A STEP FORWARD FOR STRENGTHENING COOPERATION BETWEEN RIVER BASIN MANAGEMENT PLANNING AND FLOOD RISK PREVENTION AND AMONG COUNTRIES - *JOINTISZA* PROJECT - A REVIEW

A. CIUREA[1], I.S. RÎNDAŞU-BEURAN[1], B. ION[2], A. BĂRBIERU[1], R. D. BOGZIANU[1]

ABSTRACT. – A Step Forward for Strengthening Cooperation Between River Basin Management Planning and Flood Risk Prevention and Among Countries - JOINTISA Project. This synthesis review is about description of the JOINTISZA, an ongoing project regarding strengthening cooperation between river basin management planning and flood risk prevention in order to enhance the status of waters of the Tisza river basin, the biggest tributary of the Danube river.

Keywords: Tisza River basin, cooperation, river basin management, flood risk management.

1. INTRODUCTION

In a shared river basin there are some issues like over-exploitation of water resources, water regime modifications, water contamination, and a number of flood events – negative effects of which are amplified by climate change, *that require harmonised and integrated actions* from different management authorities in the countries.

The JOINTISZA project started in 1 January 2017 and would be finished in 30 June 2019. The project is developing under ***Danube Transnational Programme*** (DTP), which is a financing instrument of the ***European Territorial Cooperation*** (ETC), better known as INTERREG. ETC is one of the goals of the ***European Union cohesion policy*** and provides a framework for the implementation of policy exchanges and joint actions between national, regional and local actors from different Member States.

The DTP promotes economic, social and territorial cohesion in the Danube Region through policy integration in selected fields.

In order to achieve a higher degree of territorial integration of the very heterogeneous Danube region, the transnational cooperation programme acts as a policy driver and pioneer to tackle common challenges and needs in specific policy fields.

[1]"Romanian Waters" National Administration, Bucharest, e-mail: anemari.ciurea@rowater.ro, sorin.randasu@rowater.ro , adrian.barbieru@rowater.ro, razvan.bogzianu@rowater.ro
[2] National Institute of Hydrology and Water Management, Bucharest, e-mail: bogdan.ion@hidro.ro

The Danube Transnational Programme finances projects for the development and practical implementation of policy frameworks, tools and services and concrete small-scale pilot investments.

The overall budget of the project is **2,254,126.80 euro**, the contribution of the **European Regional Development Fund (ERDF)** being **1,702,467.90 euro** and **Instrument for Pre-Accession Assistance (IPA) 213,539.86 euro**.

Jointisza project is included in the **Priority Programme-Environment and culture responsible in the Danube region.**

The JOINTISZA project will ensure that flood risk management planning becomes more deeply embedded in the River Basin Management planning process, and will also facilitate the involvement of interested stakeholders and relevant sectors (flood risk, water resource, urban hydrology and drought management). The ICPDR will ensure the utilisation of the already existing GIS system and will facilitate the expansion of the database with information about tributaries of the Tisza River Basin larger than 1000 sqkm². The project will involve the joint efforts of the five countries that share the Tisza River Basin – Hungary (HU), Romania (RO), Serbia (SR), Slovakia (SK) and Ukraine (UA) and the ICPDR-Tisza Group and the EU Strategy for the Danube Region (EUSDR), Water Quality Priority Area (PA4) and Environmental Risks Priority Area (PA5) platforms will build a bridge between stakeholders for conveying information from expert level to policy level.

The best way to protect and manage water is by a close international cooperation between all the countries within the river basin – bringing together all interests upstream and downstream. All countries of the European Union are using a river basin approach for water management since the adoption of the EU Water Framework Directive (WFD). Hungary, Romania, Serbia, Slovakia and Ukraine share the responsibility for the Tisza river basin and undertook jointly activities towards the implementation of the EU Water Framework Directive and the EU Flood Directive (FD). These efforts were supported by the European Union in the frame of the TISAR 2007 and led to good results.

The partnership is composed of four levels of the most relevant institutions: national ministries and water management administrations for assuring coordinated planning and implementation of measures on national level (policy level), water research institutes for high professional work (operating level), international organizations also for strenghtening transnational aspects of the planning and controlling of results and outputs (control level) and different stakeholder institutions for transparency (social level).

These 17 partners are: General Directorate of Water Management (HU), Ministry of Foreign Affairs and Trade (HU), National Administration "Romanian Waters" (RO), Ministry of Water and Forest (RO), National Institute of Hydrology and Water Management (RO), Water Research Institute (SK), Regional Environmental Center for Central and Eastern Europe (HU), International Comission for the Protection of the Danube River (AT), Global Water Partnership Central and Eastern Europe (SK), World Wide Fund for Nature Hungary (HU), The ”Jaroslav Černi” Institute for the Development of Water Resources (SR),

Public Water Management Company "Vode Vojvodine" (SR), Secretariat of the Carpathian Convention (AT), Interior Ministry of Hungary (HU), Ministry of Agriculture and Environmental Protection Water (SR), Tisza River Basin Water Resources Directorate (UA), State Agency of Water Resources of Ukraine (UA).

