU and international advances in the field	11
4. Comparison of the activities in the Sava River Basin and related Danube River Basin initiatives to the advances at EU level.....	14
Annex I: ISRBC activities.....	15
Annex II: Activities in Sava River Basin riparian countries.....	24
Annex III: Danube River Basin initiatives	42
Annex IV: EU and international advances in the field	49

Figures

Figure 1: Sava River Basin at the territory of the Republic of Slovenia and its sub-basins, (IzVRS: Danube Report, 2010) 4

Figure 2: Land use in Sava River Basin at the territory of Republic of Slovenia by Corine, (Danube Report, 2010)..... 5

Figure 3: Significant flood risk areas in Sava River Basin at the territory of Republic of Slovenia . 6 (Danube Report, 2010)..... 6

Tables

Table 1: Hydrological characteristics of main tributaries of Sava River Basin on the territory of Republic of Slovenia (Danube Report, 2010) 5

1. Introduction

This Report delivers an overview of the relevant, already completed and on going, activities regarding flood management and climate change in the Sava River Basin and in areas having direct influence on it. This particular task also contributed to brief recognition of stakeholders in the region who could be contacted in the process of preparation of the Program for Development of the Flood Risk Management Plan in the Sava River Basin. Development of the Flood Risk Management Plan (FRMP) also results from the signed Protocol on Flood Protection to the Framework Agreement on the Sava River Basin, by which, the four riparian countries, Parties to the FASRB, obliged themselves to be in line with EU directives in regard to the food risk management issues in the Sava River Basin, an to develop a Flood Risk Management Plan for the Sava River Basin.

This Report also covers important completed or on going activities regarding Sava River Basin. The Sava River Basin initiatives are given through ISRBC activities and activities undertaken into riparian countries. Moreover, the Report also gives an insight into and related Danube River Basin activities and initiatives. In order to get full insight into activities at European and international level, the Report shows the most relevant completed or on going projects regarding flood risk and climate change.

2. An overview of activities in the Sava River Basin and related Danube River Basin initiatives

This chapter focuses on major, both national and international, activities in the Sava River Basin. By screening the web sources and using material from International Sava River Basin Commission (ISRBC), as well as in collaboration with national experts dealing with water resources management, the Report systematically outlines the most relevant activities. All significant completed and on going projects and activities are presented. This activity has also brought an initial identification of the stakeholders related to the flood risk management.

2.1 Flood Risk Management (FRM) planning in the Sava River Basin

Focusing on the Sava River Basin the major activities and plans have been undertaken or coordinated by ISRBC. In addition, Sava riparian countries have also begun with their national activities related to the flood risk management planning. After comprehensive screening of the ISRBC documentation and available data, there are substantial activities, which are carried out, in previous years.

There is some diversity in FRM methodology applied among the EU Member States and the same situation is also present among the Sava countries. Within the EU, some countries are in the process of finalizing the Preliminary Flood Risk Assessment (PFRA) (e.g., Germany, Czech Republic, and Slovakia) and some others are developing Hazard maps for sub-basins and river stretches (e.g., Austria). Among the Sava countries, a similar diversity is present: with Slovenia, as a Member state, having more advanced compliance status and having PFRA development under preparation, Croatia also fulfilling plan to complete PFRA by the end of 2011, and Serbia and Bosnia and Herzegovina (BiH) entering the PFRA process, despite the fact of not having any

formal obligation of implementing the EU Directives deadlines. Serbia will finish PFRA process by the end of 2011.

In addition to the general approach towards establishing a methodology for FRM, Sava countries in the past have been engaged in many different hydraulic and hydrological modelling exercises for some portions of the Sava River. Most of these projects focused predominantly on one-dimensional and preferably stationary modelling concepts using historical hydrological data available for the wider area.

Since the Flood Risk Management Plan (FRMP) might be integral part of much wider River Basin Management Plan (RBMP), the starting point in this overview is the current status in the Development of the Sava River Basin Management Plan (SRBMP). This activity is defined in FASRB and its objective was to support the capacities in the Sava Basin countries Slovenia, Croatia, Bosnia & Herzegovina and Serbia in river basin management planning in compliance with the EU Water Framework Directive (WFD) requirements. The International Sava River Basin Commission (ISRBC) coordinated the project, initially supported by Secretariat of the ICPDR. Links to other relevant projects in the region were established to make best use of available resources, to avoid overlaps and to harmonise on going activities.

Another relevant document is the Sava River Basin Analysis Report, the characterisation report according to the Art. 5 of the WFD, approved at the 13th Special Session of the ISRBC, in September 2009. The Permanent Expert Group for River Basin Management (PEG RBM) of the ISRBC coordinated the preparation of the above-mentioned document. Furthermore, other expert groups and the Secretariat of the Sava Commission also contributed to the preparation of the Report, as well as many other experts from the beneficiary countries and external consultants from the CARDS project. Analysis provides an overview of General Sava River Basin characteristics, like climate conditions, ground water and surface water management in relation to WFD, water quality and water quantity, as well as navigation issues (Annex I). The Annex II entitled "*Flood Management in the Sava River Basin*" is the most relevant part of the Sava River Basin Analysis Report to this project. It is also a baseline document for development of the Flood Action Plan for the Sava River Basin (see *Report on Identification and assessment of existing legislation, strategies and plans related to FRM planning and climate change adaptation* for details). Annex II provides information on threats and prone areas as well as on historical flood events in the Sava River Basin. Furthermore, the same document outlines in comprehensive manner the existing flood management in the Sava River Basin riparian countries, long-term flood protection strategies in the countries and national flood prediction and warning practices. Appendices of the Annex II describe in a detail the flood management current approach in Bosnia and Herzegovina, Croatia and Serbia.

During 2008, the ISRBC initiated with U.S. Army Corps of Engineers (USACE) several activities along the lines of the *Sava River Study* which includes the Sava river modelling, Sava river flood risk mapping, and developing of HEC-HMS model (see activity tables in Annex I). The Phase I of the Sava River Study provided ISRBC with necessary tools to meet defined goals set up by the PEG for Flood Prevention (FP). These goals relate to floodplain management in the Sava River Basin including a Preliminary Flood Risk Assessment (PFRA), flood hazard and risk mapping, Flood Risk Management (FRM) plan, and flood forecasting, warning, and alarm system.

For the purpose of the above Study, the USACE developed the following: a Digital Elevation Model of the Sava River Basin, a preliminary HEC-HMS rainfall runoff model of the Sava River

Basin, a single HEC-RAS hydraulic model of the Sava River from the confluence with the Danube River to the Slovenian border, preliminary GIS-based inundation mapping of the Sava River floodplains. The hydrologic model (HEC-HMS) of the Sava River Basin is used for generating flood hydrographs for the unsteady flow modelled by the HEC-RAS. Particularly, the main goal was to provide the Sava countries with basic Hydrology and Hydraulics (H&H) models. The USACE utilizes the industry-standard software products including HEC-RAS and HEC-HMS. Up to now, the results are sufficient for implementation of a basin-wide flood plain management plan that could include a flood risk assessment methodology, preparation of joint flood risk and flood hazard maps, and design and implementation of a joint flood forecasting and flood warning system. The USACE recommends investing in the development of an updated DEM using LIDAR (Light Detection and Ranging) and appropriate post-processing to obtain much more accurate geometry in the hydraulic model.

In order to support and assist the ISRBC and the beneficiaries in preparing and starting the implementation of an integrated RBM plan, a new project entitled "*Preparation and Implementation of the Sava River Basin Management Plan*" has been launched (see Annex I). The main objective of this project is to facilitate approximation to the EU environmental acquis in the field of water management through identification of priority objectives common for the countries of the Sava River Basin, including Montenegro. Technical assistance in preparation and implementation of the Sava RBM Plan is managed by DG Environment of the European Commission and implemented by the Consortium from the Slovak Republic, while the ISRBC, through its Secretariat and the PEG RBM, provides facilitation and review of the project implementation to a certain degree. The project started in 2009 and it will be implemented within 2010 and 2011.

In regard to the climate change, the on-going project on Water and Climate Adaptation Plan (WATCAP) for the Sava River Basin is undertaken and financed by the World Bank, with limited involvement of the ISRBC and the Sava countries. The project includes hydrological/hydraulic/climatic modelling of the entire Sava River Basin for a number of climate change scenarios; assessment of possible effects of climate change onto different aspects of water management in the basin, analysis of alternatives for adaptive management in the Sava River Basin, with respect to climate change. This project has very ambitious goals and possibly important benefits for the Sava countries. Risks for successful implementation and reaching all anticipated goals are time constraints and limited budget. Consequently, wide agreement with the stakeholders in the region on the modelling inputs, as well as discussion on mid-term and final results may be lacking. However, the final project outputs could be a good starting point for some activities anticipated in this project, especially for discussion and agreement on the adaptation measures by the Sava countries. The WATCAP is to be finalized by mid 2011, tentatively. Climate experts from the Sava River Basin riparian countries have provided analyses of climate trends in the basin. The range of methods used by national experts emerges from their agencies' historical and ongoing judgments of what tools best characterize nationally important phenomena from an operational point of view. The toolboxes are not uniform and differ from country to country.

In 2008 PEG FP prepared a comprehensive overview of projects in the Sava River Basin in the last twenty years. The projects are relatively small-scale and concern hydrologic analysis and hydraulics on parts of Sava mainstream and its tributaries, as well as mapping with the availability of input data.

Besides the activity on Preparation of a detailed Program for Development of the Sava FRM Plan, the ISRBC's 2011 Work Plan considers the information exchange in production of the flood hazard and flood risk maps for the Sava River Basin, support and coordination of all activities in harmonization of methodologies and joint actions and plans of the Sava countries. Moreover, in frames of the activity A3, which is a topic of another assignment, within this project, it is planned to elaborate various existing climate change scenarios for the region, their expected impacts on water cycle, and more specifically on frequency and magnitude of extreme flood events. The activities will be coordinated through the Secretariat, PEG FP, Ad-hoc Expert Group for Hydrological and Meteorological Issues (Ah HM EG) and Ad-hoc GIS Expert Group (Ah GIS EG) as responsible bodies of the ISRBC. Detailed developments of hydrological and hydraulic modelling, implementation in GIS, as well as screening of other activities of PEG FP will be performed within the course of the project. Detail description of the activities is given in form of tables in Annex I.

2.2 National activities of the Sava countries

National activities of the Sava River Basin riparian countries mainly follow EU directives, even though each country has its own priorities according to the existing capacities. Since Slovenia is a Member State its current implementation status is more advanced in quality and quantity of documents present herein. This chapter gives brief overview of these activities and detail description in form of the tables is given in Annex II.

2.2.1 Republic of Slovenia

2.2.1.1 Background information

Sava river basin, together with its tributaries represents nearly 1/2 of national territory of Republic of Slovenia, exactly 13904 km². It is the national longest river (221 km). It starts in the North West Alpine region by two separate sources, Sava Dolinka and Sava Bohinjka and it flows downstream to South East, collecting waters from tributaries such as Kamniška Bistrica, Savinja from mountainous Karavanke region in the North, from Ljubljana and Krka from the southern Karstic region and from Kolpa and Sotla-border rivers with their hilly region (Figure 1).

In the most of its length Sava has torrential character, due to its own and its northern tributaries characteristics (Savinja, Kamniška Bistrica, Sora), but the Karstic character of Ljubljana and Krka prolong high discharges after heavy rain periods. The slope of the basin surface varies from 52 % in Sava Dolinka sub basin, to less than 10 % in Ljubljana sub basin, Table 1.

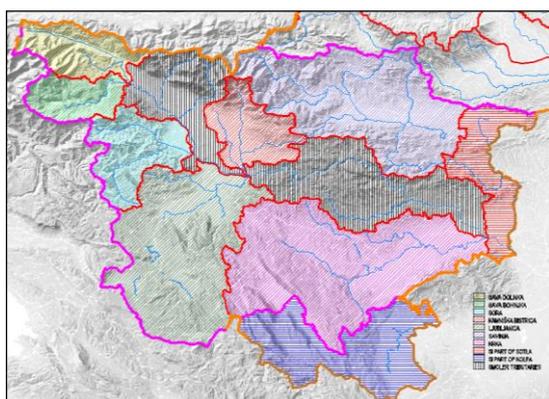


Figure 1: Sava River Basin at the territory of the Republic of Slovenia and its sub-basins, (IzVRS: Danube Report, 2010)

River-sub basin characteristics	Average slope %	Density of the river net km/km ²	Gauge station	F (km ²)	sQs (m ³ /s)	Q _{1%} (m ³ /s)
Sava Dolinka	52	0,8	Blejski most	505	22	480
Sava			Radovljica	908	43	1150
Sava			Šentjakob	2285	85	1800
Sava			Litija	4821	158	2450
Sava			Čatež	10186	272	3600
Sora	39	3	Suha	566	19,3	750
Kamniška Bistrica	26	1,5	Kamnik	195	7,2	260
Ljubljanica		1	Moste	1763	56	450
Savinja	33		Laško	1664	40	1400
Krka		0,7	Podbočje	2238	52	490
Sotla			Rakovec	560	9,3	400
Kolpa			Metlika	2002	71	1272

Table 1: Hydrological characteristics of main tributaries of Sava River Basin on the territory of Republic of Slovenia (Danube Report, 2010)

Average precipitation in national part of Sava River Basin is 1585 mm, evaporation 722 mm and run-off 863 mm. The basin is predominantly covered by forests and semi natural areas (9040 km²), agricultural land (4310 km²), the rest (420km²) are artificial surfaces (settlements, roads and other artificially modified areas). There are about 1,200.000 inhabitants living in the basin in 3755 settlements, 14 of them with more than 10.000 inhabitants, 14 with less than 10.000 and more than 5000, Figure 2.

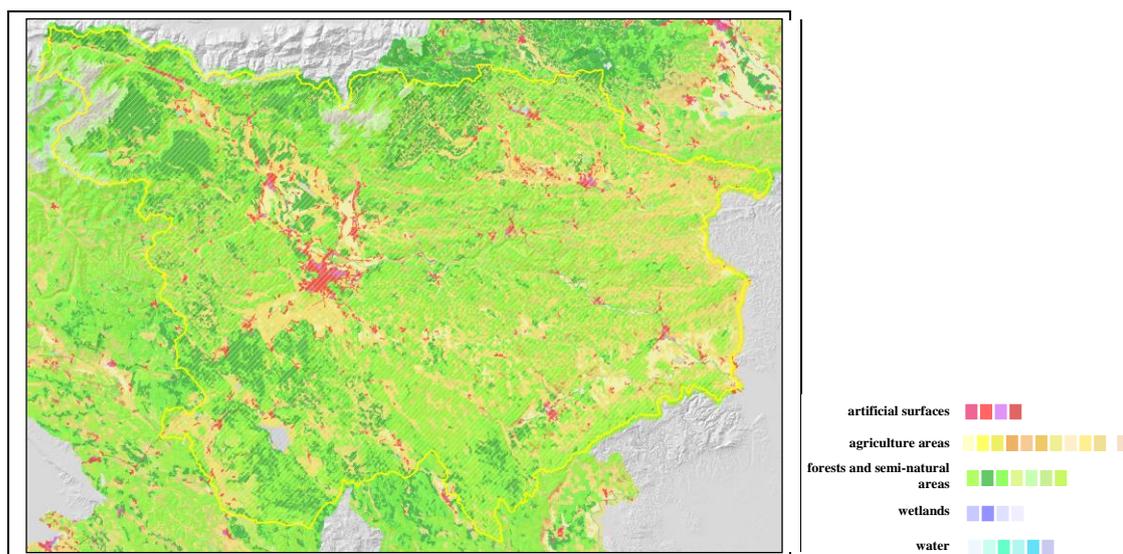


Figure 2: Land use in Sava River Basin at the territory of Republic of Slovenia by Corine, (Danube Report, 2010)

Most of the settlements are located in floodplains and in the narrow valleys. At this stage of assessment, there is about 430 km² of flood areas in the basin, of those about 28 km² artificial surfaces with about 65.000 inhabitants living in the flood risk areas. The most significant flood risk areas, due to pluvial floods are Ljubljana plain, caused by Ljubljanica and its tributaries, flood plains at Krško and Čatež caused by Sava and Krka and flood plains around Celje due to Savinja River and its tributaries, Figure 3. Narrow valleys, such as Železniki, upper Savinja valley, are endangered especially by torrent flash floods, associated with substantial erosion.

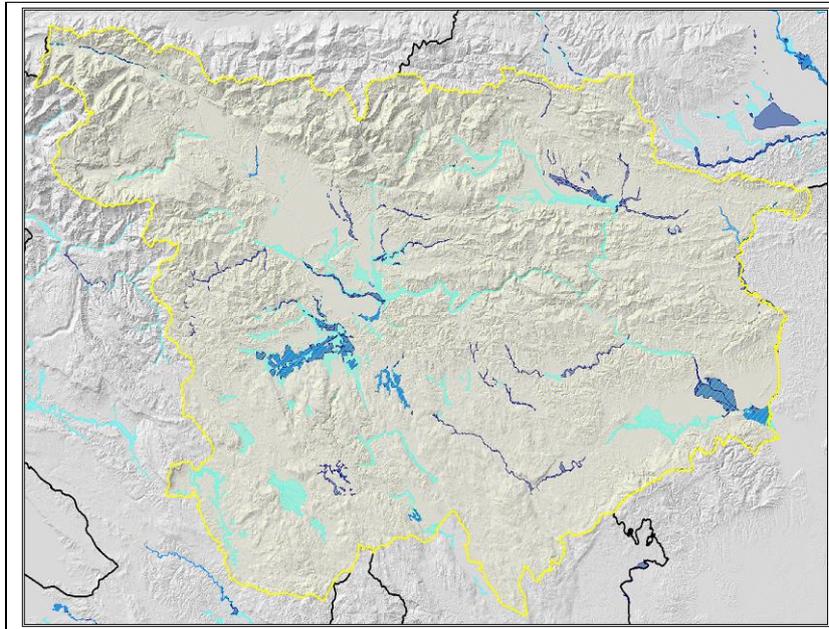


Figure 3: Significant flood risk areas in Sava River Basin at the territory of Republic of Slovenia (Danube Report, 2010)

Up to recently, main measures were focused on technical measures for local flood protection, mainly regulation of short stretches of watercourses, building by-pass channels and embankments, retentions such as Prigorica (10 mio. m³) in Krka river sub basin and Sotelsko jezero (5 mio. m³) in Sotla river sub basin.

