Proceedings of the

Workshop on Flood Risk Management Measures & Links to EU WFD

Zagreb, Croatia

11 – 12 November 2015

United Nations Educational, Scientific and Cultural Organization
Venice Office
Regional Bureau for Science and Culture in Europe

World Meteorological Organization
Weather • Climate • Water

icpdr iksd
International Commission for the Protection of the Danube River
Internationale Kommission zum Schutz der Donau

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Abstract

The International Sava River Basin Commission (ISRBC) organized this *Workshop on Flood Risk Management measures & links to EU WFD* jointly with the United Nations Educational, Scientific and Cultural Organization – UNESCO Regional Bureau for Science and Culture in Europe, Venice (UNESCO Venice Office); the World Meteorological Organization (WMO); the International Commission for the Protection of the Danube River (ICPDR). The workshop was held on 11-12 November 2015 at the Sheraton Zagreb Hotel, Kneza Borne 2, 10000 Zagreb, Croatia. The workshop was coordinated with ISRBC Permanent Expert Group for Flood Prevention.

This capacity-building workshop was dedicated to flood risk management measures and addressed interests and needs of a broad range of participants including representatives of the institutions and organizations from the Danube River Basin, and in particular from the Sava River Basin, involved in integrated flood risk management, policy and decision makers at the national and international level, authorities dealing with water and flood management, the civil protection sector and experts in the field of floods.

The workshop objectives were to assess, discuss, and inform participants on policies and practices in the Danube River and Sava River basins concerning: (1) flood risk management planning, prevention and preparedness in the context of existing policy and regulatory frameworks, including flood forecasting and warning systems, awareness raising and capacity building, (2) Emergency response and recovery in the context of flood defense measures, lessons learned from May 2014 floods on mutual assistance, mitigation and recovery, (3) Integrating flood risk reduction and Natural Water Retention Measures (NWRM) into a basin wide approach, in the context of the EU Water Framework Directive (WFD) and also taking into consideration decision making processes and economic and financial aspects.

Observations and insights provided during session presentations and subsequent group discussions were documented by the rapporteurs and are included in this report.

Foreword

The International Sava River Basin Commission in cooperation with the United Nations Educational, Scientific and Cultural Organization - Regional Bureau for Science and Culture in Europe, Venice; the World Meteorological Organization; the International Commission for the Protection of the Danube River - organized and conducted a Workshop on Flood Risk Management measures & links to EU WFD at the Sheraton Zagreb Hotel, Kneza Borne 2, 10000 Zagreb, Croatia, on 11-12 November 2015.

The organizers have decided to publish the proceedings of the workshop to further share the knowledge and practical experiences presented at the workshop and to summarize the significant insights and observations made by the participants. These proceedings provide an overview of the state of knowledge and practices in flood hazard assessment related to extreme natural events risk. They also include references and electronic links to information sources presented and discussed during the workshop. In particular, all the slides presented can be viewed at the public web page: http://savacommission.org/event_detail/0/0/349/2.

We hope that, like the workshop itself, these proceedings will draw the interest of the many stakeholders engaged with flood risk management in the Danube and, in particular, the Sava River basin. We believe that collaborating in sharing flood risk information among the Sava River Basin countries will strengthen their cooperation and allow them to leverage limited resources and increase security of living in the whole area. The many scientific and technical interactions participants developed during the workshop are already a fantastic demonstration of the benefits such collaboration and cooperation can bring.

Dejan Komatina
International Sava River Basin Commission

Philippe Pypaert
UNESCO Regional Bureau for Science and Culture in Europe, Venice

Tommaso Abrate
World Meteorological Organization, Climate and Water Department

Raimund Mair
International Commission for the Protection of the Danube River

Acknowledgment

The concept, planning and execution of this workshop, and the preparation of these proceedings were achieved by the organizing committee composed of the officials of the Secretariat of ISRBC, as well as UNESCO Venice Office, WMO and ICPDR. The organizing committee consisted of: Dejan Komatina, Dragan Zeljko, Ana Marinić, Mirza Sarač, Philippe Pypaert, Tommaso Abrate, Raimund Mair, Renata Fürt, Ivan Milovanović and Tomislav Majerović.

Many of the organizing committee members were also presenters and moderators of group discussions.

The organizers are grateful for the support provided by Adrian Slob, the overall workshop moderator, and by the following

INVITED PRESENTERS/SPEAKERS AND MODERATORS OF GROUP DISCUSSIONS:

- Firas Al-Janabi
- Marijan Babić
- Marina Babić-Mladenović
- Maria Berglund
- Lucia Bernal Saukkonen
- Anna Cestari
- Nenad Đukić
- Zoran Đuroković
- Darko Janjić
- Igor Liška
- Dijana Oskoruš
- Sašo Petan
- Almir Prljača
- Enes Šeperović
- Luka Štravs

RAPPORTEURS OF GROUP DISCUSSIONS:

- Martina Egedušević
- Jovanka Ignjatović
- Esena Kupusović
- Radovanka Pavlović
- Irma Popović Dujmović
- Petra Remeta
- Žana Topalović
- Tatjana Vujnović

Event photos

Opening of the Workshop

Plenary session

Group discussion

Group discussion

Group discussion

Acronyms and abbreviations

APSFR	Areas of Potential Significant Flood Risk
ARSO	Slovenian Environment Agency
AVP SAVA	Sava River Watershed Agency, Sarajevo, Bosnia and Herzegovina
CBA	Cost Benefit Analysis
DHMZ	Meteorological and Hydrological Service of the Republic of Croatia
DRBD	Danube River Basin District
DHI	Danish Hydrological Institute
EC	European Commission
EFD	EU Floods Directive (Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks)
EU	European Union
FASRB	Framework Agreement on the Sava River Basin
FFWS	Flood Forecasting and Warning System
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
GIS	Geographical Information System
HIS	Hydrological Information System
HFS	Hydrological Forecasting System
ICPDR	International Commission for the Protection of the Danube River
INSPIRE	Infrastructure for Spatial Information in the European Community
IPA	Instrument for Pre-accession Assistance
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
ISRBC	International Sava River Basin Commission
NWRM	Natural Water Retention Measures
PFRA	Preliminary Flood Risk Assessment
RBM	River Basin Management
RBMP	River Basin Management Plan
RHMZRS	Republic Hydro-Meteorological Service of the Republic of Srpska, Bosnia and Herzegovina
SRB	Sava River Basin
UNESCO	United Nations Educational, Scientific and Cultural Organization (Venice Office - Regional Bureau for Science and Culture in Europe, Venice)
WB	World Bank
WFD	EU Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy)
WaterML	Markup Language - standard information model for the representation of water observations data
WBIF	Western Balkans Investment Framework
WMO	World Meteorological Organization

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1. Introduction

1.1 Background to the Workshop on Flood Risk Management Measures and Links to EU WFD

In May 2014 the Sava River Basin was confronted with a major flood event. A large area of the basin within Croatia, Bosnia and Hercegovina and Serbia was hit by continuous, heavy rainfall. This led to flash floods, erosion and landslides along small watercourses, and to big floods along the Sava River main course and its right tributaries.

This was the most significant flood event in the Sava River Basin since the establishment of the ISBRC. The Parties cooperating under the Framework Agreement on the Sava River Basin (FASRB) committed themselves to further cooperate for the preparation of the Flood Risk Management Plan for the Sava River Basin, establishing a Flood Forecasting, Warning and Alarm System in the Sava River Basin, exchanging the information relevant for sustainable flood protection, as well as undertaking any other agreed activities that can contribute to the improvement of the flood management in the basin.

One of the activities that can contribute to the improvement of the flood management in the basin is close communication between countries which can be achieved by ensuring adequate communication throughout the process to ensure mutual awareness of objectives, direction, progress and decisions (e.g. via workshops, meetings, etc.).

The Workshop on Flood Risk Management Measures & links to EU WFD was jointly organized by the UNESCO Venice Office, WMO, ICPDR and ISRBC. This inter-sectoral workshop explored advances and innovations in flood risk management practice, putting focus on the exchange of experience on structural and non-structural flood mitigation measures and approaches and links with nature/wetlands management in river corridors, as well as on the linkage between the WFD and EU Floods Directives (EFD). Part of the focus was put on the flood forecasting and coupling of weather and hydrology prediction models.

The workshop provided a valuable input for planning and implementation of activities of ISRBC foreseen by the Protocol on Flood Protection to the FASRB (Protocol on FP), and other activities in the field of flood risk management.

These proceedings contain all the papers presented at the workshop.

1.2 Topics

The following topics were discussed at the workshop:

I - Flood risk management planning, prevention & preparedness

- Policy and regulatory framework
- National/International flood risk management planning
- Flood forecasting and warning
- Raising awareness & Capacity building

II - Emergency response and recovery

- Flood defense measures
- Recovery and lessons learned from May 2014 floods
- Mutual assistance and mitigation

III - Integrating flood risk reduction and river basin approach

- Natural Water Retention Measures
- Links to EU Water Framework Directive
- Decision making - economic and financial aspects

These different topics were highlighted in the workshop in several plenary presentations, then discussed in smaller – and more interactive – groups.

The workshop was highly participatory, involving a group work on specific topics, as well as discussions on the linkages and on the benefits of an inter-sectoral approach to flood risk, river basin and civil protection management.

1.3 Results and conclusions

During the two days, twenty-two papers were presented in three sessions. After each session, discussions were organized in three separate groups, with 27-30 participants in each group, preselected by the organizers while taking into account the position and affiliation of participants. The arrangement ensured that each participant could express his/her opinions about the whole agenda. Discussions were then summarized by the moderators of each group, and presented at the closing session.

The success of the workshop was ensured by a smooth organization of the sessions, group discussions, and social events.

THE FOLLOWING MAIN CONCLUSIONS ARE THE FRUIT OF THIS COLLECTIVE EFFORT:

- The elaboration of a basin-wide (e.g. Sava and/or Danube) catalogue of measures would be useful to strengthen the common understanding on the range of potential measures and terminology in the process of the flood risk management plan development.

- The basin-wide catalogue of measures should be elaborated through a joint body (e.g. ISRBC and/or ICPDR) and address a wide range of potential measures relevant for flood risk management, inter-linkages (e.g. to the WFD) and related issues, ensuring that a "no harm rule", as set in the Protocol on Flood Protection, is respected.

- In the process of the exchange and dissemination of information related to flood risk management (e.g. flood/drought forecasting), responsible institutions should have a PR person to communicate with the wide public of one country as well as among countries.

- The inter-sectoral coordination and cooperation in flood risk management planning through a joint body (e.g. ISRBC and/or ICPDR), as a mechanism of cooperation and coordination, will ensure the establishment of higher standards and support the necessary improvements at the national level.

- Considering in particular the links with land use planning, new multipurpose land use categories, like potential retention areas, where activities can coexist with floods need to be defined. For these target areas, new regulations should be introduced, including:
  - A mandatory building code for all new urbanization in flood prone areas (urbanization in any case should be reduced in flood prone areas to the minimum possible extent);
  - Improved hydrological standards for the design of any other kind of interventions in flood prone areas.

- The marginalization of gaps in coordination needs to be orchestrated at national level, while international organizations should help accelerating and challenging the process, taking into account basin-wide issues and perspectives. In this view, further institutional strengthening and capacity building is needed, considering in particular the involvement of policy makers, scientists and local communities in multidisciplinary and transdisciplinary approaches:
  - A top-down approach to ensure a coordinated implementation of measures (ISRBC and/or ICPDR can make recommendations);
  - A bottom-up approach involving local communities, but also the hydropower sector, in the definition and implementation of flood prevention and emergency measures, which should be facilitated by (e.g. ISRBC and/or ICPDR) through the organization of workshops with all relevant stakeholders and the support of multidisciplinary teams.

- According to the EFD, countries of an international river basin like the Sava river basin are requested to prepare a cost-benefit analysis based on a commonly agreed methodology. The estimation of the benefits of non-structural measures at the basin level (like flood forecast and warning, which can be expressed only as a percentage of potential damages) remains in fact a challenge in flood risk management planning and emergency management.

- A joint body like ISRBC and/or ICPDR has also a responsibility in establishing an operational manual of measures and activities addressing flood defense and emergencies at the basin level. An inventory of emergency equipment for flood defense should be established at the basin level (e.g. movable defenses, pumps, boats, sandbags, etc.) as a basis for possible aid interventions, exchanges and cooperation in the case of emergencies.

- Similarly, joint discharge measurements (in-situ) on transboundary rivers during flood events should be organized and coordinated by ISRBC, on the basis of its common Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin (Data Policy).

- Training exercises and simulations for better preparedness and exchange of experiences, practices and lessons learned between countries, in order to stimulate better coordinated responses to possible future floods, should be ran at the basin level.

- Measures for long-term resilience and fast flood recovery should finally include:
  - Raising of public awareness in order to prepare citizens better "living with floods";
  - Mandatory insurance for flood disaster (e.g. citizen taxation);
  - Compensation mechanisms for possible flooding damages in specific flood areas.

1.4 Workshop papers

The workshop technical topics were divided into three panel sessions:

SESSION 1: Flood risk management planning, prevention & preparedness
SESSION 2: Emergency response and recovery
SESSION 3: Integrating flood risk reduction and river basin approach

Sessions consisted of the presentations and group discussions with a concluding session, which provided an opportunity for the workshop organizers to summarize session's presentations and group discussions. Discussions based on these summaries identified suggested areas for further work.

Each session is documented as a chapter in these proceedings. The chapters begin with an agenda overview followed by presentation lists, as well as summary of the group discussions and abstracts by the presenters, which are in some cases only for case studies of related session. References are provided in the abstracts. Appendix C provides a listing of the workshop presenters.

To aid the interested reader who wishes to view all of the workshop presentations, every chapter related to specific workshop session provides a listing of electronic information sources

In total, about ninety participants (88) of the workshop included policy and decision makers at national and international level, as well as experts, from institutions and organizations from governmental, non-governmental and academic sectors from the Danube River Basin, particularly the Sava River Basin, working in the fields of integrated flood risk management, civil protection and environmental protection.

A list of all workshop attendees and their affiliations can be found in Appendix B.

2.
SESSION I - FLOOD RISK MANAGEMENT PLANNING, PREVENTION & PREPAREDNESS

2.1 Agenda items overview

Policy and regulatory framework

- Policy framework and coordination requirements in floods, river basin and civil protection management
- Protocol on Flood Protection to the FASRB & Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin

National/International flood risk management planning

- Structural and non-structural measures in flood risk management
- Case studies:
  - Slovenia
  - Croatia
  - Sava River Basin
  - Danube River Basin

Flood forecasting and warning

- System development, warnings issued and dissemination of messages
- Case studies:
  - Flood forecasting in Slovenia
  - Flood forecasting in Croatia
  - Flood forecasting and warning system for the Sava River Basin
  - Flash flood guidance system in South East Europe

Raising awareness & Capacity building

- Raising hazard/risk awareness, providing access to information and communication with media, face-to-face and web-based learning, trainings and collaborative platforms, access to justice

Group discussions

GROUP 1: Catalogue of measures in FRM Plans relevant for the whole river basin

GROUP 2: Exchange of information among countries and dissemination of information to wide public

GROUP 3: Inter-sectoral coordination and cooperation in flood risk management planning, prevention & preparedness

2.2 Overview of presentations

Policy and regulatory framework
Policy framework and coordination requirements in floods, river basin and civil protection management – F. Al-Janabi
http://www.savacommission.org/WFRM/01

Policy and regulatory framework
Protocol on Flood Protection to the FASRB & Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin – D. Zeljko
http://www.savacommission.org/WFRM/02

National/International flood risk management planning
Structural and non-structural measures in flood risk management – M. Babić-Mladenović
http://www.savacommission.org/WFRM/03

National/International flood risk management planning
Case study: Slovenia – L. Štravs
http://www.savacommission.org/WFRM/04

National/International flood risk management planning
Case study: Croatia – M. Babić
http://www.savacommission.org/WFRM/05

National/International flood risk management planning
Case study: Sava River Basin – M. Sarač
http://www.savacommission.org/WFRM/06

National/International flood risk management planning
Case study: Danube River Basin – I. Liška & R. Mair
http://www.savacommission.org/WFRM/07

Flood forecasting and warning
System development, warnings issued and dissemination of messages – F. Al-Janabi
http://www.savacommission.org/WFRM/08

Flood forecasting and warning
Case study: Slovenia – S. Petan
http://www.savacommission.org/WFRM/09

Flood forecasting and warning
Case study: Croatia – D. Oskoruš & T. Vujnović, P. Mutić, Ž. Klemar, T. Jurlina
http://www.savacommission.org/WFRM/10

Flood forecasting and warning
Case study: Sava River Basin – A. Cestari
http://www.savacommission.org/WFRM/11

Flood forecasting and warning
Case study: Flash flood guidance system in South East Europe – F. Al-Janabi
http://www.savacommission.org/WFRM/12

Raising awareness & Capacity building
Raising Awareness & Capacity building for Flood Disaster Risk Reduction – P. Pypaert
http://www.savacommission.org/WFRM/13.1

Raising Hazard/awareness, providing access to information and communication – P. Pypaert
http://www.savacommission.org/WFRM/13.2

2.3 Summary of group discussions

GROUP 1
Catalogue of measures in FRM Plans relevant for the whole river basin
Raimund Mair, moderator
Martina Egedušević, rapporteur

Questions:
- Existence of national catalogues of measures?
- What would be the benefit of a basin-wide international catalogue of measures?
- What actions are needed to develop a basin-wide catalogue of measures?
- What are the main issues that should be addressed in the catalogue of measures?