The main general objective of the project is strengthening approaches and cooperation among the relevant actors of the river basin management planning process especially actors of flood risk prevention/flood protection sector to enhance the status of waters of the basin. In line with the Danube Transnational Programme initiative, the first Integrated Tisza River Basin Management Plan (ITRBMP) outcomes, as well as the ICPDR Tisza Group's goal, the project aims to facilitate dialogue between sectors relevant from water quality management point of view. The project will take strong emphasis on stakeholders involvement using good practices of previous FLOODRISK project, and as learning interaction, introducing the shared vision planning method. The project workpackages are fully in line with the EU water policy documents, mainly with the Water Framework Directive and Flood Directive including the key elements of the River Basin Management Plan. In long term the project will initiate the change of better contribution to the implementation of the Flood Risk Directive and Water Framework Directive and will further strengthen cooperation of the countries of the Tisza River Basin involving countries from both EU and Non-EU region.

The specific project objectives are:

- *a better integrated river and flood risk management planning at Tisza River Basin scale.* The national water and flood risk management strategic documents and plans towards the development of an integrated transboundary management plan. The first specific objective is to update the ITRBMP with special emphasis on integrated approach of river basin management and flood risk protection planning. The updated plan will include integrated Joint Programme of Measures to enhance good status of waters;

- *a strengthened sectorial and stakeholder involvement*. The second specific objective is to better facilitate stakeholder involvement from two sectors (river basin management and flood risk protection planning) into the overall integrated river basin management planning process utilizing Shared Vision Planning method. Cooperation with relevant international organisations is a further asset towards fulfilling this objective and they offer further option for the better involvement of the aimed target groups.

The working packages of the project are: *WP0- Project preparation*-lead by project consortium, *WP1-Project management,* lead by General Directorate of Water Management (HU), *WP2-Communication activities,* lead by Regional Environmental Center for Central and Eastern Europe (REC), *WP3-Basin characterization–surface waters*, lead by Water Research Institute (SK), *WP4-Water quantity issues*, lead by "Jaroslav Černi" Institute for the Development of Water Resources (SR), *WP5- Flood management*, lead by National Administration "Romanian Waters" (RO), *WP6- Syntesis*, lead by Global Water Partnership Central and Eastern Europe (SK).

JOINTISZA focuses on the interactions between two key aspects of water management — river basin management (RBM) and flood protection (FP) — while taking into account the relevant stakeholders who play a pivotal role in the Tisza RBM planning process.

Furthermore, **the pilot actions**, focusing on urban hydrology management (Oradea and Debrecen), drought management (an area including Kisköre reservoir in Hungary) and flood management (on Crasna river in Romania) will enable the involved actors to develop new approaches and contribute with their outcomes to the updated management plan.

A long-term goal of the project will be to generate momentum for improved implementation of the Floods Directive and Water Framework Directive, targeting four specific groups: national water administrations, water research institutes, international organisations and other interested stakeholders, and NGOs.

Finally, **the main output of the project will be an updated final draft of the Integrated Tisza River Basin Management Plan** (the second edition). After that, the draft will be presented into ICPDR Tisza Group and will be approved at ICPDR level.

JOINTISZA project implementation will achieve **the following outputs:** ● an improved geographic information system (GIS); ● guidelines on best management of urban hydrology, and organisation of related trainings; ● a guidance paper on climate change–induced, water quantity issues to assist in overcoming challenges; ● a final draft of the updated ITRBMP; and ● a strategy on public involvement and participation. The pilot actions will enable the involved actors to develop approaches and to contribute their outcomes to the updated management plan.

The official Kick-Off Meeting and First Stakeholder Event of the JOINTISZA project took place on March 1-2, 2017 in Szentendre, at the Conference Center of the Regional Environmental Center for Central and Eastern Europe (REC).

The Kick-Off Meeting brought together representatives of the project partners and associated strategic partners from these five countries that shared the basin. The meeting was centred on: building a consortium-type spirit; agreeing on efficient internal management and communication processes; reviewing and detailing project activities and the project work plan; and agreeing on immediate steps for the next period.

2. GENERAL INFORMATION ABOUT FLOOD PROTECTION INFRASTRUCTURE AND FLOOD MANAGEMENT

One of the main added value of the project is an overview of the flood risk aspects in the Tisza basin and the development of a common strategy to face with.