2.2.1.2 FRM related activities

Recent flood events, especially those in 2009 and 2010 pointed out, that Slovenia will have to focus much more on basin wide management of floods, taking into account hydrological changes, due to climate change. Recently, it was recognized that measures has to be focused on reduction of flood risks, and preventive measures have to be included, such as public awareness of flood hazard, information of former flood events in physical planning documents, special building standards, etc .The protection of natural retention areas such as Ljubljansko Barje and Cerknjiško jezero and many smaller are becoming an important objective of spatial planning at all levels, national and local.

Flood risk management in Slovenia is a responsibility of the Ministry of Environment and Spatial planning, which is preparing policies, programs, plans, organizing public services for water works, preparing and financing most significant new investments to reduce flood risks. Environmental Agency of the Republic of Slovenia, which functions within the ministry is

responsible for hydrological monitoring and as a member of EFAS (European Flood Alert System) and MAP D-Phase (Mesoscale Alpine Program) is preparing forecasts up to 10 days ahead and launching flood warnings to the Notification Centre of the Republic of Slovenia, although the Ministry of Defence, department for civil protection is responsible for preparation of Civil Protection Plan and its performance during flood events.

2.2.2 Republic of Croatia

2.2.2.1 Background Information

The Sava sub-basin in Croatia covers 25.770 km² (27,0 % of the whole sub-basin). The total area of the Sava River Basin amounts to 95.551 km². Other parts of the Sava River Basin lie in Slovenia, Bosnia and Herzegovina, Serbia and Montenegro. In Croatia, the Sava flows in the length of 510 km and for the most part constitutes the border with Bosnia and Herzegovina (313 km). The total length of the Sava River is 945 km. The Sava River in Croatia is mostly recharged with water from the mountainous western part of the basin (the Sava River basin in Slovenia) and larger right-hand tributaries – the Kupa, Una, Vrbas, Ukrina, and Bosna rivers. Parts of the Kupa river in Croatia constitute the state border with Slovenia (total length of the 100 km), while parts of the Una River constitute the state border with Bosnia and Herzegovina (total length of 130 km).

2.2.2.2 FRM related activities

Competent bodies for flood protection issues in Croatia are Government of Croatia, Ministry of regional development, forestry and water management, Croatian Waters, which develop and implement legal provisions. Croatian Waters completed several studies for sub-basin of the Sava River Basin. Both hydrologic analysis and hydraulic modelling have been performed for the following sub-basins: Krapina, Česma, Ilova including Pakra, Orłjava and Kupa. Relevant completed and on-going activities in Flood Management in Croatia are:

- Collection of information on the flood risk which has been completed by means of adequate forms (related to: hydrology, hydraulics and mapping practices in Croatia, regulatory and institutional set up and responsibilities and flood protection structures);
- The assessment, performed in 2009 within the first preparation of the Sava River Basin Analysis Report;
- Part of the Sub-basin Level Flood Action Plan for the Sava River Basin;
- PFRA has been completed for almost the entire Sava River Basin (completion of the PFRA for the entire Sava River Basin is expected to the end 2011), PFRA is completed for the following sub-basins: Krapina, Česma, Ilova including Pakra, Orłjava and Kupa (see the Annex II).

For specific activities see the Annex II.

2.2.3 Bosnia and Herzegovina

2.2.3.1 Background information

The flood risk management and associated climate change issues in BiH are characterised by partially developed flood risk management activities closely connected to other water protection issues (like water pollution and water management) and physical planning documents. Flood risk management activities are parts of complex integrated water management system having its watercourses, groundwater, lakes and hydraulic structures including administrative parts.

The floods in BiH are often characterized with its sudden nature and high risk in damage, having huge impact on flood prone areas (inhabitants, goods, buildings). Therefore, the flood risk management systems have a central role in Water Management Strategy in the Federation BiH (strategy for the Republic of Srpska is in development phase). The Strategy in BiH adopts a principle that system's management has to be coordinated with development of other water sectors as well as water related stakeholders (like agriculture, forestry, hydro energy, physical planning and navigation).

2.2.3.2 FRM related activities

In BiH there are on-going activities aiming at harmonisation of Integrated Water Resources Management (IWRM) for Sava River Basin part in compliance with the same procedures conducting in the whole Sava basin as well as in the Danube River Basin. The most important activities are those related to active participation of delegates and experts for implementation of IWRM, establishment of PEG within ISRBC, participation in ICPDR expert groups. In regard to the assessment of FRM and climate change, the outcomes in BiH have been often transferred and built into the institutional frameworks and legislation. In addition, the outcomes are also incorporated in institutional databases, tools and instruments.

The basic methodological approach in implementation of these activities was done through different phases. During the first step a wider group of participants were acquainted with basic principles that should be followed. This was organised by water resources sector within numerous thematic workshops, round tables, by publishing adequate materials and journals (e.g., "Voda i mi") that may be found in Sava River Basin Agency in Sarajevo. In such a way a preliminary study of available international and national relevant documents, especially in segments, which define content and level of elaboration of preliminary flood risk management, has been harmonised. This approach also comprises the following activities:

- Mutual harmonisation of abovementioned documents and necessity to adjust relevant national legislation to the requirements of EU Flood Directive (EFD);
- Input and output elements necessary for development of the project including development of basic approach to adjust it to EFD;
- Availability of national documentation which is either directly or indirectly connected to flood risk management plans and its usability for obtaining abovementioned input elements necessary for the evaluation of this activity;
- Flexible software (applicable to IWRM plans) and database with relevant data from the abovementioned projects.

Analysing content and recommendations from the international documentation it can be seen that EFD has been set to fill some gaps within the WFD because of the following:

- It was noticed that the EFD has filled the missing part of WFD, because flood risk management as a part of IWM plan had not been elaborated enough in WFD
- In the BiH the floods appear to exhibit higher frequency and wider extent either as a result of climate change or increasing number of inhabitants and buildings in flood prone areas.
- In the BiH the future Flood Risk Management plan should be evaluated in accordance with EFD indicating that FRM is only a part of wider water risk management plan, which for the country like BiH has to be considered at the transboundary level.

As a result the approach in BiH has been accepted directing further activities to follow three-step approach already defined in EFD:

1. Preliminary flood risk assessment
2. Flood Risk Mapping
3. Development of flood risk management plans

With such approach and implementation of the activities (e.g., adjusting existing BiH water resources legislation with EU legislation and development of water management strategy) a basis for further flood risk management projects has been established. In order to initiate such projects, which will be part of IWRM plan, some important activities have been carried out.

Besides abovementioned activities some additional activities have been dedicated to the analysis of existing data, projects and preparation of new documentation aiming at creation of reliable maps and databases for Flood Management Planning of Sava River Basin part in BiH as well as for other river basins. These activities resulted in various analysis and available maps including data for mathematical models, flood maps, flood risk maps (hydrological, hydro morphological, maps for damage assessment and economic analysis). It is expected that in the future activities some of these results will be utilized and updated for the development of initial FRM development in BiH. Simultaneously many different agencies and relevant institutions are continuously testing parameters of developed models on the endangered watercourse areas.

Besides abovementioned projects there is on-going project *Support to BiH Water Policy*. The overall objective is to ensure the protection and rational use of water resources in BiH by application of integrated water management principles and other EU water-related policies. Detail about the project is given in the Annex II.

2.2.4 Republic of Serbia

2.2.4.1 Background information

Republic of Serbia is the most downstream country in the Sava River Basin shared by Slovenia, Croatia, Bosnia and Herzegovina and Montenegro. About 17% of total basin area is in the territory of Serbia.

RS stretch of the Sava River, 209 km long, has characteristics of a typical alluvial watercourse flowing through wide lowlands. Between the mouth of the Drina River (km 177) and the Croatian border (km 209) the river is the border line between Serbia and BiH.

Sava River tributaries at the Serbian section are:

- The Drina River (right tributary), the most significant both by catchment area and flow. The catchment is shared by BiH (37%), Montenegro (31.5%), Serbia (30.5%) and Albania (1%). There are many transboundary rivers in this river basin (Drina, Lim, Cehotina, Crni Rzav, Beli Rzav). Drina makes the border between BiH and Serbia in its downstream reach;
- Several small right tributaries with catchments located only within the Serbian territory. The largest one is the Kolubara;
- Several left tributaries, the most important being the Bosut River.

2.2.4.2 FRM related activities

The preliminary flood risk assessment will be prepared by the Ministry and will cover the entire territory of the country. Preparation of flood hazard and flood risk maps is the obligation of public water management companies. In 2017, flood risk management plans shall be delivered for the territory of the Republic of Serbia and for its water districts.

Republic of Serbia is involved in all activities of ICPDR and ISRBC, related to flood risk management planning. The Protocol on flood protection to the FASRB is passing through ratification process in Serbia.

2.3 Danube River Basin initiatives, primarily lead by the ICPDR with possible impact on the Sava River Basin

The review of the initiatives and activities lead by ICPDR, has been performed by reviewing relevant ICPDR documents, particularly ICPDR Flood Protection Expert Group (FP EG) plans and current status of achievements. Sava River Basin flood protection, prevention and mitigation shall be done in support of the implementation of the Programme on Sustainable Flood Protection in the Danube River Basin. Some tasks are directly linked to Danube sub-basins such as to review and update of the flood action plans in sub-basins by going over the current situation and set targets and respective measures for reducing adverse impacts and the likelihood of floods, increasing awareness and level of preparedness and improving flood forecasting. The action plans were adopted in 2010 and will be updated as needed in accordance with the new developments in flood protection, prevention and mitigation at the national level. However, the Report on Achievements in Flood Protection in the Danube River Basin is defined as living document presenting the progress made in the implementation of the ICPDR Action Programme and of the European Flood Directive, so the permanent follow up will be required during execution of the whole assignment.

An important issue is ICPDR reporting formats for the different stages of implementation of the EFD which will be applied for the activities related to the implementation of EFD in the Danube River Basin as well as for the updates of flood action plans in sub-basins. ICPDR reporting

formats for preliminary flood risk assessment are expected to be ready by mid 2011 and draft reporting format for flood risk mapping by the end of 2012.

The issue that concerns flood risk management in the Sava River Basin is ICPDR coordination platform for EFD implementation to reaching a common understanding on the requirements for the implementation of the Floods Directive, and for linking with other related activities in the Common Implementation Strategy (CIS) and at EU level for support of the implementation. As not all ICPDR Contracting Parties are EU Member States ICPDR will provide a platform for information exchange and for discussion on key EFD implementation issues at the Danube River Basin level as well (level A). For the Danube River Basin District a single roof report on preliminary flood risk assessment will be prepared on the level A describing the approaches taken by the countries including the coordination aspects. The report will also address all topics from the EU Reporting Sheet on preliminary flood risk assessment. It is expected that Table of Contents of the preliminary flood risk assessment report will be ready by the spring 2011 and preliminary flood risk assessment report by the end of 2011. The key task of the assignment will be to establish the platform at the level B and also at smaller scales for some specific purpose (for. ex. vulnerable areas).

The ICPDR project is going to develop a scalable system of flood risk maps for the Danube River floodplains, which should be followed for the Sava River Basin. Transnational methodology and models will be defined and implemented for flood risk assessment and mapping.

The ICPDR FP EG plans to foster harmonization of the flood forecasting methodologies and coordinate interlinking regional and national agencies on sub-basin and basin level to facilitate and promote the exchange of source data and forecasting and warning in transboundary sub-basins. Sava River Basin Program should be in line with accepted ICPDR methodology. Since the ICPDR FP EG Progress report is not expected before the end of 2011 it will be necessary to watch the interim reports or similar documents regarding this very important issue. The ICPDR FP EG will supervise the continuous testing and operation of the existing Danube EFAS (European Flood Alert System) and cooperate on its updating with the EC JRC. Danube EFAS includes rainfall and flood forecasts throughout the river basin, and maps showing rivers potentially reaching critical alert levels for all Danube tributary rivers with upstream areas larger than 4,000 km².

ICPDR Information Management and GIS Expert Group (IM&GIS EG) Work plan reveals that the DanubeGIS System Development is in advanced phase. It is expected that up-to-date server hardware and software in 2011. Modern interactive WebGIS viewer will be introduced in the period 2011-2012. The Report on overlap and differences with WISE, INSPIRE, and WasserBLICK is expected by the end of 2011. Tisza sub-basin level is already included in the plan, which could be a good example for the Sava River Basin.

Detail description in form of tables is given in Annex III.

3. Overview of recent EU and international advances in the field

There are several key documents that affect and advice to decision makers and water managers on how to assess various impacts on water quantity and quality, how to perform risk assessment, and how to develop and implement appropriate strategies. Guidance on Water

and Adaptation to Climate Change, published by United Nations Publications in 2009 comprehensively evaluates topics related to climate change adaptation that takes into account the transboundary dimension of water management and concept of integrated water resources management. Specific problems and requirements of transboundary basins, with the objectives of preventing, controlling and reducing transboundary impacts of national adaptation measures and thereby preventing and resolving possible conflict. The emphasis is laid on common approach and cooperation for riparian countries in adapting to climate change thus maximizing benefits and minimizing costs.

The document Best Practices on Flood Prevention, Protection and Mitigation (2004) concerns the “best practice document”, which is an EU update of the United Nations and Economic Commission for Europe (UN/ECE) Guidelines on Sustainable flood prevention (2000). It is a living document that will need continuous input and improvements as application and experience build up in all countries of the European Union and beyond. The “best practice document” comprises basic principles and approaches, now-how to translate and implement the principles and approaches.

UNECE Workshop on Water and Climate Change: How To Develop an Adaptation Strategy in Transboundary Basins brought together countries and main international actors engaged in activities on water and adaptation to climate change, in particular in transboundary basins. In particular, the workshop aimed to assist governments implementing pilot projects on adaptation to climate change under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) in planning and implementing the objectives, steps and activities of the projects. The workshop also discussed how to ensure a continuous exchange of experience on adaptation to climate change in transboundary basins through a pan-European platform under the Water Convention.

The Danube FLOODRISK project focuses on the most cost-effective measures for flood risk reduction: risk assessment, risk mapping, involvement of stakeholders and risk reduction by adequate spatial planning. The project promotes transnational, interdisciplinary and stakeholder oriented approaches and brings together scientists, public servants, NGOs and stakeholders who jointly develop a scalable system of flood risk maps for the Danube River floodplains. Transnational methodology and models will be defined and implemented for flood risk assessment and mapping. This results in proposals for flood mitigation measures, adjustments of spatial development plans, assessment tools for economic development in flood plains and raised awareness of flood risk of stakeholders, politicians, planners and the public. Flood hazard maps show the inundated areas and optional additional information like inundation depth, flow velocity and direction (local maps also dynamic processes). The simulation will use a hydrodynamic approach. Flood risk map will show the potential losses related to a set of events. The calculation is based on assets by land use and damage functions, adjusted for each land use data set. Damage functions and the number of people endangered will be calculated and showed together with vulnerable infrastructure, cultural heritage and industry. FLOODRISK Manual guide of harmonized requirements on the flood mapping procedures for the Danube River is expected to be completed by the end of 2012.

The Integrated Project FLOODsite is one of the European actions, which support the Flood Directive. FLOODsite covers the physical, environmental, ecological and socio-economic aspects of floods from rivers, estuaries and the sea. It considers flood risk as a combination of hazard sources, pathways and the consequences of flooding on the people, property and the

environment. The project worked on an integrated European methodology for flood risk analysis and management for rivers, estuaries and the coast. Techniques and knowledge to support integrated flood risk management like sustainable “pre-flood” measures, flood event management and post-event activities are evaluated. Frameworks for decision support for long-term and flood event risk management are also elaborated. The project worked on seven Pilot Studies in FLOODsite covering areas liable to river, estuary or coastal flooding. The results from River Tisza Basin are valuable for other Danube River sub-basins like Sava.

FLOOD-ERA dealt with the evaluation of structural and in particular non-structural measures as part of flood risk management strategies. The FLOOD-ERA research project puts emphasis on the overall challenge of evaluating non-structural measures and comparing them with structural measures. The categorisation of measures evolved from civil engineering where it indicates structural measures in a “positive” way and summarises all remaining activities as non-structural. It predominately aims at a generic framework for evaluating all kinds of measures dedicated to the reduction of flood risks. In order to test draft concepts 6 case studies have been chosen within the countries funding the FLOOD-ERA project. The draft framework will be tested in site-specific investigations. The final elaboration could serve as a basic methodology for evaluation of guidelines for FRM practice.