Summary of discussion:
A catalogue of measures can be a very useful tool and background document, outlining potential measures which could in a second step be selected from and implemented through the Flood Risk Management Plans.

National catalogues of measures are already in place in some countries (e.g. Romania, Slovenia) and other countries are working on it / are intending to elaborate a catalogue of measures (e.g. Serbia, Bosnia and Herzegovina, Moldova, ...).

A basin-wide catalogue of measures (e.g. Sava basin or Danube basin) would be considered as useful for creating a common understanding on the different potential measures which could be taken and to create a common understanding, share experiences and to create a joint terminology (glossary).

A basin-wide catalogue of measures would be useful for the elaboration and/or adaptation of targeted national catalogues of measures, which would afterwards be useful for the selection of appropriate measures.

Such an activity should be undertaken in the frame of a "joint body" like the ISRBC and/or ICPDR and the respective relevant Expert Groups e.g. on flood protection, hydromorphology, public participation, etc. The activity should be based on national experiences which are in place (e.g. already existing catalogues of measures) but also looking beyond, e.g. experiences in other basins (like Rhine), EU CIS process or even beyond Europe (looking outside the box).

A clear, targeted and transparent procedure would be required for the elaboration of such a catalogue of measures.

The catalogue should address a broad range of potential measures relevant for flood risk management, including e.g. land use planning, water retention measures, structural and non-structural measures, preparedness measures, early warning systems, operational aspects of existing infrastructure (e.g. hydropower), etc.

Also procedural aspects regarding ways how to implement different measures would be considered as useful for practical application. Furthermore, the quantification of positive effects of NWRM would be useful in order to further clarify the potential of such measures for flood risk management and reducing flood peaks. Also the impact and relation to other legislation, i. e. the EFD, Natura 2000, etc. would be useful (synergies and potential conflicts).

GROUP 2
Exchange of information among countries and dissemination of information to wide public
Philippe Pypaert, moderator
Tatjana Vujnović, rapporteur

Questions:
- What actions are needed to develop information exchange (mechanisms) among countries related to the flood forecasting?
- What information (on what topics?) should be disseminated to the public? And what actions related to this should be performed in the FRM planning?

Summary of discussion:
Bilateral and multilateral agreements for data exchange exist and their application is mandatory but not always automatic, even if ISRBC has established the legal and software tools to support such exchanges.

There is, however, a need for harmonization of warning levels between the countries, and relevant staff in institutions should be trained in the use of common alert systems and protocols in order to facilitate data exchange and coordination of interventions.

By doing so, the thresholds for meteo-alarm and hydro-alarm could be harmonized between the countries (currently every country has a different point of declaring alerts and warning). Data circulation, starting usually from hydro-meteorological institutions, should be improved so to ensure that citizens could be reached in the shortest delay possible in the case of emergencies.

When planning any measure, the emphasis should be put on entire river basin. Administrative borders should not be an obstacle to effective and efficient planning. This implies transboundary cooperation and effective communication, as well as public consultation/participation on both sides of any border. The public at large should be consulted on measures for flood protection.

GROUP 3
Inter-sectoral coordination and cooperation in flood risk management planning, prevention & preparedness
Dejan Komatina, moderator
Radovanka Pavlović, rapporteur

Questions:
- What inter-sectoral coordination and cooperation in flood risk management planning, prevention and preparedness is needed for the FRM planning?
- What actions are needed to make it work?

Summary of discussion:
Participants in the group discussion pointed to major problems in terms of inter-sectoral cooperation at the national level and emphasized need for inter-sectoral coordination and cooperation in flood forecasting and warning, environment, spatial planning and land use, construction and infrastructure, emergency situations management, civil protection, etc. Improvement of communication, data exchange, activities coordination, operational procedures. Legislative regulation by countries is a prerequisite for more efficient inter-sectoral coordination and cooperation. EU accession process is a good opportunity to achieve this objective.

2.4 Abstracts of presentations

2.4.1 Policy and regulatory framework

Protocol on Flood Protection to the FASRB & Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin

By

Dragan Zeljko
International Sava River Basin Commission

Keywords: FASRB, Protocol on FP, Data Policy, Sava GIS, Sava HIS

The Framework Agreement on the Sava River Basin, in force since 2004, represents an overarching legal basis of cooperation of the Sava countries: Slovenia, Croatia, Bosnia and Herzegovina and Serbia (the Parties) in water management. Transboundary cooperation for sustainable development of the region is the main objective of the Agreement. One of its three specific goals is undertaking of measures to prevent/limit hazards (floods, droughts, ice and accidents) and to reduce/eliminate their negative consequences. Aiming to ensure preconditions for sustainable flood protection in the Sava River Basin, the Parties have agreed to prepare the Protocol on Flood Protection to the FASRB. The Protocol on FP was signed in 2010 and entered into force on November 27, 2015, following the long-lasting procedures of ratification in all the Parties. It represents the firm legal basis for enhancing the cooperation of riparian countries in flood management, via their joint platform – ISRBC.

By the Protocol on FP the Parties have agreed to cooperate in the following main activities:

- Development of the Flood Risk Management Plan in the Sava River Basin, with all the preliminary steps required by the EFD;
- Establishment of the Flood Forecasting, Warning and Alarm System in the Sava River Basin;
- Exchange of information relevant for sustainable flood protection;
- Implementation of all measures stemming from the planning documents mentioned above or from any other mutually agreed action.

It is important to emphasize that significant joint actions have already been undertaken, even before the Protocol on FP formally entered into force. This has been achieved through the work of ISRBC and its relevant expert bodies. The following activities can be listed as the examples of achievements:

- Preparation of the joint Preliminary Flood Risk Assessment for the Sava River Basin;
- Development of the Program for preparation of the Flood Risk Management Plan for the Sava River Basin;
- First-ever hydrologic model for the whole Sava River Basin and the unsteady hydraulic model for the Sava River, etc.

It is expected that the implementation of mutually agreed activities will be accelerated in the near future, having in mind that the necessary prerequisites are met: the Protocol on FP is in force and the implementation of main activities has been secured through several projects and supporting actions.

One of the essential elements of cooperation in an internationally shared basin is the exchange of data and information among cooperating countries. This issue has been addressed by ISRBC since its establishment through: development of the Sava GIS; preparation of hydrological yearbooks for the whole Sava River Basin and an initial system of presentation of real time hydrological data on the web site of ISRBC.

Exchange of primarily hydrometeorological data and information has been significantly improved since July 2014, when all hydrometeorological services and several water agencies of the Sava countries signed the Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin (Data Policy). Data Policy, prepared within the work of ISRBC and with support of the World Meteorological Organization (WMO), is fully in line with the WMO resolutions 25 & 40 on exchange of hydrological and meteorological data and products. Data Policy outlines main principles and minimum level of data and information exchange and can be reached at: http://savacommission.org/basic_docs.

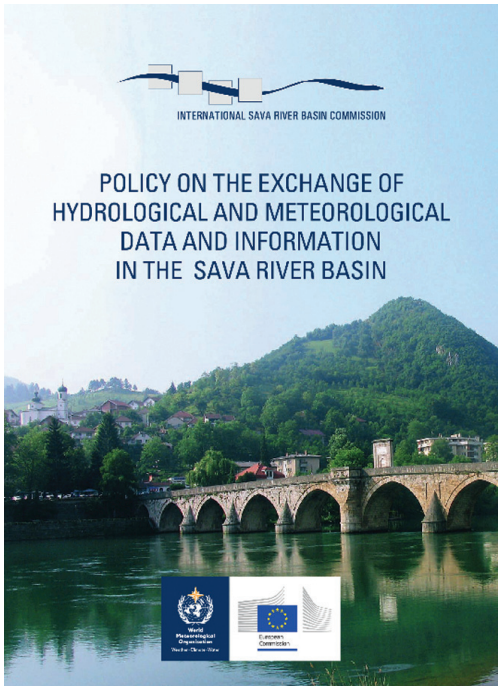

FIGURE 1. Frontpage of Data Policy

The most significant recent advance in implementation of Data Policy is the establishment of the Hydrological Information System of ISRBC (Sava HIS), as an effective tool for supporting the Sava countries in sharing and disseminating of hydrologic and meteorological data, information and knowledge about the water resources in the basin.

Sava HIS generally consists of the two components:

- Application for historical data management (part of Sava GIS)
- Application for real time data management

Sava HIS database model is compliant with Water ML 2.0, while the metadata model structure is compliant with ISO 19115 and INSPIRE.

Sava HIS has a different level of functionalities for public and registered users.
Sava HIS can be reached directly at www.savahis.org:

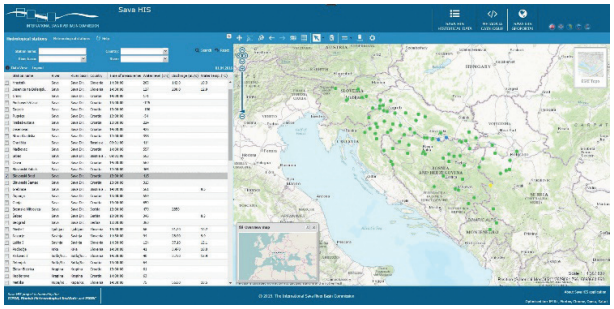

FIGURE 2. Interface of Sava HIS Real-Time Data web application

or through the Sava GIS Geoportal at www.savagis.org:

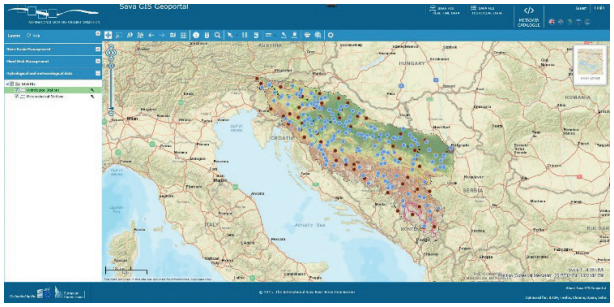

FIGURE 3. Interface of Sava GIS Geoportal

2.4.2 National/International flood risk management planning

Structural and non-structural measures in flood risk management

By

Marina Babić-Mladenović
Jaroslav Černi Institute for the Development of Water Resources

Keywords: Flood risk management, structural measures, non-structural measures

Flood risk is usually defined as the function of hazard, exposure and vulnerability (Kron, 2005; IPCC, 2012). Hazard is defined as the potential occurrence of a natural or human induced physical event that may cause consequences as loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. Hazard is therefore only a potential for harm, loss or damage. It exists where land is prone to flooding, and increases with depth of inundation, velocity of flow, and duration of inundation. Flood hazard, as a "natural" component of flood risk, will worsen in climate change conditions. Exposure to flood refers to the presence of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by flood. Actual consequences of flood depend on how vulnerable people and assets are to danger and damage. This includes the characteristics of a person or group and their capacity to be aware of the flood risk and to be well prepared, to know what to do during a flood emergency, and to have access to emergency services and post-flood support.
This definition of flood risk is highly relevant to flood management planning, because each of the 3 contributing and necessary conditions for flood risk are treated or managed using diverse types of measures (Figure 1). Structural measures are commonly used to modify flood hazard (including flood frequency, depth of inundation, and flood extent). A wide range of non-structural measures is applied to reduce exposure to flood hazard through land use control but also to decrease vulnerability to exposure. Structural measures have the impact on environment, while non-structural measures are focused on society.

Structural flood control works modify flood hazard in different ways: (1) Flood control reservoirs and flood detention basins reduce flood discharges downstream, directly modifying the physical characteristics of floods in terms of their spatial extent of inundation, depths of flooding, and flood flow velocities; (2) Flood dikes (levees) and river training directly modify the spatial extent of flooding, also affecting flood depths and flow velocities; (3) Flood diversion channels modify the spatial distribution of flooded areas, reducing hazard in the areas where more people and assets are exposed. Watershed management (including erosion control and torrent control measures) is an important structural measure, aiming at runoff and sediment regulation.

It is important to pass the message that flood hazard can only be reduced, but never fully eliminated.

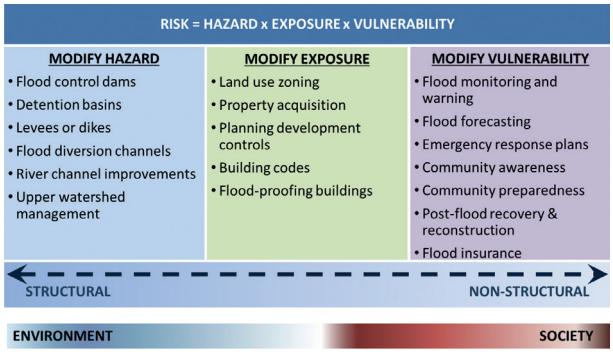

FIGURE 1. Set of flood risk management measures

After the implementation of different structural measures, there is still the residual risk due to possible failure of flood protection structures (breach of levee, etc.), failure of a reservoir or severe flood exceeding a design standard (levee overtopping). It is especially important to keep in mind the residual risk in areas protected by levees, where particular risk from rapid arrival of fast-flowing and deep water flooding exists, with little or no warning if defenses are overtopped or breached. Furthermore, implementation of structural measures encourages fast development in the protected area, and the value of property and number of people at risk increase because residents and users of the protected area don't understand that the risk is only changed and has not been eliminated.

Exposure is human component of flood risk, and it is permanently growing. People who live and work in, or transit through, as well as private properties, commercial assets, and public infrastructure in flood hazard areas are exposed to floods. Flood risk increases with increasing exposure (higher intensity of land use, rising value of property or assets located in flood-prone areas, and growing population that live or work in the endangered area or use it for other purposes). Development on floodplains is usually in the interests of national and social progress, and must be permitted, but these areas should be managed wisely – through adequate spatial planning. Regulation of land use is most effective when directed at future development, and includes residential development (appropriate types of buildings, limitations, proper locations of public services like schools, hospitals, emergency services, etc.), permitting of enterprises (storage of hazardous materials should be prohibited), planning of public infrastructure (routing and/or locations of key infrastructure – electricity substations, water supply, water treatment, and sewerage facilities). Regulation of land use relies on flood hazard maps, where different zones or categories of flood hazard are defined.

Measures to manage vulnerability in flood risk management are always non-structural. These measures are especially important for management of the residual risk. This set of measures requires careful planning, regular review of plans to maintain preparedness and swift mobilization of planned actions during flood emergencies. Adequate precautions can reduce vulnerability to floods, if applied prior to flooding: (1) Established support services (flood forecasting and decision support systems); (2) Developed reliable communications systems and flood warning data networks; (3) Determined evacuation routes and temporary refuge facilities; (4) Advance planning and training of emergency management procedures. Emergency response to flooding includes: (1) Supply of materials, telecommunications, transport, and power for flood defense emergency measures and flood fighting units; and (2) Evacuation and rescue, together with other actions necessary to manage public safety and security. Very important set of non-structural measures relates to recovery activities after flood: (1) Delivery of material needs of flood victims, including temporary supply of food and shelter; (2) Support services as clean-up, prevention of epidemics and waterborne diseases, and counselling to overcome personal distress and financial problems; (3) Repairs and rehabilitation of public infrastructure; (4) Financial assistance for incurred losses, housing repairs, businesses.

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Case study: Slovenia

By

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Keywords: flood risk, flood risk management, EU Floods Directive, flood risk management plan, catalogue of flood protection measures, cost benefit analysis

Slovenia has been coping with approximately 100-150 mil. EUR of annual flood related damages in the last 25 years. The officially assessed direct damages after larger flood events in the last 25 years for Slovenia are:

- for year 1990 - app 580 mil. EUR,
- for year 1998 - app 180 mil. EUR,
- for year 2007 - app 200 mil. EUR,
- for year 2009 - app 25 mil. EUR,
- for year 2010 - app 190 mil. EUR,
- for year 2012 - app 310 mil. EUR and
- for year 2014 - app 255 mil. EUR.