The Tisza River Basin, with its total area of 157,186 km², is the largest sub-basin in the Danube River Basin and the river is the longest tributary of the Danube (966 km), and the second largest by flow, after the Sava River (Table 1).

In Ukraine there are two main organizations at national level involved in the flood risk management: State Agency of Water Resources of Ukraine (SAWR) and State Service of Emergency Situations (SSES).

Table 1. ***The main tributaries rivers of the Tisza River with catchment areas over 1000 km²***

Country	Watercourse name
Ukraine	Bodrog, Latorica, Uzh, Tur, Borzhava, Rika, Teresva
Romania	Vișeu, Iza, Tur, Someș, Șieu, Someșul Mic, Lăpuș, Crasna, Crișul Alb, Crișul Negru, Crișul Repede, Barcău, Ier, Mureș, Arieș, Târnava, Târnava Mică, Sebeș, Strei, Aranca, Bega, Bega Veche
Slovakia	Bodrog, Uh, Laborec, Latorica, Topla, Ondava, Hornád, Torysa, Rimava, Slaná, Bodva
Hungary	Túr, Szamos, Kraszna, Hernád, Sajó, Bódva, Zagyva, Tarna, Hármas-Körös, Fehér-Körös, Fekete-Körös, Kettős-Körös, Sebes-Körös, Berettyó, Dong-éri-főcsatorna, Kálló-ér, Maros
Serbia	Zlatica, Begej, Stari Begej

Tisza basin within Ukraine fits to administrative borders of Zakarpattya oblast and is located within two orographic rayons (Carpathian Mountains and Hungarian lowland about 35% of the basin) (Fig. 1).

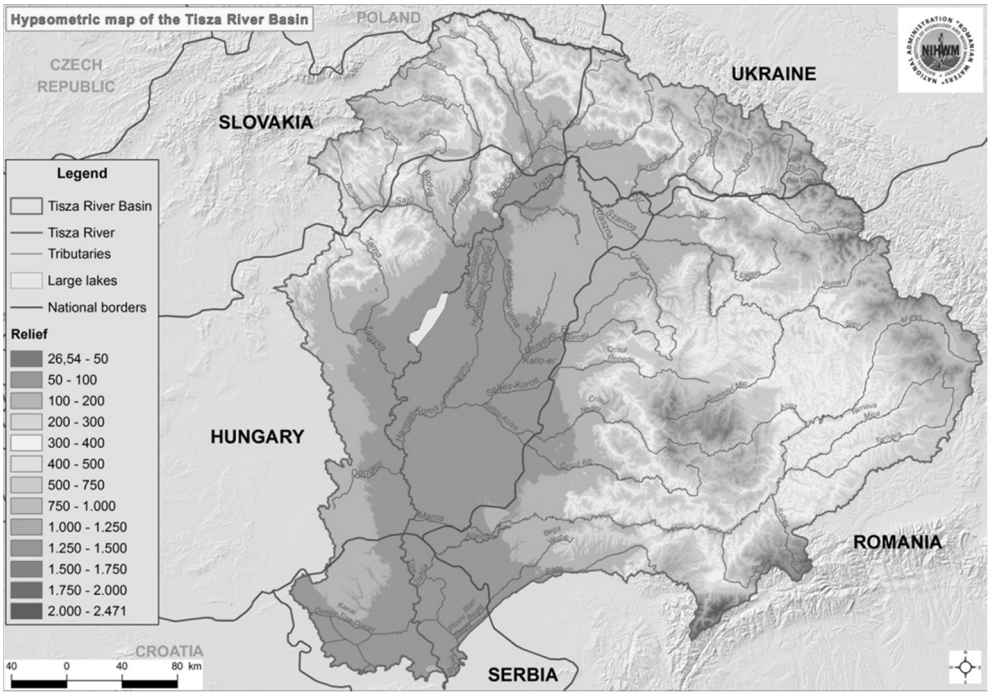

Fig. 1. ***The Tisa river basin***

There are two structural level that take part in formation of geological structure of the territory (the lower structural level and the Folded Carpathians). The climate is a moderate continental with preponderant influence of the Atlantic. The main tributaries of Tisza with river basin surfaces more than 1000 km^2 are Bodrog, Latorica, Uzh, Tur, Borzhava, Rika, Teresva, Bila Tisza, Chorna Tisza. In the basin within the low-land area, the variety of sod-podzolic soils prevail, mountain-forest and meadow-forest soils prevail in the mountainous area, meadow and meadow gley soils prevail in the flood-plain bench of the rivers.

Zakarpattya Oblast includes 13 rayons and 11 cities, 5 of them are the cities of oblast sub-ordinance, i.e. Uzhhorod, Mukachevo, Khust, Beregovo and Chop and 6 of them are the cities of rayon sub-ordinance, and a total number of 579 rural settlements.