Within RISKBASE project leading European scientists and representatives of major, European stakeholder groups reviewed and synthesized the outcome of previous EC framework projects, and other major initiatives, related to integrated risk assessment-based management of the water/sediment/soil system at the river-basin scale. One EU project is AQUATERRA related to Danube River Basin. Project’s deliverable is generic approach and guiding principles to integrated risk-based management of river basins. It also gave recommendations towards evolution and implementation of risk-based management in national and community policies and towards implementation in management, as well as proposal for the European research agenda related to risk-based management. A number of European river basins have been considered during the project execution, including the Sava river basin, based on contribution of the ISRBC.

EnviroGRIDS Black Sea catchment project uses Earth Observation System (EOS) to store, analyze, visualize and disseminate data and information on past, present and future states of the region, as well as to assess and predict its vulnerability and sustainability. Using EOS data the project will create drivers scenarios of changes such as climate, demography and land cover. A web-based observation system, which will include attractive visualisation tools will warn about environmental risks and help regional and governmental agencies to prepare the most adequate responses. The promotion of improved data access and use in the Black Sea catchment and the building of regional capacity on Observation Systems will influence the planning methods in Danube River Basin.

Detail description in form of tables is given in Annex IV.

4. Comparison of the activities in the Sava River Basin and related Danube River Basin initiatives to the advances at EU level.

An overview of the most relevant activities at EU and international level showed initiatives undertaken in both Danube and Sava riparian countries are in a line with global initiatives in EU. The main objective is to assess the risk and to develop flood risk maps. A global initiative is to apply transboundary principle and to consider river basins as basic platforms for flood management. The main obstacle could be different level of flood management in river basin riparian countries. Therefore, processes, projects, activities and initiatives usually take more time than required. Danube River basin and Sava river basin also face such problem. However, already finished projects indicate that systemic approach in planning phase and stepwise model for achieving final goal i.e. final flood risk plans. As regards climate change and influence to flood risk EU projects are still in investigation phase. The correlation obviously exists and comparing flooding with climate data could easily prove it, but there is still question how these findings incorporate into flood management processes and into flood risk mapping practice.

It is apparent that Sava riparian countries have been performing similar activities that concern the flood management. These activities are mainly based on national strategies or plan and follow actual legislation. PFRA as the first step in preparing FRMP is on-going activity in all riparian contrives ensuring that following activities could be implemented according to the Protocol on Flood Protection to the Framework Agreement on the Sava River Basin. The Program for Development of the Flood Risk Management Plan in the Sava River Basin should follow up the results of the countries' activities fostering application of EFD and guide them towards harmonized flood risk management plan for the whole basin. The good practice, lessons learnt and experience in the Danube river basin as well as application of flood risk management and research in other areas explored within EU projects could give good basis for development of common plan for SRB.

Annex I: ISRBC activities

Activity title: PREPARATION AND IMPLEMENTATION OF THE SAVA RIVER BASIN MANAGEMENT PLAN	
Funding institution: DG Environment of the European Commission,	Contact institution/person: ISRBC (International Sava River Basin Commission), Kneza Branimira 29/II, Zagreb, Croatia http://www.savacommission.org
Starting date : 2009	Ending date: 2011
<p>Description of the activity:</p> <p>The main objective of the activity is to facilitate approximation to the EU environmental aquis in the field of water management through identification of priority objectives common for the countries of the Sava river basin, including Montenegro.</p> <p>The project consists of two components: the first component, Technical assistance in preparation and implementation of the Sava RBM Plan, is managed by DG Environment of the European Commission and implemented by the Consortium from the Slovak Republic, while the ISRBC, through its Secretariat and PEG RBM, provides facilitation and review of the project implementation to a certain degree.</p> <p>The second component, Support to the ISRBC in preparation and implementation of the Sava RBM Plan, represents a direct grant of the EC to the ISRBC, with the primary aim to supplement the actions and activities of the first component.</p> <p>The First component of this project aims to:</p> <ul style="list-style-type: none"> - Provide support and assistance to the ISRBC and the Beneficiaries in preparing and starting to implement an integrated RBM plan; - Develop necessary capacities and information base to prepare an integrated RBM plan for the Sava river basin; - Facilitate coordination of the water-related support projects in the Sava river basin. <p>The second component has the primary aim to supplement the actions and activities of the first component, by focusing on:</p> <ul style="list-style-type: none"> - Data collection and knowledge building; - Coordination of the integrated Sava RBM Plan; - Sava GIS core establishment; - Public participation and dissemination, and - Development of the Sava RBM Plan follow-up strategy. <p>Important to emphasize in the context of UNECE project is following: CC is elaborated in separate chapter of the SRBMP-draft; Flood issues are partly elaborated in chapter on Hydromorphological alterations and in the chapter on the Integration of water protection with other development s in the SRB</p>	
Methodology used for assessment of FRM and climate change: N/A for this type of activity	

Activity title: THE SAVA RIVER MODELING**Funding institution:**

U.S. Army Corps of Engineers,

Contact institution/person:USACE, www.lrn.usace.army.mil,
ISRBC, Kneza Branimira 29/II, Zagreb, Croatia,
www.savacommission.org**Starting date : 2008****Ending date:****Description of the activity:**

The U.S. Army Corps of Engineers (USACE), working in partnership with the ISRBC, ISRBC member nations and the U.S. State Department, prepared hydraulic and hydrologic models of the Sava River. The intent of the project was to establish a single hydraulic model of the Sava River that can be a tool to help meet the goals of fostering multilateral cooperation and flood-hazard protection in the member Sava countries through the development of a regional floodplain delineation and flood-risk mapping effort. The work supports the charge of the ISRBC's Permanent Expert Group for Flood Protection (PEG FP) to develop a flood risk assessment methodology leading to joint identification of potential significant flood risk areas, prepare joint flood risk and flood hazard maps, develop and implement a flood risk management plan, and design and implement a joint flood forecasting and flood warning system. The results of the PEG FP tasking are requirements of EU Water Framework Directive and EU Flood Directive.

The models prepared in this phase of the work are useful for these purposes, but should be further refined to increase their utility. The results of this project should provide the International Sava River Commission with the tools necessary to progress toward their goals of floodplain management in the Sava River Basin including a Preliminary Flood Risk Assessment, Flood Hazard and Risk Mapping, Flood Risk Management Plan, and a Flood Forecasting, Warning, and Alarm System.



Source: REPORT OF THE SAVA RIVER MODELING /
ISRBC & USACE

Figure: HEC-HMS Basin Model used to Develop
Flow Hydrographs for Unsteady Modelling

The work products developed by the USACE include a single HEC-RAS hydraulic model (steady and unsteady) of the Sava River from the confluence with the Danube River at Belgrade to the Slovenian border, a preliminary HEC-HMS rainfall runoff model of the Sava River Basin, preliminary GIS-based inundation mapping of the Sava River floodplains, and a workshop to deliver the work products, explain the development process and provide information on U.S. floodplain management practices. USACE developed a preliminary hydrologic model (HEC-HMS) of the Sava River Basin for use in generating flood hydrographs for the unsteady flow HEC-RAS model (Figure).

This model provides the opportunity for the ISRBC and participating partners to adjust hydrologic parameters and calibrate the model to known flood hydrographs. Additionally, it is worth mentioning that the ISRBC Secretariat collected and set up georeferenced geometry of the Sava River from Belgrade to Radovljica, as well as for some other major tributaries.

These products directly support the goals of the ISRBC and should serve their immediate needs while providing a basis for augmentation to meet future analytical needs. In addition to these products USACE gave several recommendations.

Methodology used for assessment of FRM and climate change: N/A

Activity title: SAVA RIVER BASIN ANALYSIS (SRBA) REPORT	
Funding institution: EC CARDS, UNECE	Contact institution/person: ISRBC, Kneza Branimira 29/II, Zagreb, Croatia http://www.savacommission.org
Starting date : 2007	Ending date: 2009
<p>Description of the activity: SRBA provides the characterization and assessment of water resources in the SRBA in accordance with Article 5 of the EU WFD, including an additional consideration of the important issues such as flood management and development of navigation in the basin. Accordingly, the Analysis has been accepted by the Sava Commission "as a good basis for further activities on development of the Sava River Basin Management Plan". It provides:</p> <p>Overview of the Sava River Basin - related to FASRB in the context of cooperation in river basin management. This includes the following topics: History of cooperation towards the FASRB; Goals of the FASRB; Facts about ISRBC.</p> <p>General Characteristics of the Sava River Basin - related to basic facts on the SRBA such as: location, area and countries sharing of the basin, relief and topography, land cover / land use in the basin, soils. The general characteristics also include overview on climate conditions, main hydrographic features, groundwater and ecological characterization (wetlands) in the SRB. Main hydrographic features are presented through the description of the Sava River and its main tributaries, which provides the overview of the "Sava River Basin Analysis' Rivers (agreed list of the Sava rivers for the purpose of the SRBA report).</p> <p>Overview of Water Management in the Sava River Basin - describes the Administrative Framework, provides a list of Competent National Authorities for implementation of the WFD and states Multilateral and bilateral arrangements. Water Quality - covers topics such as the characterization of surface waters and groundwater. It is significant part of this Report, but it is not relevant to our task. Water Quantity - is discussed through the following three topics: Elements of water balance in the SRBA; Water Use and Demands and Economic analysis of water use in the SRBA. Elements of water balance in the SRBA are discussed through the presentation of the facts about: Climate conditions; Hydrologic characteristics; Water balance and Extreme events like floods and droughts. Overview of water use and demands also covered water demand scenario for 2015 in the SRBA. Topics related to Flood Management in the SRBA are treated in annex to this Report. Intensive discussions on the methodology and collected data on significant flood events, flood protection structures, as well as of flood management in the Sava countries can be found in ANNEX II to this Report. Because of this ANNEX II shall be treated as a separate document/activity within A1. Appendices I to III - describes the existing flood management in Bosnia and Herzegovina, Croatia and Serbia. The following topics are covered: the basic characteristics of the SRBA, basic information on flood prone areas, information on historical floods, presentation of existing flood management (especially issues such: commanding responsibilities, system and state of the flood protection structures, structure of the drainage system and national flood prediction and warning practices), long-term flood protection strategy, possible impacts on present flood protection level.</p>	
<p>Methodology used for assessment of FRM and climate change: Methodology used to define the climate in the area of research consists of dealing with following issues:</p> <ul style="list-style-type: none"> - identification of climate types for the area, - determination of the existence and level of distinction between cold and warm seasons if it exists, - description of characteristics of warm and cold season, - classification of climate conditions within the basin into general types, - identification of most significant factors that cause climatic modifications, - determination of the existence and sharpness of dividing lines between identified climate categories. 	

Activity title: ANNEX II TO SRBA REPORT: FLOOD MANAGEMENT IN THE SAVA RIVER BASIN**Funding institution:**

ISRBC & Parties to FASRB

Contact institution/person:ISRBC, Kneza Branimira 29/II, Zagreb, Croatia
<http://www.savacommission.org>**Starting date :** 2008**Ending date:** 2009**Description of the activity:**

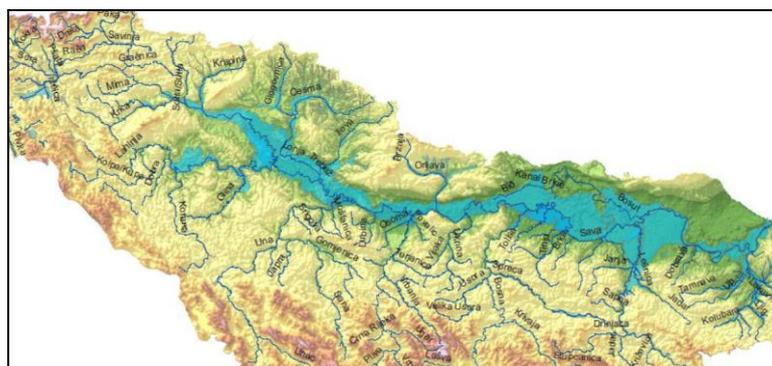
Topics related to Flood Management in the Sava River Basin are treated separately in second of two annexes to Sava River Basin Analysis Report. ANNEX II – FLOOD MANAGEMENT IN THE SAVA RIVER BASIN is significant and represents a core database of consulting services (A1) to be provided. Because of this ANNEX II is treated, as a separate document, and at this point its content will be presented as follows. Annex begins with presentation of basic information on: prone areas, threats and historical flood events within SRBA. The next part of Annex (main and most extensive part) deals with the Existing Flood Management in SRBA. Thus, with topics such as:

- Commanding responsibilities which presents institutional arrangements in Bosnia and Herzegovina, Croatia, Serbia and Slovenia,
- Design / construction criteria, system and state of the flood protection structures.

For each of the countries previously mentioned topics are discussed but there is no comparison between countries on these issues, nor it is chosen approach, which covers all states issue by issue. The very same approach is applied to the presentation of long-term flood protection strategies and to the description of the National Flood Prediction and Warning Practices. The second last part of the Annex deals with the cooperation and common effort in the SRB by describing activities under the lead of the ISRBC. Annex ends with the presentation of recommendations on further regional cooperation in flood management.

Assessment of FRM and climate change (1/2):

Initial setup of a methodology for defining flood management in the Sava River Basin is presented in the part of Annex II entitled “**Basic information on prone areas and threats**”, and serve in pointing to the relevant data. At the beginning key areas where floods occur and list of important flood prone areas of the Sava River are presented. The list of important flood prone areas of the transboundary tributaries to the River Sava is also provided. Based on this data a graphical representation (Indicative map) of important floodprone areas along the Sava River is created (figure below).



Source: ANNEX II (SRBAR): FLOOD MANAGEMENT IN THE SAVA RIVER BASIN / ISRBC

Figure: Indicative map of important floodprone areas along the Sava River

Information on **historic floods** on the Sava River and its tributaries in the whole Sava River Basin are presented. A special emphasis is given to several large floods occurred on the Sava River and throughout the basin, during the last century.

Commanding responsibilities is the next topic and it is discussed in terms of expressing the current institutional arrangements that exist in Bosnia and Herzegovina, Croatia, Serbia and Slovenia (each

country separately). The attention is given to identification of:

- Legal framework regulating FRM, flood protection and water management - the main legal instrument/s (legislative documents) which determines the protection against harmful water or against harmful water effects (and specify with which other documents were compliant - both domestic and foreign)

Assessment of FRM and climate change (2/2):

- Institutions responsible for the law (on flood risk management / protection) implementation as well as documents in which their responsibilities are defined
- Institutions responsible to provide for the financial sources,
- Spatial distribution of responsibilities for the implementation of legal provisions,
- Other institutions such as Hydro-Meteorological institutions, whose activity is associated with the FRM,
- Strategic plans and other types of flood protection plans for all levels (state, local, ...),
- Method of establishing the operational flood protection at all levels,
- Proceedings and measures for flood and ice protection.

Topics such as **design / construction criteria, system and state of the flood protection structures** are analyzed through the determination of:

- On what the flood protection system in the Sava Basin relies mostly,
- Used return period floods and freeboard,
- The degree of completion of Flood protection system (expressed in percentage),
- What is the impact on the flood regime in the state analyzed (as in the downstream countries) of the existing system and state of the flood protection structures,
- Are there any national parks, nature parks or other protected area if such areas exist then one should make a list with information about their location and size,
- The state of maintenance and inventory of possible damage to flood protection structures, in particular hydraulic,
- State of the monitoring process,
- The state of reconstruction that have been implemented and are ongoing,
- Why were constructed Flood protection structures which were analyzed along the river and its tributaries (classification according to what it protects: larger settlements, significant industrial facilities, agricultural land);
- Impact on current flood protection level which can be caused by: too few reliable data about impact of climate changes on flows, large pressure to change land use and lack of non-structural measures,
- Whether in spatial planning procedures incorporated important principle - the preservation of existing flood hazard areas,
- Is there a decree to prevent and limit the land use, which is generating new flood risk potentials - this is considered as the most important preventive measure in line with flood risk management plan.

National Flood Prediction and Warning Practices - adequate hydrologic information, flood prediction and warning system are needed for implementation of both integrated water resources management and flood risk management in the Sava River Basin. Furthermore, a strong cooperation in sharing data and information among the riparian states present the key factors. Therefore the following circumstances are determined:

- The role of the Hydro-Meteorological Institutes, or similar organizations in each country;
- The type of data (hydrological and meteorological data) collected by such organizations and to whom the information are being forwarded;
- The existence of on-line monitoring stations system to ensure a more efficient operative flood protection;
- The accessibility of collected data by the national protection, rescue organization and public bodies;
- Legal definition of State Hydro-Meteorological Services role in flood protection;
- Existence of plans to improve forecasting and warning procedures and to incorporate more extensively radar surveillance for those rivers on which flood waves rise within $T_p \leq 10$ hours

- The possibility for improvement of operative practices in national forecasting departments with forecasting tools based on international cooperation;
- The existence of quality cooperation between the Weather and Hydrological forecasting staff in national forecasting departments (because it can be extremely beneficial in preparing and issuing hydrological forecasts and flood warnings).