Therefore it is estimated that the floods in Slovenia have caused approximately 1750 mil. EUR (app 2150 mil. EUR with the taxes) direct damages in the last 25 years and approximately 980 mil. EUR (app 1200 mil. EUR with the taxes) direct damages in the last 10 years alone.

In the year 2007 the Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (the so called EU Floods Directive) was adopted with the aim of overall, more effective and more harmonised flood risk management in all EU member states. EU Floods Directive envisages a 6-year flood risk management planning cycle (the first one for years 2010(2009)-2015, the second one for years 2016(2015)-2021, etc.).

Slovenian Preliminary Flood Risk Assessment was adopted and made publicly available on December 22nd 2011. The two main components of the Slovenian Preliminary Flood Risk Assessment are a detailed listing of flood events (and their adverse consequences), which had occurred prior to year 2011 in Slovenia, and a classification of approximately 1200 identified flood risk areas into more and less significant ones according to the criteria of human health, economy, cultural heritage and environment at risk. Based on the results of the preliminary flood risk assessment and after a long and thorough public consultation process 61 areas of potential significant flood risk were identified in Slovenia. By the end of 2013 flood hazard and flood risk mapping was done for the areas of potential significant flood risk. For the purposes of flood hazard mapping the 10-year flood (high probability scenario), 100-year flood (medium probability scenario) and 500-year flood (low probability scenario) were chosen as relevant for Slovenia. All of the Slovenian flood hazard and flood risk maps are publicly accessible and downloadable via the eWater web portal or Slovenian Water Management Atlas.

Flood Risk Management Plan for Slovenia (the final step of the 6-year flood risk management programming cycle) addresses the flood risk at 61 areas of potential significant flood risk, which were grouped in 17 river basin districts (11 of those are in the Sava River Basin). Slovenia's flood risk management plan therefore includes 17 flood risk management plans which are logically (inter)connected and include a detailed identification and prioritisation of the necessary flood protection measures that have already been going on or still have to be put in place in particular river basin. The flood protection measures were chosen from Slovenia's catalogue of flood protection measures, which consists of 20 such measures (Table 1). Furthermore the flood protection measures are divided into flood protection projects.

Measure	Relation of the measure with the WFD goals		
	SYNERGY	POTENTIAL CONFLICT (has to be dealt with at the level of detailed planning)	IRRELEVANT
U1 **Flood hazard and flood risk mapping**	x		
U2 **Natural water retention measures**	x		
U3 **River basin wide land use adaptation**	x		
U4 **Hydrological and meteorological monitoring**	x		
U5 **Flood risk related databases**	x		
U6 **Raising awareness about flood risk**	x		
U7 **Structural flood protection measures**		x	
U8 **Individual flood protection measures**	x		
U9 **Continuous efficiency control of the flood protection measures**			x
U10 **Water infrastructure maintenance flood works**		x	
U11 **River basin control**	x		
U12 **Proper management of flood, water, hydropower and other infrastructure**		x	
U13 **Providing enough financial resources**			x
U14 **Contingency planning for maintenance works**		x	
U15 **Flood forecasting**			x
U16 **Flood warning**			x
U17 **Flood intervention activities**		x	
U18 **Flood damage assessment**			x
U19 **Post flood event analysis**			x
U20 **Financial, system, international river**		x	

TABLE 1: A list of 20 Slovenian flood protection measures (from the Slovenian catalogue of measures) and their relation to the goals of the WFD

Coordination of the flood protection measures with the goals of the Water Framework Directive was done by classifying the flood protection measures from Slovenia's catalogue of flood protection measures into three groups; measures in synergy with the WFD goals, measures which are irrelevant for the WFD goals and measures that could potentially be in conflict with the WFD goals (and will have to be checked in the later phase of the implementation of the particular measure).

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Case study: Croatia

By

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Keywords: Croatia, EU Floods Directive, flood risk management measures

The presentation included information on the implementation of the EFD in the Republic of Croatia and information on the planned structural and non-structural flood risk management measures in Croatia. The objective was to present a case study of the flood risk management planning in a member state of the European Union (EU).

Croatia joined the EU on July 1, 2013. Previously, the EFD was transposed into national legislature in 2009 (Water Act). Croatia was generally subject to the same deadlines as the other MS, with the exception of the Preliminary Flood Risk Assessment (PFRA), for which the MS deadline was December 2011, while Croatia had to report as soon as possible after joining the EU. The Flood Hazard (FH) and Flood Risk (FR) maps were due in December 2013 (reporting to the EU in March 2014), and the FRMP's are due in December 2015 (reporting to the EU in March 2016). Updates to the FRMP will be carried out in six-year cycles. Croatia completed the PFRA in 2013 and reported in 2014. IPA Twinning Project "Preparation of Flood Hazard and Flood Risk Maps" was carried out from March 2013 to April 2014. During 2014, Croatia completed the FH and FR maps, which were published in December 2014 and reported to the EU in January 2015. The FH maps are based mostly on models and studies developed by Croatian Waters in the past. Improvements to the FH and FR maps, including collection of more precise data and development of more precise hydraulic models, will be implemented during the first Floods Directive cycle as one of the non-structural flood risk management measures. Croatia's FRMP will be an integral part of its River Basin Management Plan (RBMP), which will ensure consistency and exploit links between the Floods Directive and Directive 2000-60-EC (Water Framework Directive). Croatian Waters, the national water management agency, is responsible for preparation of both RBMP and FRMP. Croatia's Draft RBMP with FRMP was completed and published for public review in April 2015. Formal public consultations and the process of Strategic EIA are ongoing. The RBMP/FRMP is expected to be approved in December 2015.

According to Croatia's PFRA, 53% of the territory of Croatia was designated as Areas under Potentially Significant Flood Risk (APSFR). These areas include areas protected by the existing flood protection infrastructure, which are under residual flood risks due to possible failure of the flood protection infrastructure. The catastrophic flooding of the Sava River in May 2014 inundated large areas of Eastern Slavonia due to dike breaches, causing two casualties and large economic damage. This unfortunate event supports the decision that had been made prior to this event to designate all such areas as APSFR's. This decision also requires consideration of measures to manage the residual flood risks in these areas in the FRMP, and such measures could be supported from EU structural funds if they are considered in the FRMP. Considering the failure mechanism of the dike breaches in May 2014, a project that would implement a structural measure of modernization of the left Sava River dike from the exit of the retention system „Central Posavlje" to the border with the Republic of Serbia (240 km) is under preparation for the EU funding.

As required by the Floods Directive, Croatia's draft FRMP includes both non-structural and structural measures to manage flood risks, with the key objective of reducing the flood risks corresponding to goals of Croatia's Water Management Strategy that had been enacted by the Croatian Parliament in 2009. These measures are classified as follows: (1) administrative measures of improving the flood risk management (including spatial planning measures); (2) implementation measures for the reduction of flood risks: (a) administrative, (b) investigations, (c) monitoring, (d) operation and maintenance, (e) investments; and (3) administrative measures for reduction of flood risks through public participation. All of these measures except (2e) can be classified as non-structural. There is no formal catalogue of measures. The programme of structural measures under (2)(e) is based on Multiannual Programme of Construction of Water Regulation and Protection Facilities and Amelioration Facilities 2013-2017 (MAP), which was adopted by the Government of the Republic of Croatia in October 2015. Implementation of the measures from the FRMP will require utilization of all available sources of funding, including national funding originating from water fees, EU funding through Operative Programme Competitiveness and Cohesion 2014-2020 and other programmes, and international loans. Croatia is currently preparing a number of projects that will implement the key non-structural and structural measures from the FRMP with the assistance of EU funds and the Council of Europe Development Bank (CEB) loans.

Planned projects/activities that will improve implementation the non-structural measures include the following:

- Improvement of the flood forecasting and early warning and alert systems, including improvement of the system for hydrologic data collection and analysis.
- Improvement of the system for mathematical modelling simulation of flood hazards, including development of necessary data and preparation of more precise flood hazard maps,
- Improvement of the system for flood risk management planning, including collection of detailed data on risk receptors and preparation of more precise flood risk maps and development of plans and programmes of implementation of flood risk management measures based on economically-prioritised measures,
- Improvement of the system for monitoring of flood protection infrastructure, including investigations of safety and stability and implementation of a technical monitoring system,
- Improvement of the system for real time monitoring and analysis of flood events,
- Improvement of the Main and Regional Flood Defense Centres,
- Improvement to the system of integrated water management and flood risk management.

Implementation of some important activities is already underway. For example, an operative flood forecasting system for the Sava and Kupa Rivers from the border with the Republic of Slovenia to their junction at Sisak was completed in September 2015 through a joint project of Croatian Waters and State Hydrometeorological Service.

As far as the structural flood risk management measures are concerned, implementation of NWRM (e.g. river and floodplain renaturation/ restoration) will be prioritized where their application is technically and economically feasible. Structural measures for protective flood risk management, such as construction and reconstruction of the water regulation and protection facilities, will be implemented where flood risks cannot be sufficiently reduced by non-structural measures and/or by NWRM. Preparation of projects is based on new feasibility studies in which the optimal flood risk management measures are identified and justified consistently with the river basin approach and the best international practice, emphasizing application of the NWRM where their application is technically and economically feasible.

In conclusion, Croatia is implementing the Floods Directive as required and is intensifying implementation of both non-structural and structural flood risk management measures through support of EU funds and international loans. It is expected that these activities will greatly assist in managing and reducing the flood risks in Croatia, which are currently at unacceptable levels.

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Case study: Sava River Basin

By

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Keywords: FASRB, Protocol on FP, Sava PFRA, Sava FRMP, Sava GIS

Cooperation in the flood risk management

Sava River Basin countries have had a long history of different activities in managing water resources, developing and building hydraulic structures, protecting from floods and the Sava River from land base sources of pollution. Legal framework for continuation of such activities after dissolution of Yugoslavia was set by the FASRB. The overall objective of the agreement is to support transboundary cooperation for sustainable development of the region. One of the particular goals is regulating the issues of sustainable flood protection in the Sava River Basin, by undertaking the measures with the aim to prevent or limit hazard, to reduce flood risk and to reduce or mitigate adverse consequences of floods.

Floods in the Sava River Basin usually occur in autumn and spring. Autumn floods, usually caused by heavy rainfall, are of shorter duration and can have very high extreme flows. Spring floods are the result of snow melt, they last longer and usually do not have large maximum discharges.

Among others, one of the reasons why the cooperation in flood management within the entire Sava River Basin is necessary are the increasingly common cases of severe flooding, which during the same flood events affecting the territory of a large part or the entire basin. As can be seen from a table 1 only in the last 15 years were occurred 11 major floods that have affected large part of the basin at the same time, with a transboundary impact and damages.

Year of flood	Affected area/river
Oct/Nov 1896	Drina River
Apr 1932	Sava River
Oct 1933	Sava River
Nov 1944	Sava River
Oct 1964	Sava River
Dec 1966	Sava and Kupa rivers
Dec 1968	Bosna River
Jan 1970	Sava and Bosut rivers
Oct 1974	Sava, Krapina, Kupa and Una
Jul 1989	Krapina River
Oct/Nov 1990	Upper Sava River Basin
Oct/Nov 1998	Upper Sava River Basin
Nov 1998	Kupa River
Jul 1999	Tamnava, Ub and Gračica rivers
Jun 2001	Kolubara, Jadar and Ljubovića r.
Mar 2006	Tamnava, Ub and Gračica rivers
Apr 2006	Sava River
Sep 2007	Upper Sava River Basin
Mar 2009	Tamnava, Ub and Gračica rivers
Dec 2009	Upper Sava River Basin
May/Jun 2010	Middle Sava River Basin
Sep 2010	Middle Sava River Basin
Dec 2010	Drina, Kupa and Una rivers
Feb 2014	Kupa River
May 2014	Middle/lower Sava River Basin

TABLE 1. Significant past floods in the Sava River Basin

Therefore, in order to contribute to the decrease of harmful consequences of floods, in particular for human life and health, environment, cultural heritage, economic activities and infrastructure, the Parties to the FASRB (Slovenia, Croatia, Bosnia and Herzegovina and Serbia) have agreed to cooperate in the implementation of these activities within the Protocol on Flood Protection to the FASRB. The Protocol on FP was signed in 2010 and entered into force on November 27, 2015.

The main cooperating activities agreed and regulated by the Protocol on FP related to the flood risk management planning are:

- Preparation of the Program for development of the Flood Risk Management Plan in the Sava River Basin (Program);
- Undertaking of Preliminary Flood Risk Assessment (Sava PFRA);
- Preparation of Flood Maps;
- Development of Flood Risk Management Plan in the Sava River Basin (Sava FRMP), starting with preparation of the Program for its development.

The Program presents guidelines for activities and actions required for the development of the Sava FRMP in line with the Protocol on FP and the EFD, taking into account the activities already finished or ongoing in the Parties and on the basin-wide level.

and for informing other Parties on the identified national APSFR. It also gives ISRBC the mandate to coordinate the activities on harmonisation of the APSFR shared by two or more Parties, identified by the Parties as the areas of mutual interest for flood protection. The Parties has been agreed to compile a joint report on the Sava PFRA, even prior to formal entry into force of the Protocol on FP, based on collected information from the Parties on the results of national PFRA and designation of the APSFR; report on the PFRA in the Danube River Basin and the report on floods that occurred in 2010 prepared by the ICPDR; information on past floods provided in the first SRB Analysis report; and other available information, e.g. general information on the basin and on flood management. Additionally, floods of May 2014 that affected Bosnia and Herzegovina, Croatia and Serbia, were described. Joint report on the Sava PFRA has been prepared in July 2014, which is considered to be the fulfilment of the obligation to ensure that exchange of information takes place between the competent authorities of states in international river basin districts, as stipulated by the EFD and the provisions of the Protocol on FP.

The Sava PFRA summarizes information on methodologies and criteria used by the Parties to identify and assess significant past floods and consequences of potential future flood and

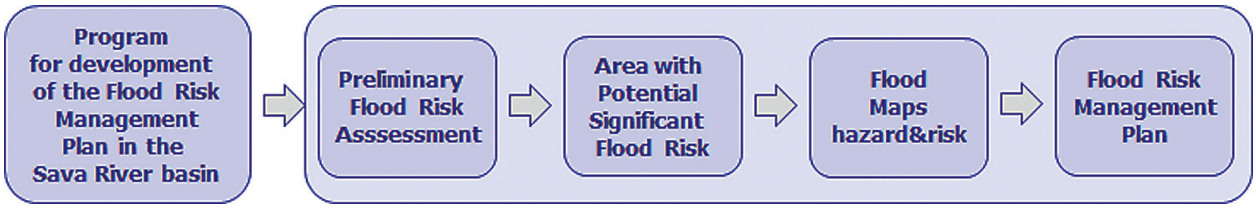

FIGURE 1. Steps of the Sava FRMP preparation

The Program has been prepared at the expert level and according to the Protocol on FP, it is foreseen that would be adopted by ISRBC within 6 months of the entry of Protocol on FP into force.

Preliminary Flood Risk Assessment

The Protocol on FP recognises ISRBC as a body for the exchange of data relevant for the national PFRA

designation of APSFR. It provides an overview of designated APSFR and forms a basis for harmonisation of the APSFR shared by two or more Parties, identified by the Parties as the areas of mutual interest for flood protection. The Sava PFRA also addresses the impacts of climate change and provides an overview of transboundary coordination and information exchange.

The document, upon its adoption by ISRBC, has also been published with the aim of efficiently informing the public and it is available at: http://www.savacommission.org/publication.

The countries had different approaches in methodology of analysing and mapping the APSFRs, so in the end was identified 1825 APSFR in the Sava River Basin: Slovenia 42, Croatia 1688, Bosnia and Herzegovina (Federation of B&H) 68 and Serbia 27. The process of information exchange and harmonisation of the APSFR in the Sava River Basin shall be completed once the information from part of Bosnia and Herzegovina – the Republic of Srpska, as well as from Montenegro is available.

Further steps

The next step of the Program implementation is the Flood Maps preparation and the Sava FRMP development. These activities will be implemented through the ongoing project "Improvement of Joint Actions in Flood Management in the Sava River Basin". The project was approved in June 2014 by the Western Balkans Investment Framework (WBIF), with the support of the World Bank and national IPA coordinators of Serbia, Bosnia and Herzegovina and Montenegro. The WBIF, under the same window of financing also supports the development of Flood Forecasting and Warning System for the Sava River Basin.