The population from Tisza River sub-basin is about 1,257 million inhabitants. Economic activities comprise branches of industry and agriculture.

Regarding the protected areas, there are 456 sites of the natural-reserved fund, 4 national wide sites, 19 national significance landscape preserves, 47 landscape preserves of the local importance, 9 nature reserves, 9 national natural monuments, 329 natural monuments of the local importance, 8 Ramsar sites.

The cultural heritage is represented by churches, monasteries, museums, cultural monuments etc.

Flood protection infrastructure is constituted from dams of about 770,1 km, bank enforcement facilities - 318,8 km, canalized water ways, channels - 1339 km, 1108 hydraulic engineering units, 30 drainage on-site pump stations, 8 multi-purpose reservoirs with the total volume capacity 25.3 $mil.m^3$, drainage system – 318,8 km.

The most important floods that occurred in Tisza River sub-basin during the analysed period (50 years) were the ones from May 1970, October 1974, July 1980, November 1998, March 2001, June 2008 and December 2010.

Ukraine is at the stage of legal approximation to the EU Flood Risk Directive, whereas implementation is planned for later (preliminary flood risk assessment – November 2018, preparation of flood risk and flood hazard maps – November 2020 and development of the Flood Risk Management Plan – November 2022).

The conclusions after studying the data from 1961 till now is that the climate affects the hydrological regime of rivers.

Bilateral agreements regarding the water resources management have been signed with Romania, Slovakia and Hungary.

Flood risk management issues in **Romania** are regulated by the Water Law and the National Strategy for Flood Risk Management in medium and long term (2010-2035). The institutions involved are organized at national (Ministry of Water and Forests through "Romanian Waters" National Administration), regional (through 11 River Basin Authorities) and local level (Water Management Systems).

The physical - geographic features of the Tisza River sub-basin on the territory of Romania are influenced by the specific relief which includes all major

relief forms, with altitudes between 75 to 2509 m.a.s.l., overlaid over crystalline and magmatic rocks, mesozoic and neozoic sedimentary rocks, with temperate continental climate and whose features take into account the relief forms, and a wide range of soils (predominant soils in the mountains – spodosols and umbriosols, luviosols in the hills and cernisols in Transylvanian Plateau and in plains).

The population from Tisza River sub-basin is about 5 million inhabitants, with an about equal distribution in the urban (about 80 urban centers) and rural areas (about 875 rural centers). Economic activities comprise branches of industry and agriculture.

Regarding the protected areas, there are 40 sites of SPA, 170 SCI type sites, about 355 natural parks.

The cultural heritage is represented by churches, monasteries, museums, cultural monuments etc.

Flood protection infrastructure is constituted from embankments works (about 3634,8 km), 133 permanent reservoirs with a total attenuation volume of 378,841 million m^3, 87 temporary reservoirs with a total volume of 199,623 million m^3, 19 polders with a total volume of 153,888 million m^3, 621,71 km of diversion canals with a derived discharge of 843,83 million m^3 and 9 hydraulic complex facilities with a total maximum discharges of 714,8 million m^3.

Drainage systems are referring to internal water leakage through drainage canals and through valleys and depressions, by maneuvering of weirs and the operation of pumping stations serving for this purpose from internal water systems and subsystems. It contains 89 drainage systems.

Taking into account hydrological criteria and the impact of the floods in terms of damages, 37 historical significant floods were selected for reporting in the first cycle of Floods Directive 2007/60/EC implementation. 29 areas with potential significant flood risk were designated along Tisza river and its major tributaries (with river basin surfaces more than 1000 km^2), based on available data analyzed through the national projects ”Plan for Protection, Prevention and Mitigation of the floods effects in the river basin” and ”Contributions to the development of the flood risk management strategy”, and on river sectors where breaches in dykes can occur.

Most of flood hazard maps reported to EC were elaborated through the national project ”Plan for Protection, Prevention and Mitigation of the floods effects in the river basin” as a result of hydrological and hydraulic studies, for a high probability scenario (maximum discharge with probability of exceeding of 10%), for a low probability scenario (maximum discharge with probability of exceeding of 0,1%) and for a medium probability scenario (maximum discharge with probability of exceeding of 1%). For the rest of the areas simplified methods (based on fuzzy systems modeling – GrassGis and approximate modeling with HEC-RAS) were developed.

Based on a methodology developed by National Institute of Hydrology and Water Management and National Administration ”Romanian Waters” –

headquarters, quality flood risk maps have been elaborated, taking into consideration three classes of flood risk (high, medium and low risk).