Activity title: HYDROLOGY REPORT FOR THE SAVA RIVER BASIN ANALYSIS (HRSRBA)	
Funding institution: International Sava River Basin Commission (ISRBC)	Contact institution/person: ISRBC, Kneza Branimira 29/II, Zagreb, Croatia http://www.savacommission.org
Starting date : 2008	Ending date: 2009
<p>Description of the activity:</p> <p>As part of activities on preparation of this Hydrology Report for the Sava River Basin Analyses very extensive technical and hydrotechnical documentation was studied in almost all countries that share the Sava River Basin. An international team of experts was formed to review the documentation that was available in their countries (the countries of the Sava River Basin). The working team systematically analyzed the available data and selected the base documentation to be used in the due course of preparation of the Hydrological Report for the Sava River Basin Analysis:</p> <ol style="list-style-type: none"> 1. Hydrological Study of the Sava River Catchment, Federal Hydro-meteorological Service of Yugoslavia, Belgrade, 1969; 2. Study for the Regulation and Management of the Sava River in Yugoslavia, Polytechna-Hydroprojekt-Carlo Lotty, 1972; 3. Master Plan for Development of Water Resource of Yugoslavia, Part I, Present status, B- Data base, Book B-II1.2.1 Climatic factors and Book B-III 1.2.2 Hydrological database, Volume 2, Belgrade, 1973; 4. Hydrological Study of the Sava River, Coordinating Committee of the Sava River Project - Zagreb and Institute for Water Resource Development - „Jaroslav Černi“, Belgrade et al., 1976; 5. Hydrology Balance of the Danube River, Federal Hydro-Meteorological Service of Yugoslavia and Institute for Water Resources Development „Jaroslav Černi“, Belgrade -1977; 6. Hydrology of the Danube River, UNESCO IHP, Bratislava, 1988; 7. Master Plan for Development of Water Resourced of Serbia, Hydro meteorological Data Bases, Institute for Water Resources Development „Jaroslav Cerni“, Belgrade, 1996; 8. Master Plan for Development of Water Resources of Bosnia and Herzegovina, Public Company for Management of Water Resources and Institute for Water Resources Management, Sarajevo, 1994; 9. Surface Water Courses and Water Balance of Slovenia Hydro-meteorological Service of Slovenia, Ljubljana, 2008; 10. Hydrological database HIS2000 (Hydrological Information System), State Hydro-meteorological Service of Croatia, Zagreb; 11. Hydrological Study of the Sava River, Croatian Waters, Zagreb, 2000; 12. Hydrological Database for Water Development of the Management Strategy, Croatian Waters, Zagreb, 2001; 13. Water Balance of Slovenia 1971-2000 and 1961-1990, Hydrological Study, Hydro-meteorological Service of Slovenia and Faculty for Civil Engineering, and Geodesy, Ljubljana, 2008; 14. System for Flood protection of Middle Posavina – Analyses of Flood Water of the Sava River, VPD d.d., 2005; 15. Study of Low Flows in the Sava River Catchment, Croatian Waters, Zagreb, 2005; 	

16. The Danube and its Basin – Hydrological Monograph, Follow-up Volume VIII, Basin-Wide Water Balance in the Danube River Basin, Regional Cooperation of the Danube Countries in the Frame of the International Hydrological Programme of UNESCO and Water Research Institute Bratislava, Slovakia, 2006;
17. Determination of Flow Regime at the Entering Profiles into Republic of Croatia with Respect to Water Quantity and Water Quality, VPB d.d. Zagreb, 2008;
18. Assessment of Present Level of Flood Protection in Federation of Bosnia and Herzegovina and Program for Improvement, Hydrological Data Base, Institute for Water Resource Management, Sarajevo.

The performed preliminary analyses have shown that all of these studies are very different in many ways. Firstly, the used working programs as well as length of the analyzed time series were different. In addition, methodologies that were applied in calculations and means of presentations of the results varied from one study to the other. Therefore, the results are often incompatible and cannot be easily compared. Furthermore, some studies fully or partially use the data from previously completed ones, often without references to the used material. This creates great difficulties in assessment of reliability of evaluation. Calculated results, for which the used time-series were not specified, may particularly be regarded unreliable.

Despite that, the team conducted a detailed analysis and selected results presented in the report. On the basis of these results, graphs and tables that are related to the whole Sava River Basin were made and presented as an integral part of the report. Attachment to this report gives perennial characteristic values of the flow regime in 80 hydrological stations. The corresponding characteristic values of treated climate elements such as precipitation, air temperature, humidity, voltage, water vapour and evaporation, are shown (according to available data) on 60 meteorological stations. Results from the reviewed studies and documents are compared and presented in the report. Comparison is provided for: long-term average annual values of mean flow, a century-old minimum and maximum annual discharge and the minimum monthly flow of 95% confidence. Schematic longitudinal profiles along the Sava River are presented for an average flow, one hundred years of low and high waters. Historic floods and droughts based on very modest (scanty) data from the reviewed documents are also commented. Basic elements of water regime (precipitation, runoff and evaporation) is presented in GIS, based on existing maps of the earliest to the most recent periods. A detailed overview of the state of water balance along the main flow of the river basin and its major tributaries: Kupa, Una, Vrbas, Bosna and Drina, is provided on the basis of elements of the Study from 1973. in which this problem is addressed most detailed.

Within the available documents flooding problems were neither adequately presented, nor considered. Hydrograms of low and high waters were processed significantly only in one study, but only in terms of statistical-probabilistic definition of interdependence of some of the analyzed parameters. The genesis of the formation of flood is not specifically addressed.

Detailed analysis of historical floods in the Danube River Basin was carried out only in the study entitled "Study for the Regulation and Management of the Sava River in Yugoslavia, Polytechna Hydroprojekt-Lotty-Carlo" from 1972.

The basis for the analysis was registered hydro-grams of high water at 60 hydrological stations in the Sava River Basin. The main parameter for the identification of significant flooding was the volume of a flood wave, which is discussed both as volume of flood waves above a certain reference (base) flow and as volume of flood waves for a fixed duration. In addition to these two parameters, flood wave travel time along the Sava River has also been discussed. The travel time was measured either between profile gauges or up to occurrences of flood flows at the mouths of major tributaries. These comments relate to the results of historical floods for constant wave duration of 60 days.

Methodology used and results of this assignment (in relation to the overall FRM activities at the Sava RB level):

Activity title: PREPARATION OF IMPLEMENTING DOCUMENTS FOR ESTABLISHMENT OF THE SAVA GIS	
Funding institution: International Sava River Basin Commission (ISRBC)	Contact institution/person: ISRBC, Kneza Branimira 29/II, Zagreb, Croatia http://www.savacommission.org
Starting date : 2009	Ending date: 2009
Description of the activity:	
<p>As part of the obligation resulting from the Framework Agreement on the Sava River Basin (FASRB), and Sava GIS Strategy that aims to establish an effective and efficient (geo) information system and spatial data infrastructure to support a wide range of water management planning activities of the ISRBC, the Secretariat initiated Project entitled "Preparation of the Implementing Documents for Establishment of Geographic Information (SavaGIS)".</p> <p>A key deliverables of the Project are the data specifications, specification of a set of tools that will access information published through a distributed water data infrastructure to deliver future Sava River Basin water resources assessments. Proposal of Sava Geo Information System (Sava GIS) architecture is one of the most important outputs of the Project.</p> <p>Beneficiary Countries:</p> <p>The signatory countries of the Framework Agreement of the Sava River Basin (FASRB) – Slovenia, Croatia, Bosnia and Herzegovina and Serbia.</p>	
Methodology used for assessment of FRM and climate change: N/A for this type of activity.	

Annex II: Activities in Sava River Basin riparian countries

Activity title: PARTICIPATION OF SAVA RIVER BASIN RIPARIAN COUNTRIES IN THE ACTIVITIES OF FP PEG	
Funding institution: International Sava River Basin Commission (ISRBC)	Contact institution/person: Kneza Branimira 29/II, Zagreb, Croatia Web: http://www.savacommission.org
Starting date : 2009	Ending date: N/A
<p>Description of the activity:</p> <p>Sava River Basin riparian countries as members of Permanent Expert Group for Flood Prevention (PEG FP) participates in numerous activities which have been completed or are still under work or are planned under the coordination of FP PEG in order to prepare a basis for development of the FRMP for the Sava River Basin:</p> <ul style="list-style-type: none"> • Protocol on Flood Protection to the FASRB • Data collection - Collection of the information on the flood risk in the Sava countries has been completed by means of adequate forms related to: <ul style="list-style-type: none"> - hydrology, hydraulics and mapping practices in the Parties - regulatory and institutional set up and responsibilities, and - flood protection structures • The assessment, performed in 2009 within the preparation of the first Sava River Basin Analysis Report (i.e. the basin characterization report developed according to the Article 5. of the EU Water Framework Directive – 2000/60/EU), provided the following outputs: <ul style="list-style-type: none"> - basic information on the flood prone areas in the Sava River Basin - characteristics of historical flood events in the Sava River Basin - responsibilities in flood management in the Parties - flood protection structures and their state - long term flood protection strategy - national flood prediction and warning practices - review of strategic plans and regulatory acts - recommendations for further cooperation in the flood management on the basin-wide level • Hydrology Report for the Sava River Basin Analysis performed in 2009 gave an expertise on the existing hydrological data on the basin-wide level, accompanied GIS maps on hydrology data, as well as a proposal of a programme for a new hydrology study for the Sava River Basin. • Hydromorphology Report for the Sava River Basin Analysis prepared in 2009, together with the hydromorphology GIS database, served as valuable input for the consecutive Sava River Basin Analysis Report (2009), as it will for the future water management related undertakings. • Joint Flood Mapping Study for the Sava River - At the moment, a Joint Flood Mapping Study for the Sava River is being prepared in cooperation with the United States Army Corps of Engineers (USACE). It will present a first step in the development of the flood hazard and flood risk maps in the Sava River Basin. • Joint hydrological study for the Sava River Basin - Preliminary activities on preparation of a new joint hydrological study for the Sava River Basin are in course. • The Sub-basin Level Flood Action Plan for the SRB (2009) - Under the overall coordination of the ICPDR and with support of the ISRBC, a Sub-basin Level Flood Action Plan for the Sava River Basin has been developed from the Action Plans prepared by the individual Sava countries. It comprises the first program of measures to achieve the defined targets for the flood management in the Sava River Basin until the year 2015. • Permanent Expert Group for Flood Prevention (PEG FP) together with Ad-hoc Expert Group for Hydrological and Meteorological Issues (Ah HM EG) are working on a project proposal for the development of information & hydrometeorological flood forecasting / warning (HMIFFW) system in the Sava River Basin. The project will focus on establishing a common hydro-meteorological information and 	

flood forecasting/warning system and in the capacity building of national authorities dealing with flood alert and water management issues in integrated water management through improvement of information management, hydrological forecasting and flood warning capabilities. The project will bring together scientists, technicians, public servants and stakeholders who will jointly develop a common platform for sharing data and flood forecasting models, while flood management procedures and water resources management, based on recent developments in flood forecasting making use of predictive uncertainty, will be specialised by each partner country according to its specific needs.

Methodology used for assessment of FRM and climate change: N/A for this type of activity.

Activity title: PRELIMINARY FLOOD RISK ASSESSMENT IN SLOVENIA

Funding institution:
The Government of the Republic of Slovenia
Ministry of the Environment and Spatial Planning

Contact institution/person:
Ministry of the Environment and Spatial Planning
Environment Directorate, Department of waters
e-mail: gp.mop@gov.si

Starting date : 2009

Ending date: 2011

Description of the activity:

Activities of Slovenia in the Preliminary Flood Risk Assessment are conducted through the establishment of Hazard indication map, and by defining Potential adverse consequences as well as Criteria of significances. Preliminary Risk Assessment is seen as a linking activity of these three defined areas related to the Flood Management and results in a determination of significant Flood Risk Areas.

The purpose of establishing Hazard indication map:

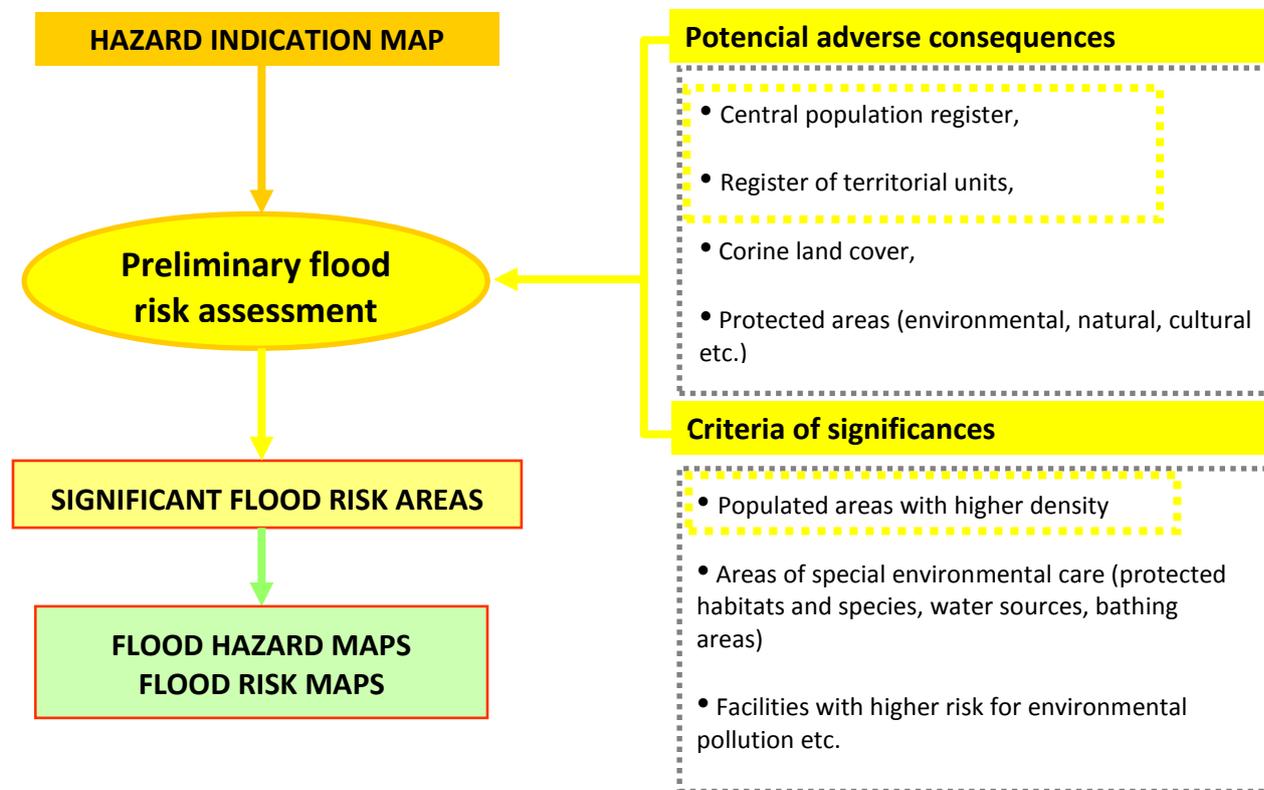
- estimation of flood and erosion conditions of the area,
- basis for spatial planning,
- informing the public about the hazards.

Establishment of Hazard indication map is based on analysis of past events, analysis of historic and archive data and analysis of the past research.

Contents of Hazard indication map:

- flood and erosion areas,
- registered events,
- common information concerning floods and erosion.

Assessment of FRM and climate change:



Activity title: "UPGRADING THE SYSTEM FOR MONITORING AND ANALYZING THE STATE OF THE WATER ENVIRONMENT IN SLOVENIA"

<p>Funding institution: European Union Cohesion Fund and Republic of Slovenia , Ministry of Environment and Spatial planning</p>	<p>Contact institution/person: Environmental Agency of the Republic of Slovenia, gp.arso@gov.si mag. Gregor Sluga, project leader e-mail: gregor.sluga@gov.si;</p>
<p>Starting date : EC Decree on approval of the project issued on 25th of May 2010.</p>	<p>Ending date: The conclusion of the project is predicted for the end of June 2015.</p>
<p>Description of the activity: “Upgrading the system for monitoring and analyzing the state of the water environment in Slovenia” is a project which objective is to ensure reliable, high quality and spatial representative meteorological and hydrological measurements to facilitate better monitoring and analysis of the state of water environment, as well as better forecasting of extreme hydrological events. In short, its aim is: Better Observation for Better Environmental Response – which gives it the name: BOBER. The entire project is a support to the better management of flood events, especially prevention of potential harmful consequences of floods. There fore the main objectives are: to upgrade and update the existing measurement network, to provide more accurate and on time forecasting and to improve understanding of water environment.</p> <p>The anticipated results of the project are:</p> <ul style="list-style-type: none"> • 248 upgraded and new measuring stations throughout Slovenia; • replacement of equipment at 33 measuring stations; • installation of an additional weather radar; • new equipment for periodic hydrological measurements and sea dynamics measurements; • provision of conditions for the operation of the Maritime Meteorological and Oceanographic Service; • upgrading the computer infrastructure in the ARSO Computer Centre; • upgrading and enlarging chemical, analytical, biological and calibration laboratories; • setting up systems to forecast the hydrological state of the Sava and the Soča rivers, sea dynamics, state of the underground water in alluvial aquifers and drought monitoring. 	
<p>Methodology used for assessment of FRM and climate change: Analysis and assessment of relevant meteorological and hydrological parameters indicating climate change are based on international methodologies agreed by WMO and European Centre for Medium-Range Weather Forecasts (ECMWF)</p>	

Activity title: TOPOGRAPHY SCREENING WITH LIDAR TECHNOLOGY	
Funding institution: Ministry of Environment and Spatial planning of the Republic of Slovenia	Contact institution/person: Ministry of Environment and Spatial planning of the R of Slovenia e-mail: gp.mop@gov.si
Starting date: May 2011	Ending date: May 2012and on
Description of the activity:	
<p>The main objective of the project is to provide topographical data of the whole territory of Republic Slovenia with LIDAR technology to establish national topographic data base to facilitate the preparation of detailed flood hazard maps, as a main basis to asses and manage flood risks at all levels, national and basin wide, as well as to facilitate spatial planning at the local level. The objective of the project is to support the flood management process under the climate change conditions.</p> <p>LIDAR - Light Detection and Ranging technology is a tool for measuring and recording elevation data for use in topographic mapping and three-dimensional terrain/surface modelling.</p>	
Methodology used for assessment of FRM and climate change: N/A for this type of activity	