The Sava FRMP shall include all the necessary steps according to the Protocol on FP and the EFD with reporting and the public consultations. Given the specific situation of the Parties in terms of EU integration (with two member states, and two countries that are not member states), and the resulting differences in EU commitments, the Sava FRMP will not be prepared in accordance with the EFD deadline (national plans of EU member states shall be completed by the deadline – December 2015, and Serbia and Bosnia and Herzegovina have a tentative plan to finish their Plans by 2017).

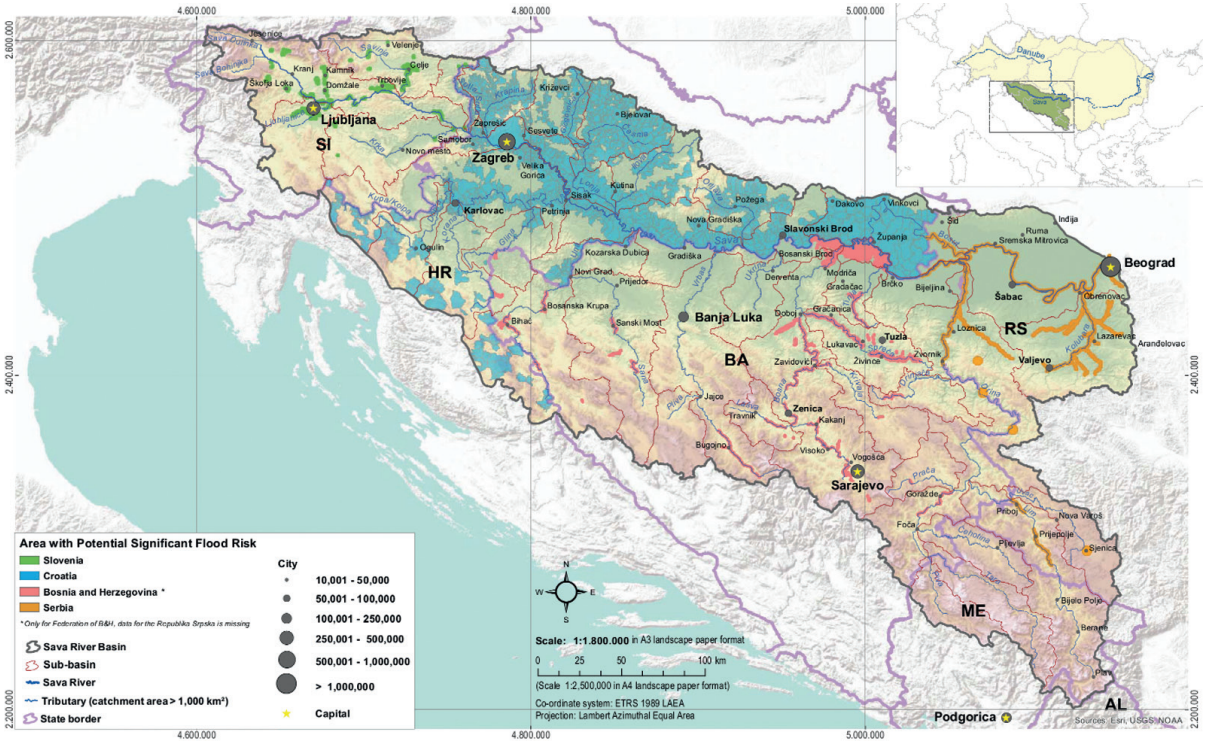

FIGURE 2. Areas with potential significant flood risk in the Sava River Basin

The Parties have been agreed that the Flood Maps at the Sava River Basin level should comprise all maps prepared by the Parties, for all identified APSFR, for the following scenarios:

- (i) floods with a medium probability (return period of 100 years), and
- (ii) floods with a low probability, or extreme event scenarios (regardless of the return period considered by the Party).

Country	Medium probability	Low probability
SI	HQ100	HQ500
HR	HQ100	HQ1000 – for unprotected areas
		Infrastructure failure scenario – for protected areas
BA	HQ100	HQ500
RS	HQ100	HQ1000
ME	HQ100	HQ500

TABLE 2. The national definitions of floods with medium and low probability

The flood risk maps should be prepared on the basis of a minimum set of information, showing the potential adverse consequences associated with the two mentioned flood scenarios and expressed in terms of the indicative number of inhabitants potentially affected, type of economic activity of the area potentially affected, location of IPPC installations which might cause accidental pollution in case of flooding, protected areas and other relevant information.

In order to ensure efficient and effective communication channels for ISRBC community to share and disseminate data and information related to the flood risk management (among all other areas of interest), ISRBC and basin countries established the SavaGIS Geoportal. The SavaGIS Geoportal is associated with its database and the web application for editing, loading and retrieving data and metadata. Currently, it consists of the two modules: RBM and FRM modules.

The FRM database model is designed and structured in accordance with the EFD, the EFD Reporting Guidance 2013, the INSPIRE Directive and professional requirements. It contains spatial and alphanumerical datasets for: Flood Reporting Units, PFRA, APSFR, Flood Hazard and Risk Maps, Historical Floods and Flood Protection Structures. Information on the ASPFRs identified in the Sava River Basin is already available at the Sava GIS Geoportal: http://savagis.org/map.

Generally, the FRM database model will ensure sharing and disseminating data and information relevant for development of the Sava FRMP. However, the database module for the Plan should be designed during the preparation of the Sava FRMP.

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Case study: Danube River Basin

By

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Keywords: flood risk management, Danube, ICPDR

The EFD entered into force in 2007. It requires all EU Member States to: assess their water courses and coastal areas at risk of flooding; map flood extent and assets and humans at risk; and take measures to reduce flooding. In 2010, the ICPDR agreed to implement the EFD and develop one international Danube Flood Risk Management Plan (DFRM) – coordinated by ICPDR and synergized with the WFD and Danube River Basin Management Plan of 2015.

DFRMP ensures coordination of the implementation of the EFD in the Danube River Basin District (DRBD) and provides for tailored solutions towards flood protection, prevention and mitigation according to the needs and priorities of the Danube countries.

Flood hazard and flood risk maps

DFRMP reviews the conclusions of the preliminary flood risk assessment and shows the map of the areas of potential significant flood risk as well as the flood hazard and flood risk maps of the Danube River Basin District. To ensure a coherent approach with river basin management planning the flood hazard and flood risk maps were prepared for the catchments with the area larger than 4000 km2. These maps show the potential adverse consequences associated with different flood scenarios and serve as an effective tool for information, as well as a valuable basis for priority setting and further technical, financial and political decisions regarding flood risk management. On the basis of these maps the ICPDR Contracting Parties were required to establish a flood risk management plan coordinated at the level of the international river basin district. The ICPDR agreed that two scenarios (flood hazard areas with medium and low probabilities) are relevant for the flood hazard map at the level of the international river basin district. The medium probability floods are almost unanimously based on 100 year recurrence period while the recurrence period of floods with low probability varies mostly from 300 to 1000 years.

The map on Risk and population shows the population affected by floods with low, medium and high probability in the parts of the countries belonging to the Danube River Basin District. The maps on Risk and economic activity display the share of inundated area by class of economic activity (according to Corine Land Cover) for low, medium and high probability floods. The map on Risk and installations with the potential to cause pollution shows the number of IPPC and Seveso installations affected by floods with low, medium and high probability in the parts of the countries belonging to the Danube River Basin District. Two maps on Risk and the WFD protected areas have been prepared. One map is showing Natura 2000 protected areas superposed by the flood hazard areas (for low probability floods scenario). Only the overlapping flood hazard areas are displayed. The second map displays the total numbers of affected areas designated for the abstraction of water intended for human consumption under the WFD Article 7, and of the affected bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC by floods with low, medium and high probability in the parts of the countries belonging to the DRBD.

Objectives

The ICPDR agreed upon the following objectives of the DFRMP:

- Avoidance of new risks
- Reduction of existing risks
- Strengthening resilience
- Raising awareness
- Solidarity principle

These objectives focus on the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity and address all aspects of flood risk management focusing on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the DRBD.

Measures

Flood risk management plan includes measures for achieving the objectives established for the management of flood risks for the areas identified under article 5(1) of the EFD and the areas covered by article 13(1)(b) of the EFD, focusing on the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity, and, if considered appropriate, on non-structural initiatives and/or on the reduction of the likelihood of flooding.

The measures described in DFRMP address all phases of the flood risk management cycle and focus particularly on prevention (i.e. preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas or by adapting future developments to the risk of flooding), protection (by taking measures to reduce the likelihood of floods and/or the impact of floods in a specific location such as restoring flood plains and wetlands) and preparedness (e.g. providing instructions to the public on what to do in the event of flooding).

The ICPDR agreed that only the strategic level measures reflecting the activities on the level of an international river basin district shall be presented in the DFRMP. This category includes measures with transboundary effect and measures applicable in more countries of the basin such as awareness rising, warning systems or ice protection measures. To better demonstrate the key actions of a basin-wide importance the measures presented in the DFRMP are combined with the examples of best practices.
Following the public consultation process which was launched in December 2014 and finished in July 2015, DFRMP has been finalised and adopted in December 2015.

2.4.3 Flood forecasting and warning

Case study: Slovenia

By

Sašo Petan
Slovenian Environment Agency

Keywords: meteorological forecasting, flood forecasting, hydrological warning, hydrological model, flood awareness, ARSO, Slovenia

Slovenian Environment Agency (ARSO) is a body of the Ministry of the Environment and Spatial Planning. The national meteorological and hydrological services operating at ARSO are continuously monitoring, analysing and forecasting the weather and hydrological conditions of the rivers and the sea in Slovenia. Both services are involved in the national early warning system for mitigation of natural threats to people and property with the principle task of issuing warnings on extreme and dangerous weather, weather related and hydrological phenomena. In the emergency situations, both services are following the established common operation protocols and communication strategies.

In the years between 2010 and 2015 the Slovenian Environment Agency have conducted a large scale EU funded project BOBER (Better Observations for Better Environmental Response). Within the project the meteorological and hydrological observational networks have been significantly upgraded. Almost all measuring stations have been equipped with high quality sensors and automatic data transfer to the central database has been established. Some new measuring sites as well as new meteorological parameter observations have been initialised. Additionally, hydrological forecasting system (HFS) covering the Slovenian river catchments with hydrological and hydro-dynamic models (Figure 1) has been developed by an international group of hydrological experts highly supported by the Slovenian meteorological service.

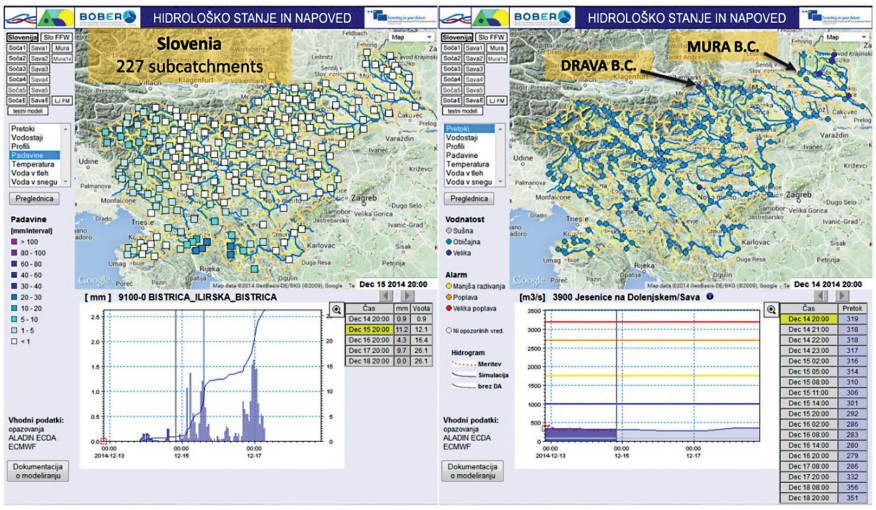

FIGURE 1. Slovenian hydrological forecasting system results: observed and predicted precipitation in the model sub catchments (left) and observed, simulated and warning discharges on the hydrological stations (right)

The HFS operates automatically and it provides discharge and water level forecasts for within the Slovenian river network up to 144 hours in advance. The simulation results are updated every hour after the latest observed meteorological and hydrological data as well as meteorological forecasts are available. While performing hydrological simulations, the HFS is considering the results from several numerical weather prediction models with various spatial and temporal resolutions (ALADIN/SI, ALADIN_ ECDA, ALADIN_ARDA, ECMWF, NMM, INCA-CE and LAEF). The HFS results are also made available to the expert community in Slovenia and in the neighbouring countries as well.

All hydrological and meteorological observations and simulations together with the warning criteria for intensive rainfall and flood hazard are considered in the processes of flood forecasting and warning. A critical evaluation of all information is performed by the meteorological and hydrological experts: it is assessed whether the upcoming event is less or more likely or unusual, spatially limited or may affect wider area and what could be the possible event impact. Finally, a decision is made for issuing a warning of a certain predefined degree – yellow, orange or red. The warning is prepared in several formats (Figure 2) and disseminated to the authorities and the end users through various means: fax, e-mail, ftp and web. Moreover, in case of significant changes of the forecasted flood scenario the warning is directly reported to the rescue units on the field. According to the bilateral agreements the warnings are also exchanged with the hydrological services and flood management authorities from the neighbouring countries (Austria, Italy, Croatia and Hungary).

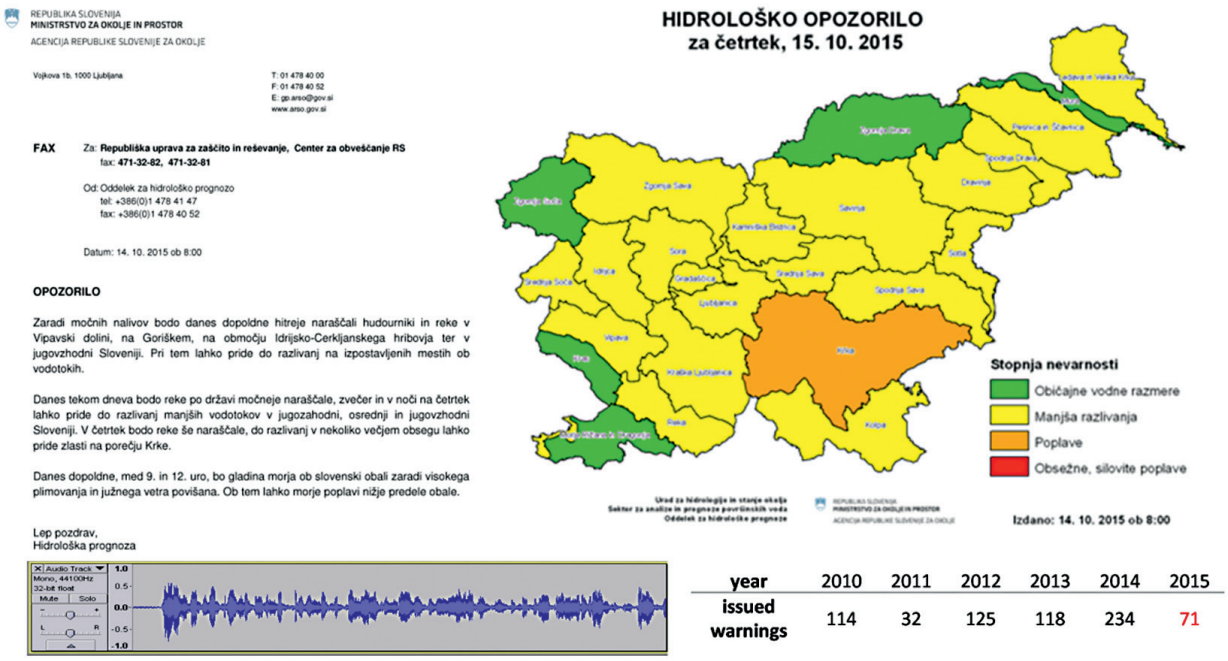

FIGURE 2. Example of hydrological warning prepared for dissemination in text (upper left), graphical (upper right) and multimedia (lower left) format. The number of issued hydrological warnings in the recent years is summed up in the lower right corner

The floods in Slovenia that occurred between 2007 and 2014 had caused tangible damage estimated to 1.5 billion euro and loss of 15 human lives. Therefore, the Slovenian Environment Agency is continuously supporting all the efforts and initiatives for increasing the general flood awareness as well as for recognition and better understanding of the meteorological and hydrological products and warnings by the general public and the media. Moreover, enhancing the processes of preparation and issuing timely and detailed flood forecasts and flood warnings, communication of the flood event uncertainty with the end users, the media and the general public are some of the key future tasks by the national hydrological service.