Potential adverse consequences consists in: 392,787 possible affected inhabitants, about 514 km of railway and 1405 km of national / European, county and communal roads, 29 SPA areas, 49 SCI areas, 70 protected for the abstraction of water intended for human consumption, 17 IED installations, 228 churches, 9 museums and 3 cultural monuments.

The results of some climate models with increasingly fine spatial resolutions to capture the complex orography of each region allowed the development of scenarios for different river basins on the territory of Romania (among them Crișul Alb and Mureș river basins) regarding the impact assessment on water resources.

Bilateral agreements regarding the water resources management have been signed with Ukraine, Hungary and Serbia.

Flood risk management issues in **Slovakia** are regulated by the Act. 7/2010 Coll. on flood protection and the institutions involved are organized at national (Ministry of Environment through Slovak Water Management Enterprise), provincial and local level.

The physical - geographic features of the Tisza River sub-basin on the territory of Slovakia are influenced by the specific relief, respectively lowlands and hillsides in the south of the area, and highlands and mountains in the central and northern part of the area. The largest part of the basin area lies at altitude of 300-500 m.a.s.l. and the smallest area takes up an altitude from 1000 to 1500 m.a.s.l. In the Tisza River Basin in Slovakia are following geological structures: neogene deposits with young vulcanite's, the older palaeozoic rocks, paleozoic rocks and Tertiary, represented by deposits of paleogene, neogene and neogeneous volcanites. The climate is temperate continental and soils are the ones from cernisole to spodisoil class. In the Tisza River Basin are 4 main watercourses with their tributaries: Slaná, Bodva, Hornád and Bodrog.

The population from Tisza River sub-basin is about 1502890 inhabitants that lives in 1175 municipalities. Economic activities comprise branches of industry and agriculture.

Regarding the protected areas, there are 5 National Parks, 9 protected areas, 13 protected bird areas and 118 areas of European interest.

The cultural heritage consists of 3819 national cultural monuments, 5 spatial cultural and historical units, 9 monument zones, 4 monument reservations, 5 World Heritage Sites.

Flood protection infrastructure is constituted mainly from dykes (784,32 km), most of them built for maximum discharges of 1% probability of exceeding, 13 permanent reservoirs (with a total volume of about 660 mn. m^3), 6 polders (with a total volume of about 54,4 mn. m^3), 25 pumping stations and 1 hydraulic complex facility.

In the Slovak part of the Tisza River Basin there are 14 drainage systems in total. Their primary function is the removal of internal waters. The drainage system in the Tisza River Basin has a flow capacity of 1,6 to 18,9 m3/s.

The most important floods that occurred in Tisza River sub-basin were the ones from 1395, 1813, 1845, July 1998, July 2004, May 2010 and June 2010, the source of flooding being fluvial, pluvial and groundwater (in 2010). The areas with potential significant flood risk were designated at locality level and resulted a total number of 222 river sectors. There are two types of areas with potential significant flood risk: with an existing potentially significant flood risk (195) and with a probable occurrence of potentially significant flood risk (27).

Flood hazard maps, resulted after mathematical hydrodynamic modeling of steady and unsteady flow, were elaborated for the geographic areas in which the preliminary flood risk assessment identified the existence of a potential significant flood risk and for areas where probable occurrence of significant flood risk can be assumed. On the maps is displayed the flood range, which could cause floods with an average return period from once in 5 years to once in 1000 years, or other flood with an exceptionally dangerous.

Flood risk maps contain data of potential negative consequences of floods, which are displayed on flood hazard maps. On the maps are mentioned data about estimated number of potential affected inhabitants by floods and other economic activities in flood potential endangered areas.

In the Fifth National Communication of the Slovak Republic on Climate Change, the results of the modeling according to the CCCM97 scenario shows that it is possible, despite the possibility of increasing the amount of precipitation, to expect a decrease in runoff from the whole area of Slovakia.

Bilateral agreements regarding the water resources management have been signed with Hungary and Ukraine.

Flood risk management issues in **Hungary** are the responsibility of the General Directorate of Water Management (OVF) under the direction and supervision of the Ministry of Interior. The OVF supervise and coordinates the 12 Regional Water Directorates.