Activity title: “ THE POWER OF WATER” labelling high waters in flood areas to rise awareness of flood risk

Funding institution:
Ministry of Environment and Spatial planning of the Republic of Slovenia, Environmental Agency

Contact institution/person:
Environmental Agency of the R of Slovenia
e-mail: gp.arso@gov.si

Starting date: March 2011

Ending date: Continuous

Description of the activity:

“The power of water” is an activity launched by Environmental Agency to rise awareness of floods by installing unified metal tablets “flood marks” on significant structures through out the country, especially in villages and towns effected by last floods of 2009 and 2010. The activity will continue and is regarded as one of the non-structural measures to reduce flood risks. Figure



Figure: Flood marking (Arso, Archive of news)

Methodology used for assessment of FRM and climate change: N/A for this type of activity

Activity title: PRELIMINARY FLOOD RISK ASSESSMENT ON SAVA RIVER SUB-BASINS IN CROATIA**Funding institution:**
Hrvatske vode (Croatian Waters)**Contact institution/person:** Ulica grada Vukovara
220, 10000 Zagreb, <http://www.voda.hr>**Starting date :** 2003**Ending date:** N/A**Description of the activity:**

Flood Risk Management in Croatia implies a comprehensive approach to reducing the likelihood of floods and their possible harmful effects on the population, economy and environment. This approach combines elements of precaution, protection, preparedness, and emergency action in case of encountering high water. The focus of actions conducted in Croatia is increasingly placed on preventive action within flood-affected areas from the protective measures in watercourses and other waters that are aimed to prevent flooding (which is the backbone of the traditional approach to flood management). Therefore numerous activities are focused on reducing the potential damage in case of flooding of unprotected or inadequately protected areas. Water Act ("Official Gazette" no. 153/09) provides that for each river basin and if necessary, for its sub-basins a preliminary flood risk assessment (PFRA) must be made. Preliminary flood risk assessment (PFRA) in Croatia is an initial basis for the realization of the first step in the process of development and establishment of flood risk management plans in accordance with the requirements of the WFD (Water Framework Directive, 2000/60/EC) and the FD (Floods Directive, 2007/60/EC). The aim of preliminary flood risk assessment in Croatia is to identify and present the topographic maps of areas that are potentially at risk from flooding or could be endangered in the future. Croatian Waters are conducting PFRA in the Sava River Basin for some time. PFRA has been completed for almost the entire Sava River Basin (completion of the PFRA for the entire Sava River Basin is expected to the end of the year 2011). PFRA is completed for the following sub-basins: Krapina, Česma, Ilova including Pakra, Orljava and Kupa (see the Figure below). Based on completed PFRA in Croatia, maps of flood hazard and flood risk maps will be made for each river basin and, if necessary, for sub-basins too. Flood hazard maps (maps) will include a demonstration of development of certain floodplain scenarios and flood risk maps will include a review of possible adverse consequences of development of these scenarios. Further on, a mathematical simulation model for the Central Posavljje has been developed which can serve as a good basis for assessing the risk of flooding in the area of coverage. It is also possible to extend this model to the downstream sections of the Sava River.

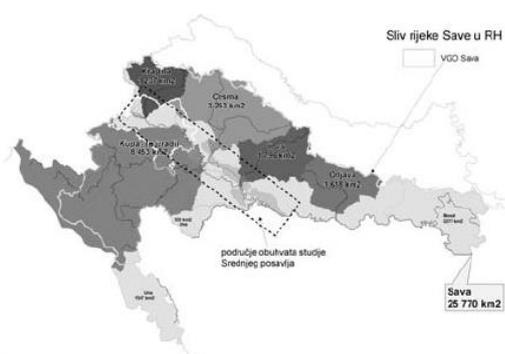


Figure: Sub-basin of the Sava River Basin for which the PFRA has been completed or is in progress

Methodology used for assessment of FRM and climate change:

For each river basin and, if necessary, for its sub-basins PFRA activities include following:

- 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 and 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.
- Showing parts of the study area (in appropriate scale) that are potentially at risk from flooding or in the future could be threatened by floods, as well as some parts of the area without a flood risk to be excluded from further activities.
- Preliminary assessment of flood damage caused by floods of different return periods (5, 10, 25, 50, 100 and 1000 years) and based on the results of the hydrologic process of high water and analysis of available information from existing studies and long-term development plans.

Activity title: MODELLING IN SAVA RIVER BASIN – CROATIA

Funding institution:
Hrvatske vode (Croatian Waters)

Contact institution/person:
Ulica grada Vukovara 220, 10000 Zagreb,
<http://www.voda.hr>

Starting date : 2005

Ending date: N/A

Description of the activity:

In Croatia, under the leadership of Croatian Waters, several studies are made for sub-basins of the Sava River Basin and in each of these sub-basins modelling was performed. Thus, studies were made for the following sub-basins: Krapina, Česma, Ilova including Pakra, Orljava and Kupa. Within all these studies hydrologic analyses have been conducted and hydraulic (1D) modelling was carried out.

In addition, the study "A system of flood control Central Posavina - update solution" (VPB, 2010.) was made. Within it, a mathematical simulation model of Central Posavina was created. The modelled area spreads approximately over 2700 km². The model simulates the operation of the system "Central Posavina" in different cases, generating high water waves, and feedback for various return periods (2, 5, 10, 25, 50, 100 and 1000-years). Based on the results of the simulation, an analysis of the efficiency and safety of the existing system of protection from flooding by high water of different return periods was conducted. Moreover, the critical sections are presented. For the undeveloped part of the system (section of the Sava River from Podsused to Jesenice), the flooding areas around the Sava River and the flood water depth are presented (Figure).

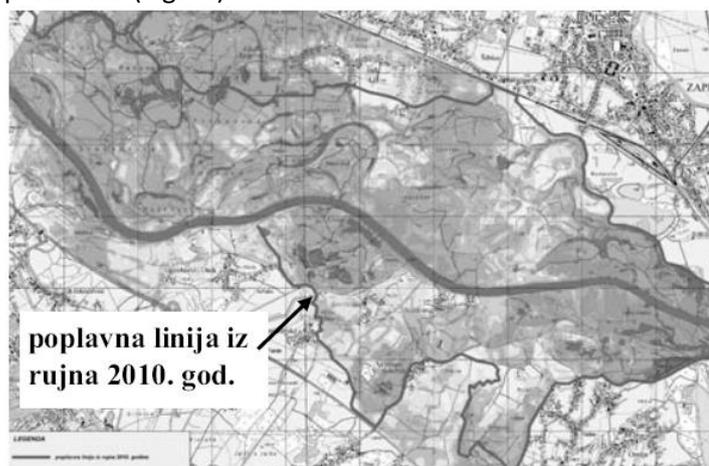


Figure: Flood areas and depth of flooding by the 100-year high water on the Sava River section Podsused-Jesenice with marked flood water wave lines for September 2010

Mathematical model of the Central Posavina is set so that it can, with less intervention, be used to implement risk analysis of floods in the area of coverage, but it is also possible to extend it on the downstream sections of the Sava River.

For the needs of the study "A system of flood control Central Posavina - update solution" (VPB, 2010), geodetic and spatial data have been previously collected and systematized, and in addition, all the necessary hydrological data processing and analyses have also been conducted.

Methodology used for assessment of FRM and climate change:

Activity title: BUILDING AND DEVELOPMENT OF GUIDELINES FOR THE IMPLEMENTATION OF WATER FRAMEWORK DIRECTIVE

Funding institution:
European Union CARDS 2004

Contact institution/person:
Delegation of the European Commission to the Republic of Croatia, Trg žrtava fašizma 6, HR-10000 Zagreb, www.delhrv.ec.europa.eu
Twinning Project Office, Ulica grada Vukovara 220, HR-10000 Zagreb, www.wfd-croatia.eu

Starting date : 2007

Ending date: 2009

Description of the activity:

In order to facilitate the implementation of Water Framework Directive (WFD) Croatia applied for assistance in the form of EU-Twinning Project with Germany as senior Twinning partner and the Netherlands as junior partner. Croatia made a formal commitment in the Twinning Work Plan which sets out the activities that enable the Croatian Ministry of Agriculture, Forestry and Water Management and Croatian Waters (Hrvatske vode) to increase its administrative and operational capacity. The overall objective of conducted activities is to improve the water quality standards and the water management in Croatia in line with EU requirements.

Those activities provides a pragmatic approach for a highly qualified WFD implementation and supports the Republic of Croatia in meeting its national goals in the fields of water use and water protection as well as the European obligation. An international team of experts assists Croatia's water administration to prepare their obligations in the field of integrated water resource management. This includes the following principles:

- Water as part of aquatic and terrestrial ecosystems and a natural resource;
- Water as a social and economic good;
- River basin approach comprehending both surface and groundwater;
- Integration of land use and nature conservation;
- Protection of sources of freshwater supply;
- Sustainable water use;
- Participatory decision making process.

Purpose:

- Further harmonisation of water management legislation with the EU water acquis;
- Common approach and institutional support to the WFD implementation in Croatia;
- Improved communication among relevant stakeholders, e.g. governmental bodies & State institutions, companies and NGO's;
- Strengthened institutional capacity.

Results of activities are presented within six components. Component 2 is most important for this overview because it deals with River Basin Management Plans and it is consisted of 5 activities as follows:

- Pressures and impacts analyses of the characteristics of river basins;
- Guidance documents developed and adapted to the Croatian situation;
- Lists of measures according to Annex VI Part B of WFD;
- Cost-effectiveness of measures;
- Guideline for methodology for the justification of derogations / exemptions

Methodology used for assessment of FRM and climate change: N/A for this type of activity.

Activity title: MODELLING IN SAVA RIVER BASIN FLOOD PRONE AREAS

Funding institution:

Agency for Water Resources of Sava River Basin
Sarajevo
Agencija za vodno područje rijeke Save Sarajevo

Contact institution/person:

ul. Grbavička 4/3
71000 Sarajevo, BiH
+387 33 565 4252

Starting date : 2000

Ending date: on-going

Description of the activity:

The activities are focused on the following:

- to use present documentation and analyse basic indicators about the flood protection system as well as adequate characteristics of hydrologic water regime in order to find their interdependence. From the methodological point of view these data and their analysis should give indications about flood risk in BiH and neighbouring countries, especially about Sava as a boundary river.
- to systemize operative data (water level, flows, profiles, land and structures in floodprone areas) from the documents to be usable as input for models, other analysis and “three step” approach:
 - establishment of mathematical models that will be used for mapping of flood probability and flood dynamics
 - establishments of the models necessary for flood risk maps
 - flood risk management mapping
- to input data into flexible database linked to adequate software for flood and other analysis
- to input spatial data about cadastre of existing structures into GIS making data usable for various analysis (for ex. hydromorphological changes)

Methodology used for assessment of FRM and climate change:

Basic methodological approach for Flood Risk Management is adjusted to flood mapping process and surface water modelling. Since the flooding event has unsteady flow there is a difference between input and output hydrograms. Besides flood level, models should be unsteady evaluating dynamic characteristics of floods (velocity, duration of flood). The conclusion is to use unsteady flows and to get data along the main watercourse: before and after the main tributaries and on the main watercourse. The consequence of such approach was the renewal of meteorological stations in BiH.

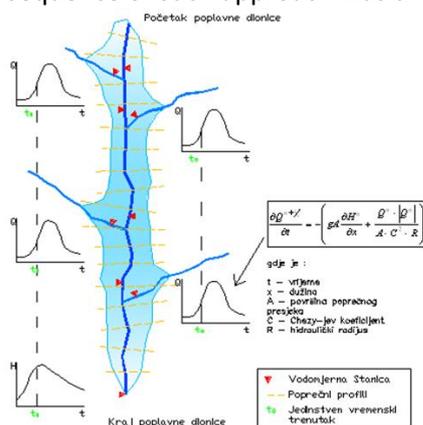


Figure 1: Distribution of minimal monitoring points for hydrological and morphological data in floodprone areas

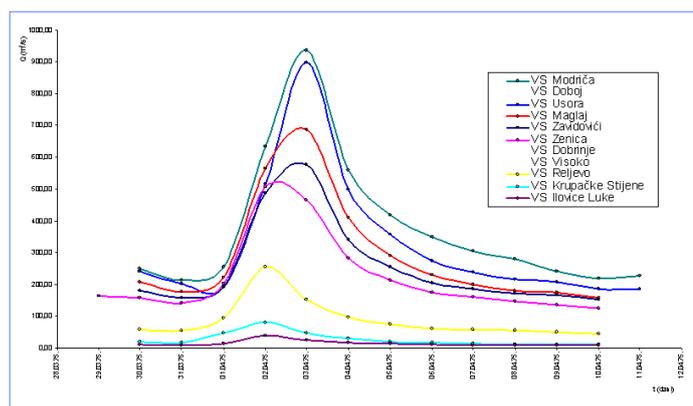


Figure 2: Summary layout of monitored daily hydrograms (river Bosna)

Figure 2 shows layout of monitored hydrograms of daily flows (river Bosna) used for model calibration. Therefore, it was possible to test the model in the most critical parts of watercourses and floodprone areas. The model was part of integrated software. It was also possible to adjust the model to changing environment regarding the flood data. Institute for Water Management Sarajevo carried out modelling task and plan development - “General flood prevention plan in Bosnia and Herzegovina” in collaboration with Ministry of Agriculture Water Management and Forestry. The project was financed by various Agencies in charge for Sava and Adriatic catchments.

Activity title: SUPPORT TO BiH WATER POLICY	
Funding institution: EC IPA 2007 Programme	Contact institution/person: PM-lead Consortium, Dubrovacka 4/I, 71000 Sarajevo Bosnia and Herzegovina, www.water.ba Delegation of the European Union to BiH, Skenderija 3a, 71000, Sarajevo Bosnia and Herzegovina www.europa.ba
Starting date : 2009	Ending date: 2011
<p>Description of the activity:</p> <p>The overall activity objective is to ensure the protection and rational use of water resources in BiH by application of integrated water management principles and other EU water-related policies. More specific activity objectives are as follows:</p> <ul style="list-style-type: none"> - To support further development and implementation of Entity Water Laws in accordance with the principles of the EU Water Framework Directive and other EU water-related Directives. - To strengthen BiH capacities responsible for the coordination and implementation of international conventions to which BiH is party to. <p>Three Main sub-activities are as follows:</p> <ul style="list-style-type: none"> - Development, harmonisation and adoption of a Water Policy and corresponding implementation strategy for BiH - Development of secondary legislation as described by the Water Laws - Public Participation Strategy 	
<p>Methodology used for assessment of FRM and climate change:</p> <p>Methodology to achieve overall objective of this activity is realizing through three main sub-activities. Each of three sub-activities consists of three to four tasks.</p> <p>The methodology used to realize the main sub-activity entitled “Development, harmonisation and adoption of a Water Policy and corresponding implementation strategy for BiH” consists of taking the following tasks:</p> <ul style="list-style-type: none"> - Define basic principles and objectives of water policy for BiH; - Develop implementing strategy to reach adopted policy; - Harmonise existing and planned activities in the water sector; - Train the staff of the Ministries and Water Agencies. <p>“Development of secondary legislation as described by the Water Laws” as a second main sub-activity will be realized through following tasks:</p> <ul style="list-style-type: none"> - Review the existing institutional set-up of the water sector and status of transposition of EU water-related legislation into BiH legislation; - Identify consecutive legal developments; - Draft specific secondary legislation and sub-laws in accordance with agreed policy framework. <p>Third main sub-activity entitled “Public Participation Strategy” will be realized through following tasks:</p> <ul style="list-style-type: none"> - Prepare "Public Participation Strategy" in accordance with the EU WFD, Entity Water Laws and Directive 2003/35/EC on public participation; - Apply public participation practices/carry out all corresponding tasks like active involvement of the general public and public hearings while developing and adopting Water Policy for BiH. 	

Activity title: MAPPING OF FLOOD PRONE AREAS ALONG RIVERS IN SERBIA

Funding institution:

Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia - Republic directorate for water

Contact institution/person:

Institute for the development of water resources "Jaroslav Cerni" - Belgrade
Dr Marina Babic Mladenovic,
E-mail: Marina.Babic-Mladenovic@jcerni.co.rs,
Phone No: +381 11 390 64 77

Starting date : 2006

Ending date: 2007

Description of the activity:

Indicative flood hazard maps (only extent of floods) were made using all available sources as hydraulic studies, post-flood reports etc. If available, data on the extent of historical floods were accompanied with the estimate of flood return period. Also, data on potential flood zones were collected, either from hydraulic studies or as rough estimates of companies in charge for flood protection. Only potential flood zones were determined along the Sava River, as a result of hydraulic calculations for $Q_{1\%}$. Only for Macva area calculations were done for probabilities 1%, 2%, 4% и 10%. Also, database contains data on historic floods on the Drina, Kolubara and other rivers in SRB.

Methodology used for assessment of FRM and climate change:

Indicative borders of flood hazard zones were presented on digital maps scale 1:300.000, using ESRI ARcGis 9.0 software. The GIS database was established, containing the following data for each indicative flood prone area:

- River name,
- River code,
- Type of flood (Potential/calculated, Historical, Estimated by WMC)
- ID of document of data origin,
- Data origin (Scanned map/Autocad)
- Year (year of historical flood),
- Probability of flood (if available)
- Notes (map scale, river bank, area, river stretch etc.)

Data on flood damage estimates for historic floods were not available.

An example of Arc View window and the data table is given on Figure 1.