During the workshop group discussions several participants have indirectly pointed out the importance of regular evaluation of the national early warning systems after the flood events.

Many countries in the region including Slovenia share common issues in the warning processes that could be improved or updated according to the actual trends in the world. In my opinion, the International Sava River Basin Commission could actively help the national authorities and hence contribute in bringing the national early warning systems to a higher operational level.

Case study: Croatia

By

Dijana Oskoruš
Meteorological and Hydrological Service of the Republic of Croatia

Keywords: flood forecasting, cooperation, data exchange policy

Extreme floods are within group of the worst natural disasters. Although there were floods in Sava and Kupa basins, floods in 2014 were the most difficult in the region and in the Republic of Croatia as well. Statistical analysis of this year's high water levels at some hydrological station showed that such events have never been recorded so far.

Since nowadays the order of magnitude of the highest discharge values for the lower Sava region was 3500 to 4000 m^3/s, Table 1. The discharge measurement performed On May 17, 2014 at the location of Slavonski Šamac getting the value of **Q=6007** m^3/s. The value exceeded the above mentioned discharge values by 50 %, meaning HQ1000.

Technical construction practices are no longer sufficient to prevent flooding nor do not guarantee an absolute safety, and should not remain the only option in the struggle against harmful water action. The catastrophic flood of May 2014 indicated the extreme importance of regional and institutional cooperation as well as providing timely information to local governments. After serious floods analysis, the extremes measured during the year 2014 are used for hydrological model MIKE 11 verification, on whose operational implementation experts from Croatian Meteorological and Hydrological Service *(DHMZ)* and Croatian Waters *(HV)* where working together with consultants from DHI - Denmark.

Recently new flooding on Kupa River, occurred in October 2015 (Figure 1), was a test for new flood forecasting system, showing good results, but some weak points that should be improved in the future.

Hydrological station	Stage 2014	Stage max	Discharge 2014 (m3/s)	Discharge max (m3/s)
Slavonski Brod	**939 cm** (18.5.2014.)	882 cm (30.10.1974).		3476
Slavonski Šamac	**891 cm** (17.5.2014.)	762 cm (21.3.1981.)	6007 (17.5.2014.)	
Županja	**1168 cm** (17.5.2014.)	1046 cm (19.1.1970.)		4161
Gunja	**1173 cm** (17.5.2014.)	938 cm (9. 4. 2013.)	4625 (16.5.2014.)	

TABLE 1. Historical stage and discharge data on Sava River in comparison with year 2014

After finishing phase 1 - Pilot project flood forecasting for Kupa and Sava Rivers down to G.S. Crnac, on 43 forecasting stations (Figure 2), next phase is in preparation. Phase 2 will include 74 forecasting locations on the part of the Sava basin up to Croatian state border with the Republic of Serbia, Figure 3.

The conclusions to be discussed in the future between countries that share Sava River basin are:

One of the most important issue is the international exchange of quality controlled data and information. This is an essential element for undertaking of basin–wide activities ranging from flood forecast and warning to the various aspects of water resources management.

This issue has to be addressed from several points of view:

- Establishment of arrangements on the data and information exchange policy,
- Improvement and optimization of the current data exchange mechanisms,
- Consistency of the measurements carried out at hydrological stations situated at the state borders.

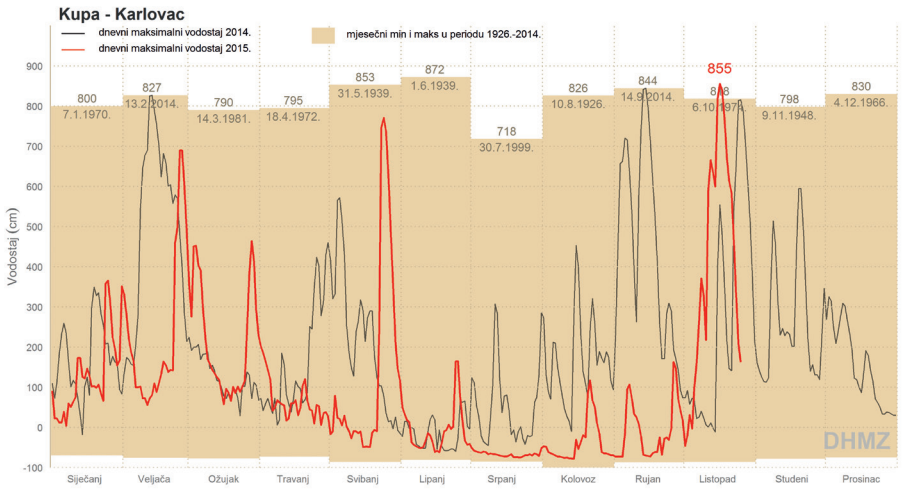

FIGURE 1. Kupa – Karlovac, maximum water levels from 2014, 2015 in comparison with period 1926-2014

FIGURE 2. Phase 1-FF for Kupa and Sava to Crnac

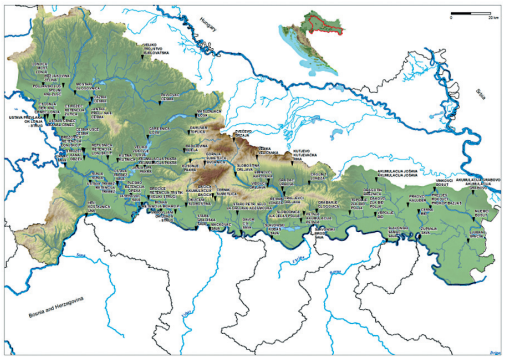

FIGURE 3. Phase 2-FF Sava to the border with the Republic of Serbia

Case study: Sava River Basin

By

Anna Cestari
World Bank

and

Mirza Sarač
International Sava River Basin Commission

Cooperation in the Sava River Basin related to common flood and drought forecasting and warning

Since 2003, the national Hydrometeorological Services of the Sava countries have cooperated on the development of a coordinated flood and drought forecasting and warning system in the Sava River Basin. ISRBC, since its Secretariat was set in function in 2006, has been a strong supporter of this joint initiative and has been actively involved in the preparation and implementation of the joint activities. A 2007 study, financed by the World Bank, proposed a program of activities for establishing a joint Flood Forecasting and Warning System (FFWS). As the estimated costs for such system were deemed too high, in excess of USD 16 million, ISRBC concluded that obtaining the funds at once were very difficult and decided to take a staged approach. In 2014, the Western Balkans Investment Framework (WBIF) has made available funds, implementation of which is to be supported by the WB to implement the first phase of the envisaged program, namely, the development of *Flood Forecasting and Warning System for the Sava River Basin (Sava FFWS).* In coordination with representatives of the Parties to the FASRB and Montenegro. Due to the WBIF rules the direct beneficiaries of the project are Bosnia and Herzegovina, Serbia and Montenegro, and it is expected that Croatia and Slovenia as EU members, through the work of ISRBC, to fully contribute to the successful implementation of the project. The WBIF, under the same window of financing also supports the preparation of Flood Risk Management Plans.

The Sava countries agreed to develop a common flood forecasting platform to serve the Sava River basin-wide forecasting system. At the same time, the countries should maintain their own autonomy in monitoring, modelling and forecasting and remain free to develop their own models and supplementary flood forecasting initiatives. The initiative is assessed as added value to their own existing or developing systems. All countries confirmed their support to the basin-wide exchange of hydro-meteorological data, expecting that flood forecasting and early warning system with well trained staff should provide better preparedness and optimized mitigation measures to significantly help reduce consequences of floods.

In order to improve the involvement of all beneficiaries, ISRBC and the WB have held thorough consultation with all stakeholders including from Croatia and Slovenia, on the preparation of the Terms of Reference for the Sava FFWS. Currently, the selection of the consultant is underway under WB's rules and procedures. It is expected that the contractor will be selected in the beginning of 2016 and the planned period of implementation of this component is 27 months.

Requirements for the Sava FFWS

The Sava FFWS must operate over very large area, including multiple forecasting centres with a duplication of the client-server system to ensure system resilience on data processing and communication. Examples of large system can be found in the US and in the UK., or in large river international basins served by one common flood forecasting system, partly serving various countries include the Rhine (185,000 km2), Po (74,000 km2) and the Mekong (795,000 km2).

It is expected that the successful implementation of this project results in:

1. Operational and coordinated flood forecasting and early warning system for the whole Sava River Basin:
    - Identification, assessment and acquisition of relevant data and information with inventory of needs for the installation of the forecasting system in each of the Sava countries
    - Development of a distributed hydrological model covering the complete Sava River Basin
    - Development of the one common platform to harmonize data and methods
    - Provide predictive uncertainty and data assimilation techniques to the forecasting system
    - Test and operationalize the use of predictions
2. Well trained staff in each of the Sava countries to provide information during the flood emergency situations;
3. Recommendations on the future improvement of the system in terms of monitoring, telemetry, model development and improved implementation with prioritization of activities and estimates of the required funding.

Slovenia, the upstream-most country, has already begun the process of establishing a system for its territory, which does not depend on data from other basin countries. The Slovenian system is currently in a mature implementation phase. Croatia too has decided to develop a system similar to the Slovenian one, but it bears a much higher need for cooperation in the basin given the necessity of obtaining information on meteorological and hydrological conditions throughout the basin, in particular from the Bosnian-Herzegovinian part of the basin due to its decisive impact on the Sava River. In the first phase, Croatia has developed a flood forecasting system for the Sava and Kupa Rivers. The system covers an area of over 40% Croatian territory on the Sava River basin.

Given the activities already implemented by the individual states the system to be established will be coordinated rather than fully joint. The Sava FFWS to be supported by WBIF project is designed to have sufficient flexibility to use data and results of various models existing in the basin (and planned within the implementation of this project), on the basis of a common platform – all with the aim of providing forecasts on the occurrence of flood on the basin level. This is particularly important for the Sava River Basin, shared by several countries with diverse financial and technical resources, which strive towards the development of a coordinated system.

Further steps

During the implementation of the project, efforts must be made to ensure the Sava FFWS receives strong support by the Governments of the Sava Countries. Using its coordination role, ISRBC will help determine the contact persons in all the country-level institutions in charge of these issues (primarily hydrological and meteorological services, and water agencies) as well as teams of experts that would cooperate per special areas of expertise (meteorologists, hydrologists, etc.) to strengthen national capacities.

This project however will only deliver some of the elements of the Sava FFWS, and to ensure a fully operational system is put in place, additional financial resources are required, especially for the purchase of monitoring equipment (an assessment of about USD 16 million was done in 2007 and now requires updating). With consent of the national institutions, there is a need to attempt to find a new source of financing for the strengthening of the systems in Sava basin countries.

Finally, in order to avoid duplication of efforts and to establish an efficient system, any other initiatives in the basin should be harmonized with the initiatives that Sava countries have agreed on and are implementing via ISRBC.

3.
SESSION II - EMERGENCY RESPONSE AND RECOVERY

3.1 Agenda items overview

Flood defense measures
- Measures for fluvial floods, flash floods and urban flooding erosion and sediment control
- Case study:
  - Active flood defense in Croatia: Regulatory framework, roles & responsibilities
  - Flood defense measures in B&H during the May 2014 flood

Recovery and long-term resilience
- Case study: Action plan and needs assessment in B&H

Mutual assistance and mitigation
- Case study: Lessons learned in Serbia from the May 2014 flood

Group discussions
GROUP 1: Recovery and long-term resilience planning
GROUP 2: Forms of assistance and modalities for transboundary cooperation in flood defense emergency situations
GROUP 3: Inter-sectoral coordination and cooperation in the flood defense emergency situations

3.2 Overview of presentations

Flood defense measures
Measures for fluvial floods, flash floods and urban flooding erosion and sediment control
– F. Al-Janabi
http://www.savacommission.org/WFRM/14

Flood defense measures
Case study: Active flood defense in Croatia - Regulatory framework, roles & responsibilities
– Z. Đuroković
http://www.savacommission.org/WFRM/15

Flood defense measures
Case study: Flood defense measures in B&H during the May 2014 flood – N. Đukić & A. Prljača
http://www.savacommission.org/WFRM/16.1
http://www.savacommission.org/WFRM/16.2

Recovery and long-term resilience
Case study: Action plan and needs assessment in B&H – E. Šeperović
http://www.savacommission.org/WFRM/17

Mutual assistance and mitigation
Case study: Lessons learned in Serbia from the May 2014 flood – D. Janjić
http://www.savacommission.org/WFRM/18

3.3 Summary of group discussions

GROUP 1
Recovery and long-term resilience planning
Philippe Pypaert, moderator
Žana Topalović, rapporteur

Questions:
- What FRM measures should be developed for recovery and long-term resilience planning?
- What actions are needed to make it work?

Summary of discussion:
One of the first recognized possible measures for long-term resilience and fast flood recovery was the introduction of mandatory insurances against disasters, for example in the form of citizen taxation. Funds collected in this way could be used for the maintenance of the defense system, protection (new developments) and flood management. Example of countries which implement such kind of insurance are Romania (20€/year for insurance against fires, earthquakes and floods), Croatia and Serbia where insurance is valid only for inland water protection. Another type of insurance would consist in the financial compensation that would be paid by the Government to owners of agriculture or urban areas that could be used as flood plains to mitigate the risk.

Another idea for fast recovery and long-term resilience would be the respect of new building codes for all urbanization areas in various levels of flood prone areas. This could help better addressing climate change adaptation and flood risk in these areas through the raising of ground floors, or adequate (i.e. green) infrastructures, etc. This should lead to integrating risks planning in urban/basin wide areas with more retentions, wetlands, forests, diversion channel (natural and artificial), dikes, pumping station, etc. Protocols for transboundary cooperation on flood protection, recovery and resilience are of crucial for all interested parties in the basin.

Long-term resilience to floods can be strengthened through a proper (inclusive, comprehensive and transparent) pre-planning for flood events preparedness, also considering the possibility to increase the retention potential of the natural environment at the basin level.

It was also stressed that hydrological standards for design should be renewed (i.e. design taking into consideration specific return periods of floods), and a "multipurpose approach" adopted in the construction of infrastructures (i.e. accumulations, detention basins, etc.) as well as in strategic planning. More generally, populations should be prepared to better "live with floods.

At a more operational level, the group recommended the following measure:
- Relevant authorities/institutions should consider extreme scenarios to avoid the collapse of flood protection structures in the case of emergencies (preparedness).
- Prevention should also include soil erosion control and a better maintenance of flood protection structures.
- An inventory of emergency equipment (such as movable defenses, pumps, etc.) should be prepared at the basin-wide level.
- Training exercises should also be ran for a better preparedness to all future floods.

GROUP 2
Forms of assistance and modalities for transboundary cooperation in flood defense emergency situations
Adriaan Slob, moderator
Esena Kupusović, rapporteur

Questions:
What forms of assistance and modalities for transboundary cooperation in flood emergency situations are needed in the FRM planning?
What actions are needed to make it work?

Summary of discussion:
Enhancement of data exchange. Short-time interval data and real time data are needed for water levels, discharge, reservoirs outflow, etc.
Cooperation between countries on sharing human resources and equipment.

Countries should established emergency centres which will communicate with other centres during emergency situations.

GROUP 3
Inter-sectoral coordination and cooperation in flood emergency situations
Dejan Komatina, moderator
Jovanka Ignjatović, rapporteur

Questions:
- What inter-sectoral coordination and cooperation (between flood emergency and public safety) in flood emergency situations is needed for the FRM planning?
- What actions are needed to make it work?

Summary of discussion:
NATIONAL LEVEL
- Need for inter-institutional coordination and clear definition of:
  - Responsibilities, i.e. who is in charge for risk assessment, who is in charge for modelling and forecasting and who is taking operational actions and measures
  - Information flow, concerning collecting of information as well as dissemination of processed data and information; there is a need for one main source of information, receiving all relevant information from abroad and from relevant institutions; dissemination of information (e.g. weather or hydrological forecast) should be done by/via authorized institutions and services
- In the process, water authorities and civil protection unites are the key actors, but other sectors, particularly hydropower sector should be involved and considered
- To focus more on coordination then subordination approach
- Besides the WFD and the EFD, to consider also other related pieces of EU legislation (Bird Directive, Natura 2000, etc.)

INTERNATIONAL LEVEL
- Concerning various international financial programs and donors that are active in the region and supporting actions at transboundary and national level, there is a need to ease pressure caused by a short implementation time in comparison with (often) too long projects' planning and preparation process.
- When implementing regional / transboundary project there is a need to have regular, institutionalized experts' meeting that will help to have a matched picture about identified problems, planned and taken actions and their impacts between countries.