The physical - geographic features of the Tisza River sub-basin on the territory of Hungary are influenced by the specific relief, which has two major relief forms: the lowland section, characterized by a very low altitude (78-140 m.a.s.l.) and poor morphological fragmentation, and, in contrast, the mountainous regions, with relatively high altitudes. This river basin has the lowest (Szeged-Gyálarét – 75.8 m.a.s.l.), and the highest (Kékes – 1014 m.a.s.l.) points in Hungary. In the Tisza sub-basin dominate are the lofty sedimentary rocks in the top 10 m caprock formations. The most sedimentary rocks are clay and sand and between the Danube and Tisza are located the most blown sand.The climate is temperate continental and the predominant soils are the ones from cernisole class. Major tributaries of the Hungarian section are: Túr (Tur), Szamos (Somes), Kraszna (Crasna), Bodrog, Sajó (Slaná), Zagyva, Körös (Crus) and Maros (Mures). The distribution system (TIKEVIR) built on the Tisza River Basin supplies water from

the Tisza to the Körös. This system can supply the Jászság, the Nagykunság, and a part of the region between the Körös and Maros river with water for irrigation, and also for the ecological water supply of the Körös River.

The population from Tisza River sub-basin is about 4048562 inhabitants, the population density being 87.3 persons/km^2. In the northern regions of the sub-basin, the industry is much larger, whereas agriculture in the southern regions is the driving force.

Regarding the protected areas, there are 5 National Parks and there are several significant landscape protection areas.

Hungary has 8 World Heritage Sites, and 4 of these are located on the Tisza River basin: the Caves of Aggtelek Karst, the Hortobágy National Park, the Old Village of Hollókő and its surroundings, and the Tokaj Wine Region.

Flood protection infrastructure is constituted mainly from dykes. There are 2942, 9 km length flood protection dyke along the Tisza River, 2826 km of which is lack of height. It means that 96 % of the Tisza valley's flood protection dykes don't reach the designed flood water level and the safety. There are also one permanent reservoir, Tisza-tó, 11 temporary reservoirs, 11 polders with a volume >1 mn. m^3, 3 diversion cannals and 2 hydraulic complex facilities. The Tisza–Körös Valley Management System (TIKEVIR) is a system of natural watercourses, dams, sluice gates, inter-basin diversion canals transferring and distributing water resources of the Tisza–Körös rivers over an area of 15000 km^2. The average inflow to the system is 680 m^3/s, while the summer low flow is 157 m^3/s. The permitted intake from the Tisza is 114 m^3/s, although the actual annual average intake is about 25 m^3/s. The flow rate is managed or controlled to some extent, as water systems are partially regulated.

In the Tisza River Basin there are 59 main drainage systems, 17704 km of canals, which are operated in exclusive state ownership. There are 395 inland water pump stations in the Tisza River valley.

The catastrophic floods of the last decades have been caused not only by the major Tisza river, but also by its tributaries. High water stages during the last 15 years in the catchment area of the Tisza River proved to be critical in 1998, 1999, 2000, 2001, 2006 and 2010.

During the flood mapping process there were prepared terrain models and 2D hydrodynamic models for 120 floodplains. In Hungary, for the total of 745 flood protection dyke breaking points in eight designed areas (three designed areas are located in Tisza River Basin) 1367 scenarios were calculated. During the 2D hydraulic modeling process the Mike 21 FM HD model was used for 50 m x 50 m square grid. The result of the 2 D hydraulic modeling consisted in the inundation maps. MIKE 21 FM models were used for modeling the unprotected floodplains. 1‰, 1 %, and 3 % probability flood hazard maps were reported to EC.

The risk maps are produced in 50 m x 50 m square grid. The flood risk assessments were expressed as financial risk (resulted an amount of financial risk of 136343 million HUF/year), human life risk, evaluation of cultural heritage (an area of 8288 ha containing cultural heritage may be affected) and environmental effects (30 floodplains of 10435 ha may be affected).

The General Directorate of Water management assessed the impacts of climate change on floods. In the Tisza River basin the annual run-off is decreasing, the flood events are more frequent. Another result of the climate change is the increasing frequency of high intensity of rainfall events, which increase the local water damage events. Regarding the degree of uncertainty of the analysis, the impact of climate change on the smaller streams and the flash floods seem clear, but for larger rivers have there is a greater risk uncertainty.

Bilateral agreements regarding the water resources management have been signed with Slovakia, Ukraine, Romania and Serbia.

Flood risk management issues in **Serbia** are regulated by the Water Law and the institutions involved are organized at national (Ministry of Agriculture, Forestry and Water Management through Republic Directorate for Water), provincial and local level.

The physical - geographic features of the Tisza River sub-basin on the territory of Serbia are influenced by the specific relief of the plain area, with low altitude planes overlaid over loess and wind sands, with temperate continental climate and soils predominantly of the cernisole class. The main tributaries of Tisza are those on the left bank coming from Romania – Old Bega and Bega Channel, the right bank tributaries having small catchments and almost all are incorporated into the Danube-Tisza-Danube Channel System (DTD).

The population from Tisza River sub-basin is about 856000 inhabitants, the majority living in settlements with less than 5000 inhabitants. The main economic activity is agriculture.