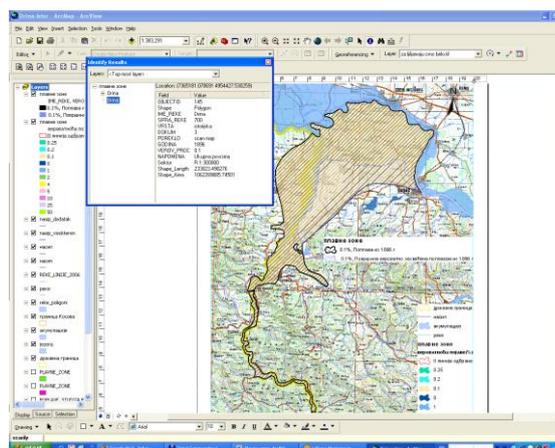


Figure 1: An example of Arc View window and the data table

Activity title: DEVELOPMENT OF A FIRST DRAFT FRMP FOR TAMNAVA RIVER BASIN, SERBIA	
Funding institution: Swedish Environmental Protection Agency	Contact institution/person: Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia - Republic directorate for water Radovanka Pavlovic E-mail: Radovanka.Pavlovic@minpolj.gov.rs Phone No: +381 11 201 33 47
Starting date : 2008	Ending date: 2010
Description of the activity:	
<p>The aim of the project was to strengthen the capacity of the Serbian water administrators in flood risk management according to the principles of the EU Flood Directive, through the development of a first draft Flood Risk Management Plan for the pilot area.</p> <p>The Tamnava River Basin (the second order tributary of the Sava river, catchment area of 722 km²) was chosen as a pilot-area for the project, because it has been often affected by floods.</p> <p>The project was divided in six phases:</p> <ol style="list-style-type: none"> 1. inventory phase, 2. preliminary flood risk assessment, 3. flood hazard maps for different scenarios, 4. flood risk maps, 5. first draft of a flood risk management plan and 6. dissemination of results. <p>The working process aimed at being a start of the Serbian implementation of the EU Flood Directive and connected with the on-going work on the EU Water Framework Directive implementation in the Kolubara River basin. The Serbian Directorate for Water (with other relevant actors) will continue with the implementation of the EU Flood Directive for other rivers and river basins.</p> <p>The objective of the project is considered fulfilled since a preliminary flood risk assessment, flood maps and first draft of flood risk management plan has been produced during the time of the project. The project is considered a first trial in iterative process of adopting national scale methodologies for a preliminary flood risk assessment, preparation of flood hazard and flood risk maps, as well as a flood risk management plan. These methodologies are currently being developed (also on an EU level) and will not necessarily comply with the methodologies used in the Tamnava project. The main target groups, which directly benefited from the project, are the Directorate of Water and the institutes involved in the flood risk management.</p>	
Methodology used for assessment of FRM and climate change:	
<p>Since official national methodologies were not yet prepared, the project was supposed to provide methodologies and techniques. The techniques used within the project comply with the EU Floods Directive and can be considered as an initial trial in preparation of official national methodologies.</p>	



Fig. 1 Position of the Tamnava RB in SRB

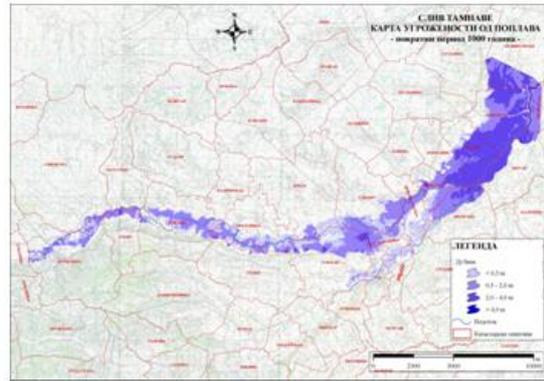


Fig. 2 Tamnava River - Flood hazard map for 1000-year flood

Activity title: PRELIMINARY FLOOD RISK ASSESSMENT FOR THE TERRITORY OF REPUBLIC OF SERBIA

Funding institution:

Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia - Republic directorate for water

Contact institution/person:

Institute for the development of water resources "Jaroslav Cerni" - Belgrade
Dr Marina Babic Mladenovic,
E-mail: Marina.Babic-Mladenovic@jcerni.co.rs,
Phone No: +381 11 390 64 77

Starting date : 2009

Ending date: On-going (to be finished by end of 2011)

Description of the activity:

The first phase of Preliminary assessment was finished 2009, and encompassed the review of available GIS data. It was decided that in 1st PFRA (2011) only floods on large and smaller rivers will be considered, while 2nd PFRA (2017) will deal also with torrents and internal floods (pluvial and groundwater floods). In 2010, questionnaires on historic floods were distributed to municipalities and a GIS database was established.

Based on available or easily derivable data, and according to draft methodology, some 56 areas of significant flood risk are determined. Ten of them are located in the Sava river basin, including sub-basins of Drina and Kolubara.

The draft report on Preliminary flood risk assessment was presented to PWC in mid April 2011 and their comments are expected. It will be published at the end of 2011 on web site of WISS (vis.srbijavode.rs)

Methodology used for assessment of FRM and climate change:

Methodology for PFRA was developed within research program financed by Republic of Serbia, Ministry of Education and Science ("Development of Draft Methodologies for the Preparation of a Preliminary Flood Risk Assessment and of Flood Maps in Accordance with Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the Assessment and Management of Flood Risks"). In a few months time, it will be published as the Rulebook on the Establishment of a Methodology for the Preparation of a Preliminary Flood Risk Assessment.

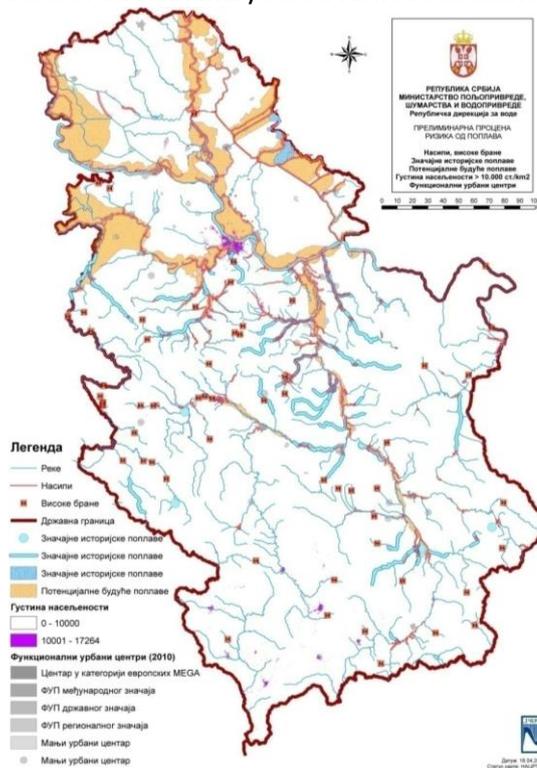


Fig. 1 PFRA base map

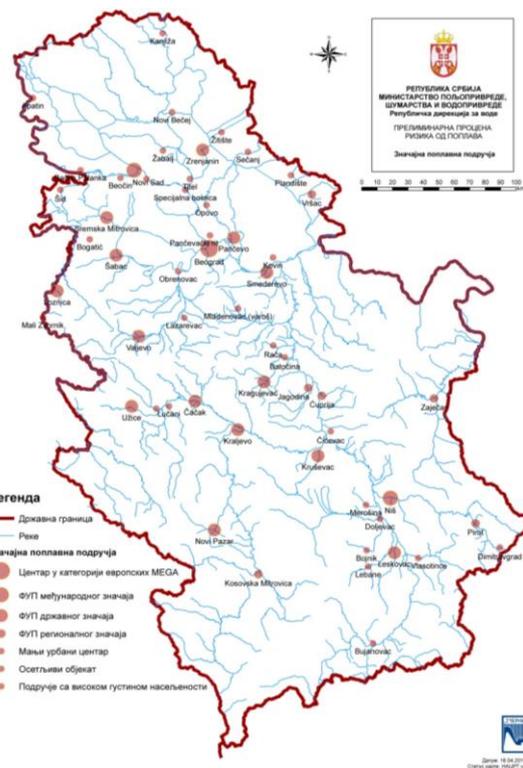


Fig. 2 Areas of significant flood risk (draft 2011)

Activity title: ASSESSMENT OF CLIMATE CHANGE ON WATER RESOURCES IN SERBIA	
Funding institution: Ministry of Science and Technological Development	Contact institution/person: Institute for the development of water resources "Jaroslav Cerni" - Belgrade Prof. dr Stevan Prohaska E-mail: Stevan.Prohaska@jcerni.co.rs , Phone No: +381 11 390 83 87
Starting date : 2011	Ending date: <i>On-going</i>
Description of the activity: Basic activities of the project are:	
<ul style="list-style-type: none"> - Analysis of climate change in the basic meteorological parameters of the hydrological cycle in Serbia in the new century based on the latest research in our country and the world - Defining the initial (zero) state regime of surface and groundwater in terms of assessment of potential impacts of climate change - Stochastic probabilistic analysis of the available long-term time series of relevant meteorological phenomena in Serbia and other countries - Trend analysis of extreme hydrological conditions as a result of climate change - Development of model for assessing the impacts of climate change on the regime of surface and groundwater - Analysis of the impact of climate change on torrential streams - Flood Control: sustainable management, raising awareness and education in terms of climate change - Impact assessment of climate change on drought occurrence in the territory of Serbia - Assessment of the impacts of climate change on agricultural production and development of guidelines for improvement and achievement of better effect in these conditions - Development of model for optimization in use of water resources in agricultural production in the new conditions and the development of modern technology equipment. 	
Methodology used for assessment of FRM and climate change: Under development.	

Activity title: RESEARCH OF CLIMATE CHANGE AND THEIR IMPACT ON ENVIRONMENT: MONITORING OF IMPACTS, ADAPTATION AND MITIGATION / SUBPROJECT 8: SERBIAN WATER RESOURCES UNDER CLIMATE CHANGE	
Funding institution: Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia - Republic directorate for water	Contact institution/person: 37 scientific-research organizations in Serbia, including Institute for the development of water resources "Jaroslav Cerni" - Belgrade (Subproject 8) Prof. dr Stevan Prohaska E-mail: Stevan.Prohaska@jcerni.co.rs, Phone No: +381 11 390 83 87
Starting date : 2011	Ending date: <i>On-going</i>
Description of the activity: The most important are the following activities within Subproject 8: - Identification of resources of surface and ground water in Serbia - Quantitative evaluation of the impacts of climate change on the regime of surface water - Monitoring of runoff and sediment discharge.	
Methodology used for assessment of FRM and climate change: Under development.	

Activity title: STUDY OF FLOOD PRONE AREAS IN SERBIA – PHASE 1 (SOPPAS)	
Funding institution: EuropeAid/128095/C/SER/RS 07SER01/33/11	Contact institution/person: EPTISA Internacional Višnja Omerbegović
Starting date : 15th March 2010	Ending date: Ongoing
Description of the activity: The specific objective of the Project is to prepare flood hazard and flood risk maps, which will be incorporated in Flood Risk Management Plans for the Project area (Danube river downstream of Belgrade and larger rivers in the Morava River basin). The results to be achieved by the Project are as follows: <ul style="list-style-type: none"> • Draft methodology for flood mapping • DTM adjusted to requirements of flood mapping in the Project area • Flood hazard maps • Flood risk maps • Risk information incorporated into regional and/or local spatial plans (pilot case) • Flood maps incorporated into WMIS • Long term concept of flood maps' handling and use • Transfer of technology.Short description of the activity with expected/achieved results. If necessary, a table, chart, figure, or map could be added on a separate sheet. 	
Methodology used for assessment of FRM and climate change: The Consultant has the obligation to formulate draft methodology for flood hazard and flood maps, because there is no official methodology in Serbia. An assessment of risk data availability and quality is under way. The methodology will be adjusted to available data, and prepared within next few months.	

Annex III: Danube River Basin initiatives

Activity title: FLOOD MONITORING AND FORECASTING IN THE DANUBE RIVER BASIN	
Funding institution: ICPDR – International Commission for the Protection of the Danube River	Contact institution/person: ICPDR, Vienna International Centre D0412 / P.O. Box 500 / 1400 Vienna / Austria / www.icpdr.org
Starting date : 2010	Ending date: 2010
<p>Description of the activity: The national flood forecasting and warning systems in the Danube River Basin differ in the frequency, methods and techniques used for monitoring and also in data collection and processing. In some countries the outdated and advanced methodologies are running in parallel.</p> <p>Therefore the ICPDR Action Programme on Sustainable Flood Protection in the Danube River Basin aims to develop the methodology and tools of data collection, processing, forecasting and dissemination where necessary and also to interlink the regional and national agencies on sub-basin and basin level to facilitate and promote the exchange of source data and forecasting and warning in transboundary sub-basins. All of the above mentioned should be in accordance with the principles of European Flood Alert System (EFAS).</p>	
<p>Methodology used for assessment of FRM and climate change: The first step in this activity was preparation of the Report on Assessment of Flood Monitoring And Forecasting in the Danube river basin, which was finalized in 2009.</p> <p>The report reviews:</p> <ul style="list-style-type: none"> - Climatic and hydrological conditions in the DRB - Flood monitoring system <ul style="list-style-type: none"> o Description of the meteorological network o Description of the hydrological monitoring network - Development of the flood information service for the Danube river basin - The role of the European Flood Alert System 	

Activity title: ASSESSMENT OF FLOOD MONITORING AND FORECASTING IN THE DANUBE RIVER BASIN	
Funding institution: ICPDR – International Commission for the Protection of the Danube River	Contact institution/person: ICPDR, Vienna International Centre D0412 / P.O. Box 500 / 1400 Vienna / Austria / www.icpdr.org
Starting date : 2009	Ending date: 2009
<p>Description of the activity:</p> <p>It starts with general description of the Danube River Basin, continues with climate and hydrological condition of DRB. Next issue is flood-monitoring system and it is presented with description of both meteorological and hydrological monitoring networks. Inventory of The bi-lateral agreements on co-operation on transboundary waters related to flood protection is presented.</p> <p>The flood information service for the Danube river basin is presented. Most important components of flood information service are: meteorological services, hydrological services and flood forecasting service.</p> <p>The hydrological forecasting system is connected to the meteorological forecasting system. Furthermore, the input of precipitation forecast is defined - Meteorological data and weather forecasts are the most important components of a flood forecasting and early warning system. Inputs of precipitation forecast are collected from several different data sources, which could be both domestic and those from international cooperation. Three main different forecasting systems, methods and models are presented and membership in ECMWF is recommended as solution for European flood forecasting services. It is also mentioned that An improvement of the forecasting process and its outputs is a never-ending story.</p> <p>The European Flood Alert System (EFAS) and its advantages for EC and National Hydrological Institutes is also presented. The advantages of EFAS for the European Commission are: Overview of current flood situation in Europe for European Commission services; Comparable results across Europe; Fostering harmonised exchange of hydrological data and information in Europe.</p> <p>The advantages of EFAS for the National hydrological Institutes could be: Additional information on possible flood situations more than 3 days in advance based on different weather forecasts; Interpretation of flood ensemble prediction system forecasts based on full sets of EPS; Increased exchange on flood forecasting issues and EPS research between the different institutes participating in EFAS.</p>	
<p>Methodology used for assessment of FRM and climate change:</p> <p>The major tasks of the meteorological services of the Danube states in the area of flood forecasting include monitoring and forecasting of the weather situation, and advisory and warnings on dangerous weather events such as heavy precipitation, storms, hail etc. Quantitative precipitation forecast belongs to the most important activities of the meteorological services. The hydrological services monitor the current situation on the rivers in the Danube river basin by gauging stations, which provide regular hydrological information that is supplemented with the data from the River Basin Authorities. Developing and introducing hydrological models into the forecasting service improved forecasting methodology. The hydrological forecasting system is connected to the meteorological forecasting system.</p> <p>Hydrological Forecasting and Products</p> <ul style="list-style-type: none"> - Forecasting Methods - the basis of the forecasting methods is a simple method of corresponding water stages/discharges, which can be seen as more traditional but is very reliable. - Hydrodynamic models - For modelling of the flood wave run at the upper part of Danube. - Rainfall-runoff model - Discharge forecasts for the tributaries on the basis of precipitation - discharge - models (N-A-models) are attached to the hydrodynamic models. <p>The flood forecasting service regularly provides hydrological forecasts to the River Basin Authorities and other stakeholders and publishes them on a web site. In case of flood it informs the flood protection authorities and other participants involved in the flood protection about flood danger and flood evolution. Warning messages are disseminated as soon as the extreme meteorological or hydrological conditions have been forecasted, and during floods they are accompanied by information on the flood</p>	

evolution and its further prediction.

An improvement of the forecasting process and its outputs is a never-ending story, in which the uncertainty of a forecast (the interaction with end-users and new tools and techniques are the key areas of future development.