Role and inclusion of hydropower plants in the service of flood protection should be investigated and checked (especially if built as multipurpose).

CAPACITY BUILDING & INSTITUTIONAL STRENGTHENING.
There is significant lack of trained human capacities at water authorities at all level, thus more trainings and capacity building activities are needed. Exchange of experiences, practices and lessons learned are needed at all levels (national, regional and basin). Capacity building across sectors is needed tackling the new EU water and related legislations.

Clear set of rules and procedures should be put in place (i.e. Protocol) that must be implemented. This issue must be tackled on river basin scale, and not be confined to administrative/country borders (e.g. a hydropower plant may be located in one country, while flood impact and damages may occur in a downstream country).

3.4 Abstracts of presentations

3.4.1 Flood defense measures

Case study: Active flood defense in Croatia

By

Zoran Đuroković
Croatian Waters

Keywords: high water waves, National flood defense plan, Master flood defense implementation plan, active flood defense, natural retention basins

In the last 15 years or so, the major part of the Croatian territory has experienced frequent extreme hydrological events which caused droughts in the years 2000, 2003, 2011 and 2012, but also floods in the years 2002, 2004, 2005, 2006, 2009, 2010, 2012, 2013, 2014 and 2015. Experience from the latest floods in Croatia shows that floods occur even where no one expects them, and that water levels higher than the high waters of long return periods for which the existing flood defense systems are dimensioned form.

Exceptionally heavy rainfall lead to the formation of high water waves which frequently reach and even exceed the maximum water levels ever recorded. This, naturally, increases the flood risk in some areas and leads to widespread flood defense activities in almost entire Croatia, with such measures requiring coordinated implementation, including mobilization of great human and material resources.

In cooperation with the National Protection and Rescue Directorate and the Protection and Rescue Headquarters of local and regional self-government units, in addition to Croatian Waters and companies licensed for flood defense works, other participants are also engaged, including members of the Croatian Armed Forces, firefighting and police forces, the Croatian Mountain Rescue Service, the Red Cross, civil protection units, utility companies and other companies in the affected area, as well as a large number of the local population and volunteers from all over Croatia.

Successful preparation and implementation of flood defense measures require well-defined legislation, as well as the adoption of appropriate flood defense plans. In line with the Water Act, flood defense is managed by Croatian Waters, and flood defense activities are regarded as emergency service. Operational flood risk management and immediate implementation of flood defense measures are regulated by the National Flood Defense Plan, the Master Flood Defense Implementation Plan, and the Flood Defense Implementation Plans for the defended areas.

The National Flood Defense Plan is adopted by the Croatian Government, while the Master Flood Defense Implementation Plan and the Flood Defense Implementation Plans for the defended areas are adopted by Croatian Waters. The National Flood Defense Plan regulates operational flood risk management, while all the technical and other details required for regular and emergency flood defense are regulated by the Master Flood Defense Implementation Plan and the Flood Defense Implementation Plans for the defended areas.

Flood defense in Croatia is implemented in territorial units for flood defense: river basin districts, sectors, defended areas, and sections. Croatia is divided into 2 river basin districts, 6 sectors and 34 defended areas.

River basin districts are territorial units for planning and reporting within flood risk management. It is on the level of the river basin districts that flood risks are assessed, flood hazard maps and flood risk maps are prepared and flood risk management plans are adopted. The Water Act defines the Danube River Basin District and the Adriatic River Basin District, with borders of the river basin districts determined by the Croatian Government.

Sectors are the main operational territorial units for implementation of flood defense. Coordination and operational management of flood defense is conducted on the sector level in all defended areas within sector borders. Defended areas are the basic units for implementation of flood defense. Sections are the lowest territorial units within the defended areas where in case of flood hazard states are monitored and flood defense is directly established on water protection structures.

Based on the National Flood Defense Plan, the Main Flood Defense Centre has been established as the central organizational unit of Croatian Waters for the management of regular and emergency flood defense on the national level. The Main Flood Defense Centre is the place of central management and main coordination and the place where a flood defense communications and notification system is established.

Flood defense can take the form of preventive, regular and emergency defense. Preventive flood defense includes regular maintenance works on waters and water protection structures for the purpose of reducing the flood occurrence risk. Regular and emergency flood defense includes measures taken immediately before the flood hazard, during the flood hazard and immediately after cessation of the hazard in order to reduce potential flood damage.

The Master Flood Defense Implementation Plan establishes the relevant water levels and criteria for declaring flood defense measures for each section. There are four stages of flood defense depending on the water level: state of alert; regular flood defense, emergency flood defense and state of emergency.

In case of a large-scale risk, i.e. when the risk is such that the human and material resources of Croatian Waters and the companies assigned with flood defense works are no longer sufficient for flood defense, other companies and the population living in the affected areas must also take part in flood defense. Orders about the obligation of specific companies and the local population to take part in flood defense are issued by the heads of local and regional self-government units. The state of emergency in the flood-affected part of a county is declared by the county prefect, while a disaster and major accident may be declared by the Croatian Government at proposal of the Head of the National Protection and Rescue Directorate.

Through a public procurement procedure, Croatian Waters assigns the immediate implementation of preventive, regular and emergency flood defense to the company that fulfils special requirements for performing flood defense activities in a particular defended area for the period of 4 years. The company performing flood defense activities is required at any moment, at first demand of Croatian Waters, unconditionally and without the right to object, to participate in terms of all available manpower, equipment and material resources during implementation of flood defense measures in a defended area where it is deployed, and if necessary to respond in terms of manpower and equipment in the implementation of flood defense measures in other defended areas as well.

Other participants can also be engaged through the National Protection and Rescue Directorate, as well as through the Protection and Rescue Headquarters of local and regional self-government units, i.e. based on decisions issued by the heads of local and regional self-government units on the obligation to participate imposed on specific companies and population from the affected areas. Operative cooperation between Croatian Waters and the Protection and Rescue Headquarters enables better coordination and use of all forces in the field, thus achieving their better operational efficiency. Apart from local and regional cooperation, the Protection and Rescue Headquarters of the Republic of Croatia holds sessions in order to prepare and coordinate flood defense on the national level.

Consequently, it can be concluded that despite frequent threats from extreme hydrological events and formation of high water waves, the traditional flood defense system in Croatia continues to function satisfactorily. In that context, it is highly important to preserve and increase the capacities of natural retention basins, i.e. extensive floodplains which receive large floodwater volumes, thus significantly reducing the flood risk.

In light of long-term forecasts it is to be expected that the trend of climate change and extreme hydrological events will continue. Therefore adaptation to such phenomena is a must, requiring urgent repairs, reconstruction and construction of individual dike sections, as well as of other water regulation and protection structures.

It is also necessary to continue improving immediate implementation of flood defense through installation of additional equipment, training and use of new technical resources, and through development of information and communication systems for the need of preparing reliable hydrological forecasts and improved monitoring of water waves. At the same time, it is also necessary to continue developing the so far successful coordination of mobilisation of all available forces which are through the protection and rescue headquarters – if needed – mobilised and take part in the implementation of flood defense measures.

It is also necessary to further improve inter-state water management cooperation for flood defense needs through better provision of information and joint development of new hydrological models for the purpose of better forecasting, monitoring and acceptance of high water waves, as well as implementation of flood defense measures and reduction of flood risks from in the endangered areas.

Case study: Flood defense measures in Bosnia and Herzegovina during the May 2014 flood

By

Nenad Đukić
Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska, Bosnia and Herzegovina

and

Almir Prljača
Sava River Watershed Agency, Sarajevo

Keywords: flood defense measures, catastrophic floods, heavy rainfall, flood wave, water-levels, consequences, damage evaluation after floods, recovery measurements after floods, share experiences, common understanding

The goal of this report is to introduce condition and activities that took place during the floods in May 2014 in Bosnia and Herzegovina and to, based on seen causes and consequences, define methodical measures for prevention and protection against adverse effect of high water-levels separately in the two Entities.

REPUBLIC OF SRPSKA

Catastrophic floods caused by precipitation which exceeded events that were recorded until now, in period 14-19 May, 2014. They had an impact on wide area of river Sava basin, in Bosnia and Herzegovina, Croatia and Serbia. The floods overtook whole Bosnia and Herzegovina area that belongs to river Sava basin, which is approximately 75% of Bosnia and Herzegovina territory and caused the loss of 23 human lives, with great material damage. The May floods was an event that has not been recorded in the last 120 years, ever since the meteorological and hydrological events are measured in Bosnia and Herzegovina. The amount of rainfall in period of 13-17 May, 2014 in some places was 2-3 times higher than monthly precipitation average, for May. These high amounts of rainfall resulted in higher water-levels, in other words, in higher watercourse flow. With that being said, the measurements of maximum water flow were conducted on many locations in river Bosna basin, which exceeds 500 years return period.

According to available data RHMZRS, it can be said that throughout the Republic of Srpska, with the exception of Eastern Herzegovina, from 1920 did not occur more rain for seven days of May. Bearing in mind that April was in the category of "wet" to "extremely wet" and that since 1925 is not measured by more precipitation in that month, the ground was saturated, so there was unprecedented floods Consequences of casualty. After several days of rainfall in early May, during the period 3-8 May, there was an increase in the water level of rivers that overcome regular and emergency flood protection level at different hydrological stations. After that, the situation has conditional pacified and water levels have declined to normal limits. In the period 13-17 May, come new precipitation across the country, except in the southern regions, which were very intense, especially in the Sarajevo-Romanija region, where on some stations fell more than 200 l/m2 of rain. On land that was saturated with water due to the rains that have fallen earlier in May, the new rainfall has rapidly transformed into surface runoff that caused flash flooding of small streams in a very short period.

The steep rise of all watercourses in the Republic of Srpska created a flood wave on all the major rivers of Una, Sana, Vrbas, Vrbanja, Bosnia and the Drina River where in less than 24 hours a flood wave raised the water level up until now, unseen borders. The sharp rise in the water level was particularly strong on the Bosna River, on the hydrological station in Doboj, where in less than 24 hours the water level rose by more than 6 meters to the night of 15/16 May and reached its highest ever recorded level of 721 cm, which is 143 cm more than the previous highest recorded water level of 578 cm by cm of 13 May 1965.

A similar situation was also on the Vrbas River, on the hydrological station Delibašino Selo, where from 14-16 May, the water level rose by 7 m and to 16 May reached a record value of 837 cm, which is 150 cm higher than it has so far been highest water level on this hydrologic station, which was recorded in September 1996 and was 687 cm.

In case of efficient measures of protection from high waters, it is evident that great attention should be given to preventative actions such as determining flood risk zones, issuing timely alerts and flood early warning announcements, as well as developing comprehensive approaches of integrated water management applicable in spatial planning, landscaping, land use management and the building of infrastructure facilities. Also, in case of existent fragmented flood protection systems and water management at the level of Federation of Bosnia and Herzegovina, Republic of Srpska and Brčko District, a higher degree of mutual coordination and cooperation should be ensured between all the authoritative institutions in Bosnia and Herzegovina. Additionally, there should be an adequate level of coordination for the activities being implemented at the regional level, most importantly with the neighbouring countries, ICPDR and Sava River Committee.

FEDERATION OF BOSNIA AND HERZEGOVINA
The catastrophic floods that hit the Sava River Basin in Federation of Bosnia and Herzegovina in May 2014 are product of a number of adverse impacts that have influenced each other and caused an unprecedented flood event in the modern history.

During the second half of April, the northern part of Bosnia and Herzegovina as well as Federation of Bosnia and Herzegovina, i.e. the Sava River Basin was affected by relatively abundant rainfall, which lasted until 5 May 2014. After a few days without precipitation, rain began to fall again on 12 May2014, and particularly significant were the 14th, 15th, and 16th of May. Continuous and quite high precipitation led to saturation of soil by moisture, so that most of the precipitation from the period 14th to 16th May turned into outflow i.e. outflow ratio was close to the value of 1. The scope was unusually large (northern half of Bosnia and Herzegovina, eastern Croatia and western half of Serbia).

In addition to such a complex hydrological situation, heavy rainfall started, which is not recorded in last 120 years since the systematic monitoring of rainfall in Bosnia and Herzegovina is carrying out. In between 14 to 16 May 2014, the registered rainfall was 200-250 l / m2, which represents a third of the total annual rainfall.

All this resulted in the enormous increase in water levels in all streams in the water region of Sava River. It is estimated that in the middle and lower parts of rivers Bosna and Spreča, the flows appeared of once in 500 years rank and on the part of Sava flow in Federation of Bosnia and Herzegovina once in 1000 years rank.

The occurred maximum water levels have significantly exceeded previously recorded maximum water levels from the previously analysed period 1961 to 1989 + 2001 to 2013 as can be seen from the following table.

Hydrological station	Watercourse	Date/Hour	Max water level	Max water level in previous period	Year
			H (cm)	H (cm)	
Raspotočje/Zenica	Bosna	15.05.2014. 08:00	527	446	2010
Zavidovići	Bosna	15.05.2014. 06:00	1011	633	1963
Maglaj	Bosna	15.05.2014. 10:00	869	740	2005
Olovo	Krivaja	15.05.2014. 04:00	668	690	1965
Modrac	Spreča	16.05.2014. 09:00	661	404	1987
Kaloševići	Usora	16.05.2014. 07:00	393	400	2006
Slavonski Brod	Sava	18.05.2014. 01:00	939	882	1974
Svilaj	Sava	17.05.2014. 21:00	757	625	2010
Slavonski Šamac	Sava	17.05.2014. 13:00	891	762	1981
Grebnice	Sava	17.05.2014. 16:00	1163	944	2010
Županja	Sava	17.05.2014. 12:00	1168	1064	1970

TABLE 1. The occurred maximum water levels which have significantly exceeded previously recorded maximum water levels

The active flood protection measures and activities to be implemented during the immediate risk of high water, during the flood period and elimination of the consequences of floods are defined by the provisions of the Federal Operational Plan for Flood Protection - FOP ("Official Gazette of B&H", No. 7/11). FOP, in addition of active flood protection measures, defined also:

- Organization (bodies) carrying out flood protection,
- Obligations of participants in the implementation of the active flood protection,
- Areas along watercourses and water control structures on which to implement active flood protection measures (areas with built protective water facilities owned by Federation of Bosnia and Herzegovina and areas with surface water of 1st category in which there are no flood control structures)
- Relevant water levels,
- Communication system
- Protection from ice
- Technical contributions of FOP.

After the presentation of the implemented flood protection, as a conclusion, it can be said that by the end of 2014, all the protection facilities were repaired and all damage occurred during the floods in May 2014 have been repaired so the facilities were brought to the level of protection they had before these floods.

The presentation gives an overview of all the implemented measures by the "Sava River Watershed Agency" Sarajevo in areas with protection water facilities (areas along the Sava river) starting from 10 May 2014 until the suspension of the regular and emergency flood protection measures on 10 June 2014. By presenting the measures implemented during the flood events in May 2014, an attempt was made to highlight the existing problems and weaknesses of both legal and technical structure and the flood protection system in Federation of Bosnia and Herzegovina. It is important to emphasize that they were designed on the basis of experience and knowledge during the implementation of flood protection in situation when the intensity and volume were significantly lower than the flood events of May 2014. All mentioned above, points to the need for innovation and improvement of the current system of implementation of the flood protection measures.

It is extremely important, as demonstrated by a group discussion during the workshop that the countries in the region share their experiences gained during the implementation of active flood protection in order to create a catalogue of measures at a broader level, i.e. at the level of Sava River Basin. That would, at the basin level, lead to unique understanding, exchange of experience and the establishment of common terminology relating to the implementation of flood protection measures. In order to increase the level of preparedness for the potential risk of flooding, it is also needed to launch the exchange of information on available equipment and resources that are available to all entities involved in the implementation of flood protection measures at the national level. A unique and harmonized action at the level of the basin in situation of a large scale floods is of immense importance. Also, as an important segment, it should be noted the importance of international assistance and the principle of solidarity in the phase of rehabilitation of damage and normalization of the situation on the ground after the passage of the flood wave.

3.4.2 Recovery and long-term resilience

Case study: Action plan and needs assessment in Bosnia and Herzegovina

By

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Keywords: Action Plan, reconstruction, measures, sub-measures, financial resources, coordination.

The presentation shows the situation in Bosnia and Herzegovina after the floods, which occurred in May 2014, with the review of activities undertaken in Bosnia and Herzegovina after floods.