Regarding the protected areas, there are 1 National Park, 2 Nature Parks, 1 Area of Exceptional Features and 5 Special Nature Reserve.

The cultural heritage consists of 266 monuments of culture, 5 spatial cultural and historical units, 11 archaeological sites and 5 famous sites.

Flood protection infrastructure is constituted mainly from dykes built for maximum discharges of 1% probability of exceeding and from the DTD, which interconnects the rivers in Vojvodina. The Dam on the Tisza River is the key structure in DTD and has an useful volume at the normal water stage of about 50 million m^3.

Drainage system is developed and contains 134 drainage systems and DTD serves as a primary infrastructure system.

The most important floods that occurred in Tisza River sub-basin after the dykes system development were the ones from 2000 and 2006. Most of the areas with potential significant flood risk are related to the state border with Romania and Hungary, and are considered as lines corresponding to river sectors.

Flood hazard and flood risk maps are to be developed taking into account that 2000 km^2 are situated in flood prone areas.

Estimation of the Climate Change impacts on floods has not been studied in details, a high level of uncertainty being associated with Climate Change effects on flood events. There are implemented and ongoing projects related to climate change impact on water resources.

Bilateral agreements regarding the water resources management have been signed in 1955 with Romania and Hungary.

3. FLOOD RISK MANAGEMENT OBJECTIVES AT TISZA RIVER BASIN LEVEL

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks states that member states shall establish objectives for the management of flood risk, for the areas, for which they conclude that potential significant flood risk exist or might be considered likely to occur.

There are many differences in the way for setting targets. One of the models is that the objectives should first be establish at national level and then detailed at the basin level/APSFR.

In general, two types of objectives can be identified: strategic and operational. The first objective relates to guiding principles, such as the principle of subsidiarity, the principle of solidarity, achieving synergy between the Water Framework Directive and the Floods Directive etc. The second objective refers, among others, to reduce new or existing risks and to minimize negative consequences.

Almost all countries define flood risk management objectives in terms of risk reduction (risk reduction for the population). Another relatively frequently used term is the achievement of a target level of protection (e.g. community protection at the flood with a 100-year return period).

The general recommendation is that the national/strategic objectives should be detailed in specific/operational flood risk management objectives, mainly to reduce the risk for APSFR areas, with "localized" measures at the level of APSFR as well as at the basin/hydrographic sub-basin level.

Tisza River Basin has an important impact in the Danube River Basin on all social, cultural, environmental and economic aspects, taking into account that is the largest sub-basin of the Danube River Basin and its longest tributary. Being aware of this importance and assuming the coordination role among the Danube countries including EU Member States, accession countries and other Danube riparian states, in the process of WFD and FD implementation, ICPDR has been very actively involved in sub basin planning activities.

Considering the contribution of Tisza river basin at the general perspective of Danube River Basin and the need to have an integrated and correlated strategy among the Danube countries, it has been agreed that Flood risk management objectives set out for the Tisza River Basin will have to follow the same objectives set out at level of Danube River basin, respectively:

- Avoidance of new risks;
- Reduction of existing risks;
- Strengthening resilience;
- Raising awareness;

- Solidarity principle.

Setting the same objectives for both international river basins can ensure the framework for a joint working effort of all riparian countries in achieving the same goals, who will eventually lead to reduction of the risk of adverse consequences for human health and life, environment, cultural heritage, economic activity and infrastructure associated with floods.

4. FLOOD RISK MANAGEMENT PROPOSED MEASURES FOR TISZA RIVER BASIN LEVEL

In order to facilitate the establishment of structural and non-structural measures, it has been used a catalogue of potential measures.

The measures proposed aim at five areas of action, closely related to the flood risk management cycle:

- **Prevention**
  - category of measure: legislative institutional, organizational measures and it includes measures like defining / improving the legal and technical framework for the implementation of Floods Directive, reviewing and updating flood risk management plans, coordinating territorial planning strategies with F.R.M.P. (in total 3 types of measures);
- **Protection**
  - categories of measures (examples: natural water retention measures - associated to watercourses, wetlands, and natural lakes, change or adaptation of land-use practices, structural protection measure – as new reservoirs development, development of diverting channels, local embankments, measures to increase population resilience, adaptation of the defence structures at the climatic changes, etc. (in total 11 types of measures);
- **Preparedness**
  - categories of measures (examples: measures regarding monitoring, forecasting and flood warning, activities of flood event preparedness exercise with interinstitutional participation, etc.); in total 4 types of measures;
- **Public Awareness**
  - one category of measures with the same name: measures to increase the awareness of the community and it includes adequate public activities of information and promotion of public participation, activities for education and training of the population; covers 2 types of measures;
- **Recovery**
  - categories of measures: emergency response actions, damage evaluation and recovery, improvement of post event documentation and analysis process, etc. (in total 3 types of measures).