Activity title: REPORT ON ACHIEVEMENTS IN FLOOD PROTECTION IN DANUBE RB	
Funding institution: ICPDR – International Commission for the Protection of the Danube River	Contact institution/person: ICPDR, Vienna International Centre D0412 / P.O. Box 500 / 1400 Vienna / Austria / www.icpdr.org
Starting date : 2010	Ending date: 2010
Description of the activity: <p>This activity provides the stakeholders and public with an overview of the achievements in implementation of the targets of the ICPDR Action Program on Sustainable Flood Protection in the Danube River Basin with a particular attention given to the progress made in the sub-basins in implementation of the action plans as well as of the EU Directive on the assessment and management of flood risks. Report on Achievements in Flood Protection in the Danube River Basin is structured according to the four basin-wide targets of the ICPDR Flood Action Programme and it is a living document, which will be updated regularly with a view of demonstrating to the wide target audience the efforts made and the progress achieved in the Danube River Basin in the field of flood risk management.</p> <p>Sub-Basin Level Flood Action Plan have been prepared under the coordination of ISRBC for sub-basins within the Danube river basin. Flood Action Plan for the Sava River Basin has also been made. Some of the topics covered in this Plan are:</p> <ul style="list-style-type: none">- Regulation on Land Use and Spatial Planning- Reactivation of former, or creation of new, retention and detention capacities- Non-structural and structural flood defence measures. <p>Firs, development and improvement of Flood Forecasting and Early Warning System were introduced. It was stated that Danube part of the European Flood Alert System (EFAS) has been developed at the EC Joint Research Centre (JRC). A brief report on the Assessment of Flood Monitoring And Forecasting in the Danube River Basin was also provided.</p> <p>Preparation of flood action plans in sub-basins is next Report topic. ICPDR published 17 sub-basin flood action plans, covering with them the entire Basin. FAP for SRB was also prepared and published. The set of plans represents a unique technical planning document that provides, for the first time, a broad overview of the measures, which all Danube countries will be taking to keep their citizens safe against the danger of floods. They are a major contribution to the finalising of flood risk management plans by 2015 as required by the EFD.</p> <p>The largest part of the Report is devoted to the presentation of the major achievements in flood risk management in the Danube countries. It also provides an overview of existing framework for trans-boundary cooperation. Major developments in flood risk management are represented country by country (Germany – Bavaria & Baden-Wuerttemberg, Austria, Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Serbia, Bosnia and Herzegovina, Romania, Bulgaria and Ukraine) through next four main topics:</p> <ul style="list-style-type: none">- Improvements in flood forecasting and warning;- Structural flood protection projects;- Capacity building, preparedness & flood mitigation;- Progress in implementation of EFD. <p>Status review and report of flood mapping and flood risk evaluation in the sub-basins and countries of the DRB were also provided as well as minimum recommendations for flood risk mapping in the DRB.</p>	

Development of flood risk maps is one of key prerequisites to an efficient flood risk management. Risk maps provide essential information to the public but are also important tools for planning authorities and the insurance industry. Status review of FLOODRISK project and other related activities were mentioned.

Methodology used for assessment of FRM and climate change:

Danube part of the European Flood Alert System (EFAS) has been developed at the EC Joint Research Centre (JRC). Operation of the system enables the Danube countries receiving EFAS information in form of early flood warning reports for floods in the next 3-10 days. This tool complements the national (DE, AT, CZ, SK, HU, SI, RS, RO, BG, MD and HR) forecasting systems and provides the forecasters with additional information helpful for decision-making on issuing a flood warning.

Important issue of this Report is Creating Forums for Exchange of Expert Knowledge. It deals with topics like coordination aspects of EFD implementation in the Danube River Basin or with some other information sources.

EU funded project "Danube FLOODRISK" aims to develop uniform flood risk maps that define flood hazards and vulnerability will form the basis for targeting measures and reducing flood damage in the Danube Basin. Begun as an initiative of the Romanian ICPDR Presidency in 2007, the project will meet requirements of the EU European Flood Risk Directive to draw up flood risk maps for areas at risk by 2013. The FLOODRISK project will be completed by the end of 2012 under the leadership of the Romanian Environment Ministry, with the involvement of all Danube countries.

Activity title: DANUBE GIS DEVELOPMENT	
Funding institution: ICPDR – International Commission for the Protection of the Danube River, Umweltbundesamt GmbH	Contact institution/person: ICPDR, Vienna International Centre D0412 / P.O. Box 500 / 1400 Vienna / Austria / www.icpdr.org Umweltbundesamt GmbH, Spittelauer Lände 5, 1090 Vienna/Austria, www.umweltbundesamt.at
Starting date : 2005	Ending date: N/A
Description of the activity:	
<p>The initial system development started in the year 2005. The first prototype was provided in 2006, the launch of the system was in 2007. In the following years continuous improvements and further features were added to the DanubeGIS expert and public systems. The first development steps were aimed at the system's ability to be used for the upload of basic data sets for WFD Roof Report Art. 5; emphasis was thus set on the availability of the relevant shape files templates, on the data up- and download tools and on security implementation. The web mapping clients subsequently were further refined and their functionality expanded, and the system was fed with more data (Roof Report 2004 maps available in the web mapping client public and as WMS services; integration of TNMN data). A workflow tool for retracing all user steps taken in the data up-and download process and a query tool for accessing regional and attribute data were also implemented. The shape file templates were extended and refined to provide a first complete framework for the data required for the Danube River Basin Management Plan 2009. Template adaptation was carried on continuously in all further development steps to serve changing or newly emerging user needs (e.g. templates for data harmonization process drafted in 2009). The continuing development of the DanubeGIS system 2008 concentrated on the implementation of means for the preparation of the Danube River Basin Management Plan 2009 (among other things creation of a metadata schema and editor) and on the integration of existing project results (maps from the Monitoring and Tisza Reports). In 2009, DanubeGIS development focused on updating the DanubeGIS metadata editor including the preparation of the necessary guidance documents. Additionally, minor system adaptations including bug fixing, continuing system improvement and small system adaptations were performed.</p> <p>At present, the DanubeGIS needs a thorough review in order to fulfil current and future user requirements. Web mapping software faced major changes in the past years and maps have become considerably easier and more comfortable to be published in the internet. For the DanubeGIS these developments become most evident in the fact that the software (web server) currently used for web map publishing is reaching the end of its life cycle and will not be further supported by the vendor. At the same time, the necessity to switch to new software also is a chance to improve the DanubeGIS and update it to current standards. The WebGIS thus can be provided with a modern look-and-feel, and functionalities should be expanded (enhanced data visualization, integrated query possibilities, improved facilities to access and download data) to make the system more useful and comfortable to use.</p> <p>DanubeGIS development report evaluates in detail the necessary adaptations for the near future as there are the web server replacement, the WebGIS client update, the hardware replacement and issues interdependent with these developments. All these adaptations and further development steps have to be done allowing compliance with other systems.</p>	
Methodology used for assessment of FRM and climate change:	
<p>DanubeGIS purpose of existence, among others is to support and develop the methodology (and tools) used for assessment of FRM and climate change. Therefore when it is talking about development of the methodology related with assessment of CC and FRM within GIS context it should be actually talk about the future development of a DanubeGIS. The envisaged future system should thus ease data preparation of countries and data submission, allow straightforward and interactive data visualization in the public and expert web viewer, ease data management and data analysis by using a database backend and enable the integration of various ICPDR databases. Furthermore, last report (2010) evaluates in detail the necessary adaptations for the near future as there are the web server replacement, the WebGIS client</p>	

update, the hardware replacement and issues interdependent with these developments, among others: improvement of data visualization and web mapping, current data upload and download options, upgrading of data validation. The decision whether to migrate to an open source web server or to ArcGIS Server affects both the data management in the DanubeGIS and the data visualization (web maps). It will depend on the further decision, whether the current data file repository should be kept or transferred to a database management system (DBMS).

Activity title: ICPDR – FLOOD PROTECTION EXPERT GROUP (FP EG) ACTIVITIES ON PFRA	
Funding institution: International Commission for the Protection of the Danube River (ICPDR)	Contact institution/person: ICPDR, Vienna International Centre D0412 P.O. Box 500, A-1400 Vienna, Austria http://www.icpdr.org
Starting date : 2010	Ending date: ongoing
<p>Description of the activity:</p> <p>The objectives of these activities are:</p> <ul style="list-style-type: none"> - To review the current status of the preparation of the preliminary flood risk assessment at the national level. - To discuss the reporting needs to EU for the international river basins in relation to Art 4. and Art. 5. of the Directive 2007/60/EC. - To discuss the aspects of the necessary coordination at the Danube River Basin District-wide level of the preparation of preliminary flood risk assessment and of the identification of areas of potential significant flood risks. - To establish the time plan for preparation of the ICPDR report on the preliminary flood risk assessment and its linking to time plans for national reports. - To agree upon the visual information (maps) for the ICPDR report on the preliminary flood risk assessment. <p>The FP EG agreed at its 17th meeting on following minimum requirements for preliminary flood risk assessment:</p> <ul style="list-style-type: none"> - Description of floods with significant adverse impacts on: Human health; Environment; Cultural heritage and Economic activity - Flood extent and conveyance routes: Shape (polygon); River stretch; Dot (or circle if no territorial information is available on the flooded area) <p>The FP EG is preparing “Preliminary Flood Risk Assessment in the Danube River Basin” to inform the European Commission, the stakeholders and public on the achievements made in the international Danube River Basin District in response to the provisions of the Articles 4, 5 and 13(1) of EFD. In drafting this document, so far the following countries participated: Germany, Czech Republic, Austria, Bosnia and Herzegovina, Serbia. The following topics are covered country by country: Overall approach and methodology of PFRA; Historical floods in the Danube River Basin; Potential adverse consequences of future floods; Areas of potential significant flood risk (APSEFR); Transboundary coordination & information exchange; Supporting transboundary activities.</p>	
<p>Methodology used for assessment of FRM and climate change:</p> <p>Within “Preliminary Flood Risk Assessment in the Danube River Basin” are described, country by country, methodologies and criteria used to identify and assess floods that occurred in the past and their past adverse consequences (including whether such consequences would be ‘significant’) and whether the likelihood of such floods remains relevant. It also addresses the methodologies and criteria used to identify and assess significant floods that occurred in the past that would have significant adverse consequences were they to reoccur in the future and methodologies and criteria used to identify and assess potential future significant floods and their potential adverse consequences.</p>	

Annex IV: EU and international advances in the field

Activity title: ENVIROGRIDS PROJECT	
Funding institution: The European Commission, (project under call FP7-ENV-2008-1, grant agreement No. 226740.)	Contact institution/person: Universite de Geneve Rue du General Dufour, Switzerland www.envirogrids.net
Starting date : April 2009	Ending date: March 2013
<p>Description of the activity: The Black Sea Catchment is internationally known as one of ecologically unsustainable development and inadequate resource management, which has led to severe environmental, social and economic problems. EnviroGRIDS project is building a data-driven view of Black Sea catchment that feeds into models and scenarios to explore its past, present and future. The project will address several GEO Societal Benefit Areas within a changing climate framework.</p> <p>The outputs of the projects will provide spatially explicit data and knowledge to nourish and promote the Global Earth Observation System of Systems (GEOSS). In addition to the Commission on the Protection of the Black Sea Against Pollution (BSC PS) and the International Commission for the Protection of the Danube River (ICPDR), enviroGRIDS is exploring ways to involve the United Nation Environment Program (UNEP) as a more active end-user of its Observation System, in order to help bridging the gap between science and policy.</p> <p>The expected outcomes of the project are:</p> <ul style="list-style-type: none"> - A gap analysis of existing regional data and observation systems to prepare recommendations for improvement of networks for data acquisition in the region/country; - An improved regional network to coordinate the efforts of partners active in observation systems; - A spatial data infrastructure to link, gather, store, manage and distribute key environmental data; - Access to a grid computing infrastructure to allow computationally intensive calculations on high-resolution spatial data sets; - Real-time access to sensors and satellites data; - Spatially-explicit scenarios of key changes in land cover, climate and demography, and their impacts on the hydrology; - A streamlined production of indicators on sustainability and vulnerability of societal benefits; - Early warning and decision support tools at regional, national and local levels; - Capacities developed in the implementation of many new Spatial Data Infrastructure (SDI) frameworks (GEOSS, INSPIRE, UNSDI). 	
<p>Methodology used for assessment of FRM and climate change: EnviroGRIDS Black Sea catchment project is bringing together several emerging information technologies that are revolutionizing the way we are able to observe our planet. As the principal aim of the enviroGRIDS project is to build capacity in new Earth Observations Systems in the Black Sea region, a specific strategy was developed, operating at three levels: human, institutional and infrastructure. At the human level, the main objectives are to inform policy and decision makers about GEOSS and INSPIRE capacities, to teach scientists how to install SDI nodes, and to prepare the project partners to become trainers themselves. At the institutional level EnviroGRIDS is targeting the need of three main and users: BSC PS, ICPDR and UNEP, and preparing the base for many other by demonstrating good practice. At the infrastructure level, EnviroGRIDS is supporting the development of SDI nodes among project partners that will serve as the base for the DSC OS. EnviroGRIDS is also developing new ways of integrating SDI with Grid computing infrastructures.</p>	

Activity title: FLOODRISK PROJECT	
Funding institution: Instrument for Pre-Accession assistance – IPA European Regional Development Fund - ERDF	Contact institution/person: Ministry of Environment, Romania 12 Libertatii Blvd., Sector 5, 040129 Bucharest www.danube-floodrisk.eu
Starting date : May 2009	Ending date: April 2012
Description of the activity: The Danube FLOODRISK project focuses on the most cost-effective measures for flood risk reduction: risk assessment, risk mapping, involvement of stakeholders, risk reduction by adequate spatial planning. The project will bring together scientists, public servants, NGOs and stakeholders who develop jointly a scalable system of flood risk maps for the Danube River floodplains. Transnational methodology and models will be defined and implemented for flood risk assessment and mapping. This results in proposals for flood mitigation measures, adjustments of spatial development plans, assessment tools for economic development in flood plains and raised awareness of flood risk of stakeholders, politicians, planners and the public. Infrastructures at risk like industry, power stations and supply infrastructure will be considered in the project.	
Methodology used for assessment of FRM and climate change: Because many different national requirements still exist and because each region could provide a different background project starts with the harmonisation work. Harmonisation starts from specification of the goals and tackles some technical questions referring to the scenario definitions, methods used, accuracy threshold and so forth. The methods for processing must be harmonized also, because they predetermine quality of results. The harmonisation of methods covers: quality management, damage assessment, modelling techniques and model border conditions, scenario definition and simulation methods. Harmonization of results should also be provided (with making of high-resolution risk maps + uniform GIS format). For the elaboration and implementation of the risk information it is of importance to involve the regional / local stakeholders in the process of the risk map development. Therefore, activities related to stakeholder involvement strategy and coordination includes: development of a common approach (method) for transnational, national and regional stakeholder identification and participation (related to flood risk) in the Danube River Basin build on the results of the ICPDR analysis and collection of feedback of the involved organisations and persons. These activities create a large quantity of data and therefore it is necessary to organize data collection and management. All data must be collected in databases to serve for the mapping actions. The main data sources for flood risk maps are digital terrain data, land use information, hydraulic data and for the damage assessment also statistics. Especially linear structures need to be considered as they have high impacts on the simulation. Having the first simulation results it is necessary to validate them by earth observation and ground information as water level, discharge, soil maps. The production of flood hazard and risk maps is based on data simulation process. The production process of flood hazard maps is an iterative process. Flood hazard maps show inundated areas and information like inundation depth, flow velocity and direction. Hydrodynamic approach is used for the simulation of the inundation areas. In local maps also dynamic processes might be displayed. An intermediate product is the water level. Based on the hazard maps the risk maps are calculated, using damage models and land use data sets as well as statistical data. The calculation is based on assets by land use and damage functions, adjusted for each land use data set. Damage functions are adjusted to the regions concerned. Also the number of people endangered has to be calculated. Vulnerable infrastructure, cultural heritage and industry have to be displayed. The maps need to be produced and published in an attractive and easy readable way for stakeholders use. Finally the risk information and risk maps should be transferred to precautionary measures of spatial planning, protection works and other structural and non-structural measures. Furthermore, exemplary implementation of the risk information into regional and / or local spatial planning need to be conducted with involvement of municipalities or in structural measures for industry or infrastructures (that includes action for the discussion and specification of local planning demands on the risk maps).	