- Floods in May 2014
- Summary of Damages and Losses
- What to do for future?
- Action Plan for Flood Protection and River Management in Bosnia and Herzegovina 2014-2017
- Needs assessment in Bosnia and Herzegovina

The floods encompassed the entire area of Bosnia and Herzegovina belonging to the basin causing the loss of 23 human lives and inflicting immense material damage (Figure 1.). A total of 70 administrative units (municipalities/cities) in Bosnia and Herzegovina were affected by the floods and suffered damages with impacts on the population, business activities and the environment. The document, drawn up with the support of the EU, UN and the WB, estimates that the total economic impact of this natural disaster in B&H amounts to 2,037 million Eur.

Following these floods the question arose: What to do for future? The answers were:

- Flood protection system in Bosnia and Herzegovina must be improved
- Coordinated and harmonised approach to the flood risk management should be established
- Cooperation with neighbouring countries and international organizations (ICPDR, ISRBC, WMO) should be improved
- Action Plan for Flood Protection and River Management in Bosnia and Herzegovina 2014-2017 shall be prepared

The floods have mobilized all individuals, legal entities, and institutions in and out of Bosnia and Herzegovina to express their solidarity in providing assistance to flood affected population and areas, but the causes of flooding, its scope, and gravity of its consequences showed that the competent government authorities in Bosnia and Herzegovina should identify the needs of improving the flood protection and water management system that would ensure greater safety of population in similar future floods.

The EU Delegation requested Bosnia and Herzegovina to design an Action Plan for Flood Protection and River Management for Bosnia and Herzegovina (Action Plan), which would create a framework were the issues of flood protection and water management would be treated in a harmonized and coordinated manner both in Bosnia and Herzegovina and the regional level.

Six key measures have been identified within the Action Plan with each measure being divided into sub-measures that need to be implemented in the 2014-2017 period in order to:

- reconstruct the damages on protection facilities and watercourses caused by the floods, erosions and torrents in 2014,
- harmonize the flood protection system with the EU legislation,
- establish a more reliable hydrological forecast system in B&H,
- create conditions for the sustainability of the flood protection system and strengthen inter-sector cooperation and coordination in B&H and the region,
- continue with the activities on full implementation of the integrated water management principle.

The total estimated funds needed for the implementation of the Action Plan amount to 303 million Eur. Of this amount, 136.6 million Euro or 45% of the funds have already been secured from the ongoing credit lines, grant instruments and secured budget resources. Several projects are currently being prepared which are envisaged to secure additional financial resources of around 51 million Euro which will bring the total amount of funds provided to 188.3 million Euro or 61.9%.

A significant number of flood management projects are being implemented. However, there is a long way to quality management of flood risk in places that can mitigate the potential risks to human health and wealth in the region. The first step is to repair the flood protection "primary line" before the heavy rains and snow melt in the spring next year. In parallel, should develop and implement a comprehensive program of flood risk management.

The Action Plan was adopted by the EC as a document of strategic character, it is the first document that was created at the state level, and in the drafting of which was attended by representatives of institutions responsible for issues of flood protection and water management.

Action Plan for Flood Protection and River Management for Bosnia and Herzegovina 2014-2017 was adopted in January 2015 year is one of the success stories in this field. Now is the moment to work on the prevention of the risk of natural disasters through the Action Plan. This Plan should be amended, because it refers to the end of 2017. To strengthen the flood protection measures and avoid the risk it is important to learn on the best practice examples, raise awareness about solidarity and adopt preventive measures.

All very well remember the floods from 2014 year and their devastating effects on families, homes, business, schools and public services. Unfortunately, these kinds of natural disasters will become more frequent, more destructive and violent, in particular due to climate change. For this reason, you should consider how to apply preventive measures to prevent future disasters like this have devastating consequences. Of course you cannot prevent the emergence of a disaster, but it can improve the response to them. Although a lot of work has been done, the after flood recovery work is not over yet. There are still a lot of to do for all of us, both at the local and international level, to bring all the flood recovery activities to the end.

3.4.3 Recovery and long-term resilience

Case study: Lessons learned in Serbia from the May 2014 flood

By

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Keywords: flood event, protection, risk, reconstruction, damage.

The heavy rain falls during April and May 2014, which affected the central and western regions of Serbia, caused extremely high water in several watercourses of River Basin Sava, Drina, Velika Morava and Danube. The floods that occurred in 50 river beds of western, central and southern parts of Serbia affected 52 municipalities, with severe damages in 24 municipalities, causing complete destruction of 485 housing units, and partial damage on 16,200 apartment and individual housing units, as well as public buildings (education, health, etc.), and local administration offices. It was affected 43 out of 99 registered areas of potential significant flood risk in Serbia. It resulted with serious destructions and massive damages to the existing flood protection structures (Table 1: Flood event comparative with current areas of potential significant flood risk).

The floods damaged large portions of flood protection infrastructure (mostly embankments) which failed either because they were overtopped or following underground erosion of their foundations (suffusion).

FLOOD VULNERABILITY	P F R A (2012):	FLOOD EVENTS 2014
Territories (%)	18 %	
Structures of FV	- 16 000 km2 (80% ag. land) - 512 settlements - 515 industrial and other facilities - 680 km of railroads	- 52 settlements 32,000 people evacuated - 304 roads and three railway bridges
A P S F R	**99**	**43**
FP structures:	FLOOD DEFENSE OP. PLAN	EMERGENCY FLOOD DEFENSE
FP lines	3723 km	1.120 km
Dams (FP retention function)	47	
HISTORICAL FLOODS	**MAJOR HISTORICAL FLOODS**	**FLOOD EVENTS 2014**
Danube, (tributaries), Tisa, Tamiš,	1965, 1966, 1970, 1977, 1981, 1987, 1999, 2000, 2002, 2005 2011, *(2006, 2010),	-
V. Morava, J. Morava, Z. Morava (tributaries)	1965, 1966, 1970, 1977,1981,	April, May 2014.
Sava (tributaries, Kolubara)	1974, 1981, (2010)	May 2014
Drina (tributaries, Jadar)	1896, (1999, 2001, 2010)	May 2014
FLOOD DAMAGES	-	**1,5 bilion Euro**

TABLE 1: Flood event comparative with current areas of potential significant flood risk

In few cases, suffusion of material in dike foundation occurred and created holes under the construction that, then, rapidly enlarged and triggered the dike failure. The high velocity of flood waves and large volume of sediments transported (sometimes, large rocks have been rolled over by the floods) produced severe erosion of the river banks and river beds and even destroyed the river bank protection (Figure 1: Embankment collapse).

FIGURE 1: Embankment collapse

After this extreme flood event, The Government of the Republic of Serbia adopted the Regulation on the Program of reconstruction of damaged water facilities in the water districts "Sava", "Lower Danube" and "Morava" in June 2014 which defined four urgent directions to eliminate the floods consequences on the flood protection facilities:

1. Emergency interventions on the flood protection facilities included the works which were carried out on the 55 most endangered sites as temporary closure of embankment breaches, temporary reinforcing of other damaged flood protection structures and facilities, ensuring the stability of the eroded riverbanks to prevent their collapse and preventing the spread of damage to the protected areas. The total value of these works was 1.75 million euro and the works were completed by the end of October 2014.
2. Emergency repair works on the flood protection facilities included works in order to achieve the anticipated stability and functionality of flood protection facilities and it was carried out at 97 critical locations with total value of 10.875 million euro. The works were completed by mid-July 2015
3. Emergency investigative and study works included preparation of technical documentation for emergency repair works, the flood event expertise, updating technical documentations for reconstruction and preparing new technical documentations for construction of flood protection facilities.
4. Preparation of new flood protection project by improving flood management system in Serbia as a part of future non-structural flood protection measures.

Bearing in the mind all of this and fact that flood event from May 2014 has not avoided, it is important emphasizing that before this flood event we had following fact available:

5. Insufficient number and length of flood protection facilities (unprotected cities and areas)
6. Predominantly "passive" flood protection measures (levees, regulated riverbeds)
7. Not enough "active" flood protection measures (dams, flood retention, derivation channels)
8. Insufficient level of flood protection (high water rare probabilities)
9. Inappropriate land use in the potential flooding areas and erosion areas

All this facts (5.-9.) after the flood event in May 2014 have positive influence as lessons learned in recognition of national flood defense project and future activity.

Improving vulnerable flood defense systems in the Republic of Serbia should base on securing financing in maintenance of flood protection systems, development of flood protection system and flood prevention and planning as part of structural measures.

As well as part of non-structural flood protection measures it is necessary to create flood risk management plans, required level of public awareness of flood risk and required level of education and participation of stakeholders.

In support to all of this, measures by EU funds are the new projects for protection of large regions as Mačva valley and Belgrade region with downstream cities. As well numerous of technical documentation is under preparation (Figure 2). For this reason, ISRBC and/or ICPDR is one of the main mechanisms for cooperation and coordination between countries in the Sava region. In near future, the high challenge for ISRBC in the term of non-EU countries is how to estimate the benefits of non-structural measures in FRMP. One possibility to ensure this activity is to use available technical groups under ISRBC or/and ICPDR. Lessons learned there, certainly represents best way for implementation of EU directives.

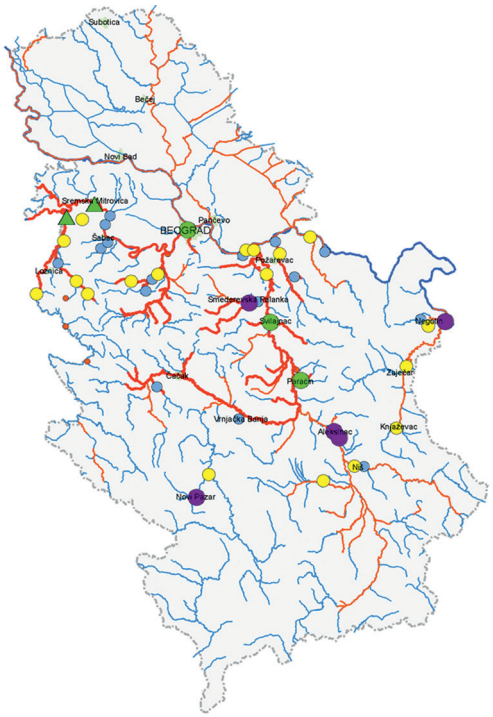

FIGURE 2: All future flood protection projects in Serbia

References

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

Directive of the European Parliament and of the council 2000/60/EC establishing a framework for community action in the field of water policy

Report on performed flood defense in 2014, December 2014, PWMC "Srbijavode", Belgrade

4.
SESSION III - INTEGRATING FLOOD RISK REDUCTION AND RIVER BASIN APPROACH

4.1 Agenda items overview

Natural Water Retention Measures
- EU Policy Document on Natural Water Retention Measures

Links to EU Water Framework Directive
- River basin management plan for the Danube
- Risks and opportunities for applying flood risk management measures under the Water Framework Directive

Decision making
- Financing strategies, cost/benefit analysis, stakeholder involvement, socially acceptable risk

Group discussions
GROUP 1: Opportunities and constraints for the application of Natural Water Retention Measures

GROUP 2: Use of cost-benefit analysis for Flood Risk Management and River Basin Management

GROUP 3: WFD Article 4.7 exemptions for flood risk management measures

4.2 Overview of presentations

Natural Water Retention Measures
EU Policy Document on Natural Water Retention Measures – L. Bernal Saukkonen
http://www.savacommission.org/WFRM/19

Links to EU Water Framework Directive
Risks and opportunities for applying flood risk management measures under the Water Framework Directive – R. Mair
http://www.savacommission.org/WFRM/20

Links to EU Water Framework Directive
River basin management plan for the Danube – M. Berglung
http://www.savacommission.org/WFRM/21

Decision making
Financing strategies, cost/benefit analysis, stakeholder involvement, socially acceptable risk – F. Al-Janabi
http://www.savacommission.org/WFRM/22

4.3 Summary of group discussions

GROUP 1
Opportunities and constraints for the application of Natural Water Retention Measures
Adriaan Slob, moderator
Petra Remeta, rapporteur

Questions:
- What opportunities and constraints for the application of Natural Water Retention Measures do you see in the Sava River Basin?
- What actions are needed to take the opportunities up in the FRM planning?

Summary of discussion:
Constrains are physical planning, especially in rural areas and costs of NWRM within floodplain management.

Opportunities are to give room to river, as well as local development (eco-tourism), and win-win for flood management and meeting other legal requirements.

NWRM should be considered as valid, appropriate and equally effective flood protection measures.

Their planning and inclusion must include a wide participatory process extending beyond experts traditionally consulted when planning flood protection and include at minimum the following sectors: agriculture, physical planning, energy, environment and nature protection, climate change, groundwater, etc.

GROUP 2
Use of Cost-Benefit analysis for Flood Risk Management and River Basin management
Firas AL-Janabi, moderator
Marina Babić Mladenović, rapporteur

Questions:
- For what issues/measures of the FRMP do you want to apply Cost Benefit Analysis?
- What steps are needed to apply cost-benefit analysis for the FRM planning?

Summary of discussion:
SRB countries are in different stage of FRM planning and CBA within FRMP has been done only in Slovenia and Croatia.

Prerequisite for CBA are flood hazard and risk maps, also prepared only in Slovenia and Croatia. A methodology to estimate benefits of measures on transboundary scale (upstream - downstream) is needed.

Ecosystem should be a part of cost-benefit analysis (ecosystem services, environmental damages/losses).

Problem is how to prepare stage-damage curves, which rarely exist. There is a possibility to use stage-damage curves prepared in some EU projects, and adjust them according to country GDP.

Flood risk management studies should be prepared for all sub-basins of the SRB (many of them also being transboundary) to find appropriate set of structural and non-structural measures. These studies may be a ground for some kind of "trade off" between countries.

Common methodology for flood risk mapping in SRB is needed, in order to establish the common ground for CBA at the SRB level.

Baseline information must be up to date and based on field work (assessment, not only desk research) including environmental and nature assessments (i.e. status of environment/nature).

GROUP 3
WFD Article 4.7 exemptions for flood risk management measures
Raimund Mair, moderator
Irma Popović Dujmović, rapporteur

Questions:
- Do you foresee that Article 4.7 on exemptions will be applied for the FRMP? And for what Flood Risk Management measures or for what situations in the Sava River Basin?
- What actions should be taken related to this in preparing the FRMP?

Summary of discussion:
Currently, there is no or weak application of Article 4.7 in the countries, but all agreed that will be a need to apply it in future.

There are difficulties how to assess requirements for application of Article 4.7 which assessing better environment options, but still there is a huge need for deeper communication and exchange of information between sectors, ministries and countries.

Relevant institutions must be educated on proper use of Article 4.7, which means that they need to understand the reasoning behind expectations, process to invoke Article 4.7 and repercussions of that. Otherwise, they will continue to use it as justification for not achieving good status and/or to develop their agenda without taking environment into account.

4,4 Abstracts of presentations

4.4.1 Natural Water Retention Measures

EU Policy Document on Natural Water Retention Measures

By

Lucia Bernal Saukkonen
European Commission
DG Environment, Unit C1 – Water

Keywords: natural water retention measures, flood protection, Water Framework Directive, Floods Directive, multi-functional.

The aim of this presentation is to describe Natural Water Retention Measures, their policy relevance, the results of the Pilot project and the issues involved in their implementation.

NWRM are multi-functional measures that aim to protect and manage water resources and address water-related challenges by restoring or maintaining ecosystems as well as natural features and characteristics of water bodies using natural means and processes. Their main focus is to enhance, as well as preserve, the water retention capacity of aquifers, soil, and ecosystems with a view to improving their status. NWRM have the potential to provide multiple benefits, including the reduction of risk of floods and droughts, water quality improvement, groundwater recharge and habitat improvement. The application of NWRM supports green infrastructure, improves or preserves the quantitative status of surface water and groundwater bodies and can positively affect the chemical and ecological status of water bodies by restoring or enhancing natural functioning of ecosystems and the services they provide. The preserved or restored ecosystems can contribute both to climate change adaptation and mitigation."[1]

NWRM are not new measures as such but have been implemented for a number of years under different names such as natural flood management measures, river restoration, room for the river, etc. With this new concept the focus is however on improving the water retention. These measures aim primarily to contribute to the achievement of the objectives of the WFD and the EFD. However the benefits that result from their impacts such as slowing and/or storing the flow, or improving the water infiltration produce benefits that have an impact on the achievement of other policy objectives from the Habitats Directive, the Biodiversity, Green Infrastructure and Climate Adaptation Strategy, and the Urban Waster Water Directive. The multifunctional and multi-sector character of NWRM requires enhanced collaboration between stakeholders representing different sectors.