Activity title: COORDINATION ACTION ON RISK BASED MANAGEMENT OF RIVER BASINS (RISKBASE)	
Responsible institution: TNO (The Netherlands) - Consortium: 9 partners from 6 countries	Contact institution/person: Project Coordinator: TNO (The Netherlands) Project Web Site: http://www.riskbase.info
Starting date : 2006	Ending date: 2009
<p>Description of the project: The project, realized within the 6th Framework Program of EU (EU FP6), provided review and synthesis of European knowledge in relation to integrated risk-assessment based management of the (ground)water-sediment-soil system at the river basin scale. The main aims of the project were to deliver guiding principles to integrated, risk-based management of European river basins, and recommendations for implementation of this approach in policies and management. To this end, a number of European river basins have been considered, including the Sava river basin, based on contribution of the ISRBC.</p> <p>The Issue of Investigation - In the last decade several European Commission (EC) funded projects and other major research initiatives have addressed and promoted risk assessment based management. Most of these initiatives focus on quality and management aspects of one specific compartment: water, sediment, soil or groundwater. However, all these initiatives stressed the importance of an integrative approach for understanding and managing the multicompartment system at the river-basin scale. Hence, there was a clear need to bring all these efforts together through the RISKBASE project as a stepping stone towards further policy development and the setting of a research agenda on this topic.</p> <p>The Project Objectives - The overall objective of RISKBASE is to review and synthesise the outcome of EC projects, and other major initiatives, related to integrated risk assessment-based management of the water-sediment-soil system at the river-basin scale. This synthesis leads to the development of integrated risk assessment-based management approaches enabling the prevention and/or reduction of the negative impacts caused by human activities on that system. More specific, RISKBASE focuses on the risks to the ecosystem goods and services provided by that system. Societies (present and future generations) depend for their well-being on these goods and services. Such goods comprise, inter alia, (drinking) water, food, fuel, medicines and building materials, whilst services are the benefits people obtain from ecosystems, e.g. life support (e.g. biodiversity, fishery, fertile soils for agriculture, water supply and protection against natural hazards), regenerative services (cycling of nutrients) and cleansing services (clean water).</p> <p>The Results - The end results of RISKBASE are: (1) An overarching, generic approach for integrated risk-based management of river basins; (2) Recommendations towards evolution and implementation of this approach in national and community policies and towards implementation in management; and (3) A proposal for the European research agenda related to risk-based management. The principle group of end-users of the RISKBASE results are people involved in the drafting of Water Framework Directive River Basin Management Plans, and specifically those involved in the first round of updating of these plans. Furthermore all other stakeholders involved in river basin management are regarded as end user, such as: EU and national policy makers, river basin commissions, industries, NGOs etc...</p>	
<p>Methodology used for assessment of FRM and climate change: The above review and synthesis is executed by leading European scientists and representatives of major, European stakeholder groups (policy makers, river basin managers, NGOs etc.). This is done in several workshops dedicated to specific issues related to risk based management at the river-basin scale. In some of the workshops these issues are studied in selected river basin cases, such as the Sava/Danube, Meuse/Dommel and Llobregat/Ter. Furthermore, RISKBASE annually organises a General Assembly (GA) and makes use of EUGRIS as web-based information exchange structure. The workshops, GA and the website are open to all who are interested and willing to contribute to achieve the RISKBASE objectives. This open, transparent and flexible work structure ensures the integration of all essential knowledge, expertise and experience in order to make RISKBASE a success. Knowledge basis was created by overview presentations by:</p> <ul style="list-style-type: none"> - stakeholders, - scientists from major European projects like MODELKEY, FLOODsite, Flood-ERA, GLOWA Elbe, MEDROPLAN, Watersketch, Eurolimpacs, REBECCA, ALARM, NoMiracle, AQUATERRA, NORMAN 	

Activity title: FLOODsite - INTEGRATED FLOOD RISK ANALYSIS AND MANAGEMENT METHODOLOGIES	
Responsible institution: FLOODsite	Contact institution/person: FLOODsite, HR Wallingford, Howbery Park, Wallingford, OXON, OX10 8BA, UK www.floodsite.net
Starting date : 2004	Ending date: 2009
<p>Description of the project: The Integrated Project FLOODsite is listed as one of the European actions which support the Directive (2007). FLOODsite covers the physical, environmental, ecological and socio-economic aspects of floods from rivers, estuaries and the sea. It considers flood risk as a combination of hazard sources, pathways and the consequences of flooding on the “receptors” – people, property and the environment. Flood risk management is a process, which comprises pre-flood prevention, risk mitigation measures and preparedness, backed up by flood management actions during and after an event. Floods often cross international borders and so must flood risk management research. Project team research on these topics is being integrated through decision support technologies, uncertainty estimation and pilot applications for river, estuary and coastal sites in Belgium, the Czech Republic, France, Germany, Hungary, Italy, the Netherlands, Spain, and the UK.</p> <p>The research themes in FLOODsite:</p> <ol style="list-style-type: none"> 1. Risk Analysis – flood sources, pathways and the vulnerability of “receptors”; 2. Risk Management – pre-flood measures and flood emergency management; 3. Technological integration – decision support and uncertainty assessment; 4. Pilot applications – at river, estuary and coastal sites; 5. Training and knowledge dissemination to professionals and the public including educational material; 6. Networking with other European and national initiatives; 7. Project coordination and management. <p>FLOODsite is active in stimulating the uptake of research advances through guidance for professionals, public information and educational material.</p> <p>FLOODsite is an “Integrated Project” in the Global Change and Ecosystems priority of the Sixth Framework Programme of the European Commission. The FLOODsite consortium includes 37 of Europe’s leading institutes and universities and the project involves managers, researchers and practitioners from a range of government, commercial and research organisations, specialising in aspects of flood risk management.</p>	
<p>Methodology used for assessment of FRM and climate change:</p> <p>FLOODsite - outputs:</p> <ul style="list-style-type: none"> - An integrated European methodology for flood risk analysis and management for rivers, estuaries and the coast - A consistent approach to flood risk management process and practice - Techniques and knowledge to support integrated flood risk management: <ul style="list-style-type: none"> - Sustainable “pre-flood” measures (spatial planning, flood mitigation infrastructure and measures to reduce vulnerability) - Flood event management (early warning, evacuation and emergency response) - Post-event activities (review and regeneration) - Frameworks for decision support for long-term and flood event risk management <p>There are seven Pilot Studies in FLOODsite covering areas liable to river, estuary or coastal flooding (Individual Pilot Studies: River Elba Basin, River Tisza Basin, Flash Flood Basins, River Ebro Delta Coast, River Schelde Estuary, River Thames Estuary, German Bight Coast). The Pilot Studies provide real-life sites with real and specific problems upon which knowledge, methods and tools can be developed and tested. They also allow for feedback into the research and development process from flood risk managers and stakeholders. The overall objective of the Pilot Studies is to ensure that FLOODsite deliverables are of real value, practicable and usable. None of the Pilot Studies test all the FLOODsite research, but all our main results are involved in at least two pilot areas.</p>	

Activity title: FLOOD-ERA**Responsible institution:**

FLOOD-ERA

Contact institution/person:

www.flood-era.ioer.de

Starting date : 2006**Ending date:** 2008**Description of the project:**

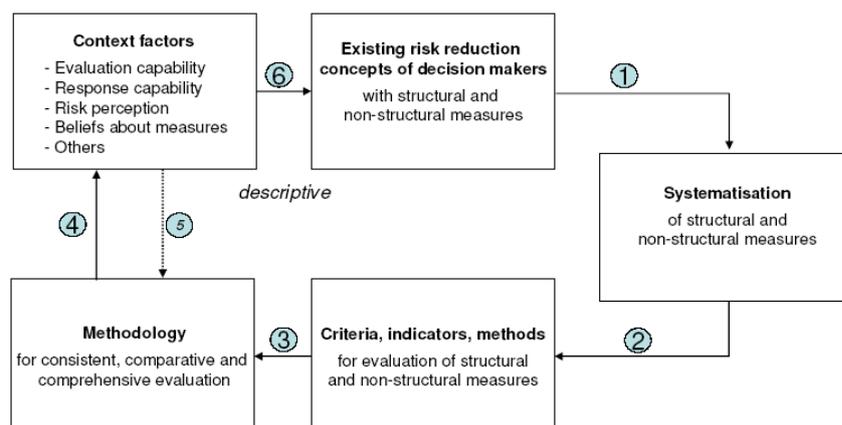
FLOOD-ERA is a European research project dealing with the evaluation of structural and in particular non-structural measures as part of flood risk management strategies. The FLOOD-ERA research project puts emphasis on the overall challenge of evaluating non-structural measures and comparing them with structural measures. Hereby it addresses not only the methodological challenges but also considers the decision making context like legal regulations and planning systems. The latter is supposed to have a strong influence on the choice between both types of measures. Research thus encompasses generic work on the systematisation, evaluation and comparison of measures on the one hand and on the context of decision making on the other hand. Moreover it includes specific investigations in European case study sites (6 case studies) to provide in-depth knowledge on the performance of measures and their acceptance. Major products are (1) the systematisation of SM and NSM, (2) the outline methodology for the evaluation of SM and especially NSM with regard to their effectiveness and efficiency, and (3) a framework on the influence of context conditions of decision makers regarding the consideration of SM and NSM. Of course the research process itself was iterative relating generic and site-specific aspects.

Methodology used for assessment of FRM and climate change:

The scope of FLOOD-ERA objectives requires a combined research design integrating different kinds of approaches. According to the major areas of interest of the project three principal approaches may be distinguished:

- A systematisation of SM and NSM,
- A normative approach to the evaluation of SM and NSM,
- A descriptive approach to analyse the context conditions of decision makers.

While above mentioned individual approaches focus on different aspects of SM and NSM, there is a strong relation between them within the combined research design of FLOOD-ERA.



Source: CRUE Research Report No I-1: Systematisation, evaluation and context conditions of structural and non-structural measures for flood risk reduction FLOOD-ERA Joint Report

Figure: Basic structure of the combined research design of FLOOD-ERA

Figure presents the relation between the individual approaches. Starting point are existing risk reduction programmes and projects of with the “real world”. They are used as basis for systemising structural and non-structural measures (no. 1). This typology provides the background for selecting, elucidating and applying criteria, indicators and methods (no. 2) which than lead to the methodology for consistent,

comparative and comprehensive evaluation of measures (no. 3). In a way, a methodology is a means to come to coherent justifications to deploy a range of structural and non-structural measures. It is one context factor of decision-makers since it comprises a rationale, a set of criteria, indicators, methods and procedures to facilitate evaluation in practice (no. 4). In turn, we consider that context conditions are relevant for developing the methodology from a “pure” scientific viewpoint (e.g. the availability of data, given objectives; no. 5). However, the influence of context on methodology is difficult to define precisely in advance why this relationship is treated as a weak influence on developing the methodology (hence, the dotted line). Finally, context conditions, internal as well as external, influence flood risk management concepts and strategies. The application of document analysis and conducting interviews are here used to elicit the major context factors and further to analyse the influence on the decision (no. 6).

Activity title: WORKSHOP ON WATER AND CLIMATE CHANGE: HOW TO DEVELOP AN ADAPTATION STRATEGY IN TRANSBOUNDARY BASINS	
Funding institution: UNECE - United Nations Economic Commission for Europe	Contact institution/person: UNECE, Palais des Nations, 8 -14 avenue de la Paix, 1211 Geneva 10, Switzerland http://www.unece.org/env/water/welcome.html
Starting date : 10 May 2010	Ending date: 11 May 2010
Description of the activity: The workshop took place on 10 and 11 May 2010 in room VII in the Palais des Nations, Geneva, back-to-back with the third meeting of the Task Force on Water and Climate (12 May 2010). It brought together countries and main international actors engaged in activities on water and adaptation to climate change, in particular in transboundary basins, with the aim to: <ul style="list-style-type: none"> - Exchange practical experience and share lessons-learned on the technical and strategic aspects of adapting to climate change; - Analyse the specific challenges of adapting water management to climate change in the transboundary context; - Show how transboundary cooperation can be established in the different steps of developing an adaptation strategy: from the assessments of impacts and vulnerability to the selection of measures; - Support countries engaged in the process of preparing national or regional adaptation strategies; - Promote the implementation of the UNECE Guidance on Water and Adaptation to Climate Change. <p>In particular, the workshop aimed to assist governments implementing pilot projects on adaptation to climate change under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) in planning and implementing the objectives, steps and activities of the projects.</p> <p>The workshop also discussed how to ensure a continuous exchange of experience on adaptation to climate change in transboundary basins through a pan-European platform under the Water Convention.</p>	
Methodology used for assessment of FRM and climate change: N/A for this type of activity.	

Activity title: BEST PRACTICES ON FLOOD PREVENTION, PROTECTION AND MITIGATION	
Funding institution: UNECE - United Nations Economic Commission for Europe	Contact institution/person: UNECE, Palais des Nations, 8 -14 avenue de la Paix, 1211 Geneva 10, Switzerland http://www.unece.org/env/water/welcome.html
Starting date : 2002	Ending date: 2003
Description of the activity: <p>The document concerns the “best practice document”, which is an update of the United Nations and Economic Commission for Europe (UN/ECE) Guidelines on Sustainable flood prevention (2000). It is living documents that will need continuous input and improvements as application and experience build up in all countries of the European Union and beyond. The “best practice document” consists of three parts. In part I the more basic principles and approaches are described. Part II concerns how to translate and implement the principles and approaches. The conclusions are drawn in part III.</p> <p>The “best practice document” includes but is not limited to the results of a high level meeting which was held on flooding in Budapest on 30 November and 1 December 2002, and working-level meeting on flooding in Bonn on 5/6 February 2003, which was prepared by Germany.</p> <p>This document aims to describe measures and best practices to prevent, protect and mitigate the adverse impact of flood events on human health and safety, on valuable goods and property, and on the aquatic and terrestrial environment. This best practice document concerns only river and flash floods. Marine and tidal floods are not taken into account. The character of the best practice document is strategic rather than technical.</p> <p>It is necessary to distinguish between different kinds of flooding and the environmental conditions that contribute to the problem. For instance, there are significant differences between on the one hand sudden flooding in upstream or headwater areas where mitigating risk involves a wide range of innovative small-scale solutions and on the other hand low land flooding where warning periods and the duration of flood events are longer and large-scale measure have to be taken. Therefore, the effectiveness of the best practices described in “best practice document” depends on among other hydrological and environmental circumstances.</p>	
Methodology used for assessment of FRM and climate change: <p>Success can only be reached if an interdisciplinary approach is adopted. Heavy precipitation cannot be managed neither can extreme floods. People have to learn to live with flood events, have to do everything to avoid anthropogenic augmentation of floods, to behave in a manner to mitigate potential risks for people and valuable goods. People have to be aware of potential and actual risks in order to induce their precautionary actions. Further more, fight against flood damages can have positive effects in different other policy fields like nature conservation for instance. It is necessary and urgent to implement experiences of the European countries presented in this document.</p> <p>For transboundary river basins, actions on international level have to be developed. For each river basin, a flood management plan should be developed. In setting up such a plan, consideration should be given to the aspect of solidarity within the river basin that is to prevent as much as practicable the passing on of problems in one geographical area into another one. The plan should be based on an integrated approach covering all relevant aspects of water management, physical planning, land use, agriculture, transport and urban development, nature conservation, at all levels (national, regional and local). In the development of a flood management plan, decision makers at all levels (local, regional, national and international) as well as stakeholders and civil society should be involved. Where applicable, the best practices described in this document should be taken into account, in particular on:</p> <ul style="list-style-type: none"> - Integrated river basin approach; - Public awareness, public participation and insurance; - Research, education and exchange of knowledge; - Retention of water and non-structural measures; - Land use, zoning and risk assessment; 	

- Structural measures and their impact;
- Flood emergency;
- Prevention of pollution.

Activity title: UNECE GUIDELINES ON SUSTAINABLE FLOOD PREVENTION

(MEETING OF THE PARTIES TO THE CONVENTION ON THE PROTECTION AND USE OF TRANSBOUNDARY WATERCOURSES AND INTERNATIONAL LAKES ECONOMIC COMMISSION FOR EUROPE)

Funding institution:

UNECE - United Nations Economic Commission for Europe

Contact institution/person:

UNECE, Palais des Nations, 8 -14 avenue de la Paix, 1211 Geneva 10, Switzerland
<http://www.unece.org/env/water/welcome.html>

Starting date : 23 March 2000

Ending date: 25 March 2000

Description of the activity:

The character of the guidelines is strategic rather than technical. They attempt to provide the essential elements to be considered when drawing up concerted action plans. These guidelines aim to recommend measures and best practices to prevent, control and reduce the adverse impact of flood events on human health and safety, on valuable goods and property, and on the aquatic and terrestrial environment. They are intended to assist the Parties to the Convention, other UN/ECE countries and joint bodies in developing and implementing sustainable measures and good management practices for flood prevention and protection that take account of economic, environmental and social considerations. As this depends on the specific conditions and circumstances in the respective catchment areas, the proposed guidelines are non-binding. Considering the evolution and trends, the approach to natural hazards requires a change of paradigm. One must shift from defensive action against hazards to management of the risk. Flood protection is never absolute; only a certain level of protection against flooding can be guaranteed. The question regularly arises as to what safety is available at what price, and how much of the remaining risk has to be accepted by society. Risk management will be the appropriate method to deal with this challenge.

There are at least seven basic principles and approaches regarding sustainable flood prevention. To implement them, cooperation at all government levels, and coordination of sectorial policies regarding environmental protection, physical planning, agriculture, transport and urban development is needed. As regards transboundary waters, cooperation is needed among the riparian countries to harmonize national policies and strategies, and to draw up concerted action plans. Basic principles are:

- Flood events are part of nature. They have always existed and will continue to exist;
- Human interference into the processes of nature has increased the threat of flooding. As far as possible, such interference should be reversed, compensated and, in the future, prevented;
- Flood prevention should cover the entire catchment area of watercourses; this also applies to transboundary waters and their catchment areas. Flood prevention has also to be based on the precautionary principle;
- Structural measures will remain important elements of flood prevention and protection. However, these measures should primarily focus on the protection of human health and safety, and valuable goods and property. Requirements of nature conservation and landscape management should be taken into account;
- Everyone who may suffer from the consequences of flood events should also take his/her own precautions. To this end, an appropriate information and forecasting systems should be established by the competent authority;
- Human uses of flood plains should be adapted to the existing hazards. Appropriate instruments and measures should be developed to reduce the risk of flooding;
- In flood-prone areas, preventive measures should be taken to reduce possible adverse effects of floods on aquatic and terrestrial ecosystems, such as water and soil pollution.

Methodology used for assessment of FRM and climate change:

The impact of all major human activities concerning flood prevention and protection in the catchment area on society as a whole should be properly considered. All major undertakings with the potential of adversely affecting human health or significantly affecting water quality or quantity, biological communities, landscape, climatic factors, architectural and archaeological heritage, or the relationship between them should be subject to environmental impact assessment (EIA) and authorization procedures. EIA should also be applied on an international scale, in particular with regard to activities with a potential transboundary effect on health and aquatic ecosystems.

Physical planning as well as urban and rural development and construction should take into account the requirements of flood prevention and reduction, including the provision of retention areas.

In setting up these frameworks local problems, needs and knowledge, and local decision-making mechanisms should be duly taken into consideration. An information policy that covers risk communication and facilitates public participation in decision-making should be developed.