In 2012 the EC adopted the 3rd Implementation Report on the WFD which assessed the 1st RBMPs adopted by Member States. Through this assessment the EC identified that hydro morphological alterations and diffuse pollution were amongst the most significant issues leading to failure in water body status. In addition measures implemented until now have not been sufficient and the causes of negative impacts on water are interlinked.

The "Blueprint Communication" published in 2012 by the EC along with the 3rd Implementation Report of the WFD, identified the policy importance of these measures and how these can reduce the impacts on floods, droughts and land use related pressures.

[1] Definition from the EU Policy document on NWRM

As a follow up activity the "Blueprint" proposed the elaboration of a document, which took the form of a policy document, by the Working Group Programmes of Measures under the CIS[2] process. This document, adopted by Water Directors in November 2014, explains the policy relevance and promotes its uptake in water management through the upcoming 2nd RBMPs and the 1st FRMPs, in accordance with both Directives.

NWRM can be categorised in four sectors and can provide the following benefits:

- Agriculture: such as intercropping which can result in slower runoff, can increase water infiltration, reduce erosion, filtrate pollution, protect ecosystems.
- Forestry: such as land use conversion which can slow and store runoff, increase evapotranspiration, increase infiltration making water available elsewhere, intercept pollutants, reduce erosion.
- Hydro morphology: such as re-meandering which can slow river water, reduce erosion, create aquatic and riparian habitats improving nature, and produce biomass.
- Urban: such as green roofs which can slow and store runoff, increase evapotranspiration, decrease temperatures, improve air quality, and reduce floods.

NWRM offer a variety of measures that are relevant EU wide. But their design needs to be tailored for each eco-region and their benefit depends on type, location, implementation design and combination with other measures.

Enhanced knowledge is required for supporting the optimisation of NWRM and their combination with other measures, for quantifying their impacts at large scale, and for estimating all their benefits. In this sense research and demonstration in pilot activities is to be promoted to gather further evidence on the (real) effects of NWRM on flood mitigation at the catchment scale and multiple impact monitoring should be part of project contributing to different EU policy objectives.

In order to improve the knowledge base and create a community of practice on NWRM, the EC started a pilot project in 2013. This project has built a catalogue of 53 measures divided in the four sectors mentioned above. The catalogue includes a description and information on different parameters for each measure such as the geographical applicability, scale, biophysical impacts, the ecosystem services provided, the policy objectives met, design parameters, costs, governance issues and funding opportunities. Also the "benefits tables" provide information in a summarized and quickly visual way. Through these tables it can be extracted that one of the "hydro morphological measure" which provides for the highest benefits is flood restoration and management. Other deliverables from the project include a Practical Guide supporting NWRM design and implementation which has been translated into 15 EU languages, a database containing 125 case studies, synthesis documents which cover the main issues on the implementation of NWRM and communication material.

In relation to funding, the EC has launched new H2020 calls on nature-based solutions. This includes NWRM. This year's focus is on cities, however there is also one call on large - scale demonstrators on nature-based solutions for hydro-meteorological risk reduction (SC5-08-2017) which results will contribute to bring further knowledge on the benefits of up scaling these measures with a river basin wide coverage.

[2] Common Implementation strategy is an informal programme of co-operation between the Commission, EEA, MS, acceding, candidate and potential candidate countries as well as EFTA countries and relevant stakeholders to develop a common approach to the technical challenges for implementing the WFD.

Other EU funding instruments are the Structural and Cohesion funds, the European Agricultural Fund for Rural Development, LIFE, and the Natural Capital Financing Facility.

But are NWRM cost effective solutions? The answer to this question is that it depends on a number of factors. One cost that can make these measures less cost effective is if land purchasing is required for their implementation (such as for example reducing flood risk by giving more space to rivers, especially in peri-urban areas where these costs are high). However this depends on a case-by-case basis as examples with land purchase and NWRM implemented close to urban areas exist as well. In this regard proper land use planning that includes water aspects giving enough "room for the river" is essential before any new developments. In this sense the French National Strategy for flood protection includes the restriction of building in floodplain areas.

In conclusion NWRM are multi-functional measures and should thus be duly considered in different planning processes as win-win options that make the best use of scarce resources.

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4.4.2 Links to EU Water Framework Directive

River basin management plan for the Danube

By

Raimund Mair and **Tomislav Majerović**
International Commission for the Protection of the Danube River

Keywords: river basin management plan, water framework directive, ICPDR

In 1994 Danube countries signed the Danube River Protection Convention to commit to transboundary cooperation in protecting the Danube. The International Commission for the Protection of the Danube River is the platform for the coordinated implementation of the WFD and EFD on basin-wide level. The objective of the WFD, that came into force in 2000, is to achieve good ecological and chemical status for all surface waters and good chemical and quantitative status for groundwater. The presentation provides an overview about the Danube River Basin Management Plan (DRBMP) – Update 2015 for the WFD planning period of 6 years, from 2015 to 2021, and the linkages to sustainable flood risk management.

The DRBMP focuses on 4 Significant Water Management Issues, which are organic pollution, nutrient pollution, hazardous substances pollution and hydromorphological alterations. Main emitters of organic pollution are point sources like untreated municipal waste water. Urban waste water treatment plants with at least biological treatment contributed to a significant decrease of organic pollution. Nutrient pollution is caused by nitrogen (N) and phosphorus (P) released into the aquatic environment. Nutrient removal technologies that are implemented in waste water treatment plants reduce nutrient pollution, next to measures on agriculture. Hazardous substances are emitted from households and public buildings, industry, agriculture and mining sites. Improving waste water treatment and industrial technologies are the most important recent activities regarding hazardous substances pollution.

Despite river restoration measures have been implemented during the past 6-years WFD planning cycle, a significant number of water bodies remains impacted by hydromorphological pressures. The main drivers are hydropower generation, inland navigation and flood risk management. With regard to the latter, river continuity interruptions caused by dams and weirs, alterations of river morphology and habitats, and disconnected wetlands and floodplains are key pressures stemming from flood protection measures.

As a result of the sum of these pressure, a significant number of water bodies does not yet reach good status/potential (see Figure 1) and will therefore require further measures for the achievement of the WFD objectives.

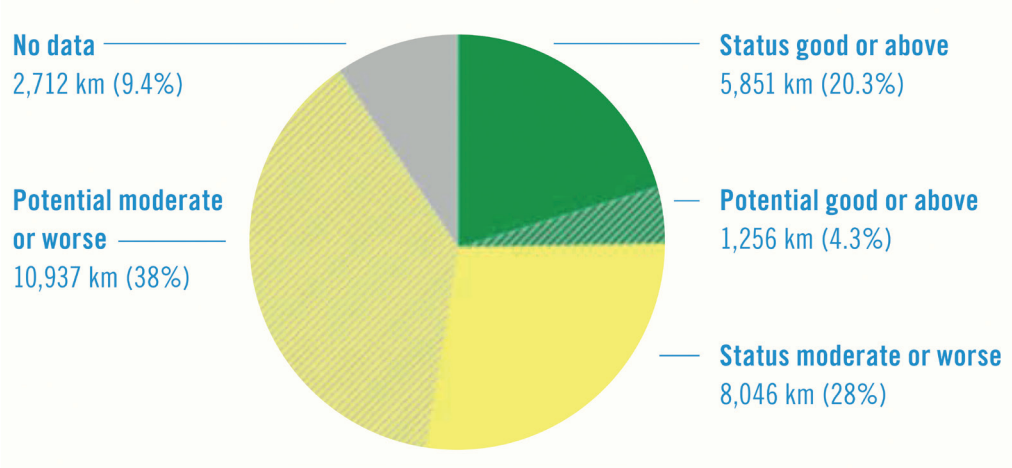

FIGURE 1: Ecological status and ecological potential for river water bodies in 2015 (indicated in length in km)

When designing measures under both, the WFD and the EFD, it is important to make best use of synergies and to avoid potential conflicts that might arise for the achievement of the objectives of both Directives. Therefore a coordinated approach is required. The DRBMP – Update 2015 addresses these issues which include inter alia the following:

- Natural water retention measures, i.e. the protection, conservation and restoration of wetlands/floodplains;
- Elaboration of an inventory, priority ranking and steps for implementation of restoration measures for the reconnection of lost floodplains and wetlands;
- New barriers for fish migration imposed by new infrastructure projects should be avoided, e.g. by building ramps instead of weirs for river bed stabilisation, where deemed to be required;
- Restoration of river morphology;
- For future infrastructure projects, integrated planning approaches are in need to be continued and further enhanced, taking environmental requirements into account from the beginning in order to prevent and reduce impacts on water status.

Several future infrastructure projects were reported by the Danube countries to be in the planning or implementation phase, including structural flood protection projects. It is important that such projects are planned and conducted in a way to ensure that water status is not deteriorated. Deterioration is only allowed in exceptional cases and following the requirements as set in WFD Article 4(7). These include

- the benefits of the new infrastructure are of overriding public interest outweighing the benefits of achieving the WFD environmental objectives,
- there are no significantly better environmental options which are technically feasible,
- all practical mitigation measures are taken to minimize negative effects on aquatic ecology, and
- the projects are reported in the River Basin Management Plans.

Meeting these requirements can pose a practical challenge and further exchange on this issue is therefore proposed for the coming years.

In summary, flood risk management and WFD implementation are key issues, bringing along potentials for synergies (e.g. NWRM, joint Public Consultation, ...) but also conflicts like (additional) pressures on water bodies (e.g. river continuity interruption, habitat degradation, ...). There is a need for a coordinated approach (which is also enshrined in the EU Floods Directive). The inter-linkages are addressed by Danube River Basin Management Plan – Update 2015 and the Danube Flood Risk Management Plan. The question is not whether but how to ensure sustainable flood protection for the population and economies in the Danube region. This will require a further exchange and strengthening of cooperation in the coming years.

APPENDIX A – Workshop Agenda

Workshop on Flood Risk Management Measures & Links to EU WFD

11-12 November 2015

VENUE:
Sheraton Zagreb Hotel
Kneza Borne 2, 10000 Zagreb, Croatia

AGENDA

Wednesday, 11 November 2015

12:00 – 13:00	Registration of participants & lunch
13:00 – 13:30	**Opening session**
	Welcome address Philippe Pypaert, UNESCO Venice Office Firas AL-Janabi, WMO Raimund Mair, ICPDR Secretariat Dejan Komatina, ISRBC Secretariat
	Introduction to the workshop Setting the scene and statement of problems and goals Agenda summary and outlook of Day 1 Workshop moderator: Adrian Slob, TNO, the Netherlands
13:30 – 18:00	**Session I – Flood risk management planning, prevention & preparedness**
13:30 – 14:00	**Policy and regulatory framework** • Policy framework and coordination requirements in floods, river basin and civil protection management - Firas AL-Janabi, WMO • Protocol on Flood Protection to the FASRB & Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin - Dragan Zeljko, ISRBC Secretariat
14:00 – 15:15	**National/International flood risk management planning** • Structural and non-structural measures in flood risk management - Marina Babić-Mladenović, Jaroslav Černi Institute for the Development of Water Resources, Serbia • Case studies: – Slovenia - Luka Štravs, Ministry of the Environment and Spatial Planning, Slovenia – Croatia - Marijan Babić, Croatian Waters – Sava River Basin - Mirza Sarač, ISRBC Secretariat – Danube River Basin - Igor Liška & Raimund Mair, ICPDR Secretariat
15:15 – 15:45	**Coffee break**
15:45 – 16:45	**Flood forecasting and warning** • System development, warnings issued and dissemination of messages - Firas AL-Janabi, WMO • Case studies: – Flood forecasting in Slovenia - Sašo Petan, ARSO Slovenia – Flood forecasting in Croatia - Dijana Oskoruš, DHMZ Croatia – Flood forecasting and warning system for the Sava River Basin - Anna Cestari, World Bank – Flash flood guidance system in South East Europe - Firas AL-Janabi WMO
16:45 – 17:00	**Raising awareness & Capacity building** • Raising hazard/risk awareness, providing access to information and communication with media, face-to-face and web-based learning, trainings and collaborative platforms, access to justice - Philippe Pypaert, UNESCO Venice Office

17:00 – 18:00	**Group discussions (reporting and conclusions)** • GROUP 1: Catalogue of measures in FRM Plans relevant for the whole river basin Moderator: Raimund Mair, Rapporteur: Martina Egedušević • GROUP 2: Exchange of information among countries and dissemination of information to wide public Moderator:Philippe Pypaert, Rapporteur: Tatjana Vujnović • GROUP 3: Inter-sectoral coordination and cooperation in flood risk management planning, prevention & preparedness Moderator: Dejan Komatina, Rapporteur: Radovanka Pavlović
18:00	**End of Day 1**
19:30	**Joint dinner**

Thursday, 12 November 2015

9:00 – 9:15	**Summary of Day 1 and Outlook of Day 2**
9:15 – 11:30	**Session II – Emergency response and recovery**
9:15 – 10:00	**Flood defense measures** • Measures for fluvial floods, flash floods and urban flooding erosion and sediment control - Firas AL-Janabi, WMO • Case study: – Active flood defense in Croatia: Regulatory framework, roles & responsibilities - Zoran Đuroković, Croatian Waters – Flood defense measures in B&H during the May 2014 flood - Almir Prljača, AVP Sava Sarajevo, B&H and Nenad Đukić, Ministry of Agriculture, Forestry and Waters of RoS, B&H
10:00 – 10:15	**Recovery and long-term resilience** • Case study: Action plan and needs assessment in B&H - Enes Šeperović, Ministry of Foreign Trade and Economic Relations, B&H
10:15 – 10:30	**Mutual assistance and mitigation** • Case study: Lessons learned in Serbia from the May 2014 flood - Darko Janjić, Public Water Management Company "Srbijavode", Serbia
10:30 – 11:30	**Group discussions (reporting and conclusions)** • GROUP 1: Recovery and long-term resilience planning Moderator: Philippe Pypaert, Rapporteur: Žana Topalović • GROUP 2: Forms of assistance and modalities for transboundary cooperation in flood defense emergency situations Moderator: Adrian Slob, Rapporteur: Esena Kupusović • GROUP 3: Inter-sectoral coordination and cooperation in the flood defense emergency situations Moderator: Dejan Komatina, Rapporteur: Jovanka Ignjatović
11:30 – 12:00	**Coffee break**

12:00 – 15:00	Session III – Integrating flood risk reduction and river basin approach
12:00 – 12:15	**Natural Water Retention Measures** • EU Policy Document on Natural Water Retention Measures - Lucia Bernal-Saukkonen, European Commission, DG Environment
12:15 – 12:45	**Links to EU Water Framework Directive** • River basin management plan for the Danube - Raimund Mair, ICPDR Secretariat • Risks and opportunities for applying flood risk management measures under the Water Framework Directive - Maria Berglund, FreshThoughts, Austria
12:45 – 13:45	**Lunch**
13:45 – 14:00	**Decision making** • Financing strategies, cost/benefit analysis, stakeholder involvement, socially acceptable risk - Firas AL-Janabi, WMO
14:00 – 15:00	**Group discussions (reporting and conclusions)** • GROUP 1: Opportunities and constraints for the application of Natural Water Retention Measures Moderator: Adrian Slob, Rapporteur: Petra Remeta • GROUP 2: Use of cost-benefit analysis for Flood Risk Management and River Basin Management Moderator: Firas AL-Janabi, Rapporteur: Marina Babić Mladenović • GROUP 3: WFD Article 4.7 exemptions for flood risk management measures Moderator: Raimund Mair, Rapporteur: Irma Popović Dujmović
15:00 – 16:00	**Closing session**
	General discussion and summary of the workshop, highlights and next steps Raimund Mair, ICPDR Secretariat Firas AL-Janabi, WMO Philippe Pypaert, UNESCO Venice Office Dejan Komatina, ISRBC Secretariat
16:00	**End of the Workshop**

APPENDIX B – List of Attendees

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Director Adviser

Almir Bajramlić
Sava River Watershed Agency, Sarajevo
Associate of Water Protection Department

Almir Bijedić
Federal Hydrometeorological Institute, Sarajevo
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Milan Blagojević
Republic Hydrometeorological Service of the Republic of Srpska, Banja Luka
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Director

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Ministry of Security
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Amer Kavazović
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Public Institution "Vode Srpske" Bijeljina
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CROATIA

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Meteorological and Hydrological Service
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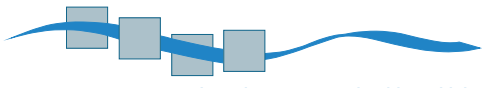

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