There are 23 types of measures proposed; for each type of measure there is provided examples (the list not being exhaustive).

The measures (indicated in the Catalogue of measures) are classified into 3 categories depending on the level of implementation, as it follows:

- **measures implemented at national level** include measures with an essential role in flood risk management, which refer to current water sector legislation, those legislative provisions with impact in this domain (insurance scheme, legislative regulations of spatial and urban planning etc.) or which impose a system of best practices in order to reduce the negative effects of floods, studies, projects, programs, including know-how transfer and experience exchange in order to support implementation of the Flood Directive at catchment and national level, that also involves cooperation between authorities at central level (in areas such as emergency management situations, meteorology, etc.)
- **measures implemented at the catchment level (River Basin Authority) -** are related with organizational and technical solutions whose effect aim to improve flood risk management across the whole territory of R.B.A.
- **measures implemented/applicable at the level of APSFR -** are specific measures "located" either at the level of APSFR or, where appropriate, on the tributary or upstream catchment basin of the respectively sector, having in this situation an effect on sectors/areas with potential significant flood risk (APSFR).

5. SYNTHESIS OF THE MEASURES PROPOSED BY COUNTRIES

Since we are at the beginning of a new FD implementation cycle, Tisza river basin riparian countries will focus in the next period on the review and updating the methods and results used during the 1st FD implementation cycle, in each of the 3 stages. Legislative framework will benefit from the results obtained during the 1st FD cycle and some of the territorial planning strategies will have to be updated according to flood hazard and flood risk maps.

Some of the main issues that will be addressed during the next years are related to integration of flash floods analysis in the methodologies and studies that will support the implementation of FD and in the same time countries will try to take into account the impact of climate change over the flood risk.

Rehabilitation and maintenance of hydraulic flood defence infrastructure

Europe has an aging water infrastructure so the need for investment in water infrastructure is high and it has many reasons: deteroriation of existing infrastructure, spatial planning development, need for upgrading infrastructure in order to meet new standards or to consider the new emerging developments.

Upgrading of existing infrastructure in order to meet new standards and development cannot be on detriment of maintenance of the latter one. Most of the central and east European countries benefit from an infrastructure developed long before the 90's so there is a real need of investments on rehabilitation and maintenance of hydraulic flood defence infrastructure.

Monitoring, forecasting and flood warning

In the integrated or total flood warning system approach, all components need to be improved if the ultimate aim of minimizing risks to people and property is to be achieved (e.g. Emergency management Australia 1999; Andryszewsky et al. 2005). Post event reviews, continuous development of technologies and the need to adapt to the new challenges (e.g. Flash flood forecast and warning) leads to a countries effort to develop the monitoring, forecasting and flood warning systems.

Involvement, information and education of the public

Public involvement plays an important role in the implementation of all the water related directives, since water it's the most precious resource of our planet. By involving members of the public in the implementation process of all water related directives, and Floods Directive into detail, it becomes more relevant the people's needs and concerns related to the subject that we are addressing. Informing the public about the results achieved during the implementation of the directive raises the confidence into state public institutions and increases also the public awareness. Involvement of the public contributes to development of different easily to follow and understandable communication platforms that support the information transfer.

Table 2. ***Proper information and education of the public contributes to understanding of the technical language and how the communities act before, during and after a flood event takes place***

Field of action	Measure Category	Code Type - Tisza River Basin	Type of measure
Prevention	Organizational measures	TISZA_M01	The definition of a legislative, organizational and technical framework for Floods Directive implementation
		TISZA_M02	Reviewing and updating plans for flood risk management
		TISZA_M03	Coordination of territorial planning strategies (plans for development of planning at national, county and regional and urban plans (Regional/Urban/Zonal/Plans) with plans for flood risk management
Protection	Natural water retention measures - associated to watercourses, wetlands, natural lakes, in accordance with Directive 2000/60 /EC	TISZA_M04	Measures to restore retention areas (flood plains, wetlands etc.)
	Change or adapt land use practices (partial recovery of ecosystem functions or structures modified by changing	TISZA_M05	Natural water retention measures in urban areas

	or adapting land use practices) in urban areas		
	Change or adapt land use practices (partial recovery of ecosystem functions or structures modified by changing or adapting land use practices), in agriculture	TISZA_M06	Natural water retention measures by changing or adapting land use practices in agriculture
	Change or adapt land use practices (partial recovery of ecosystem functions or structures modified by changing or adapting land use practices) for forest management	TISZA_M07	Natural water retention measures by changing or adapting land use practices in forest management
	Other water retention measures	TISZA_M08	Other measures to reduce water levels
		TISZA_M09	Measures to improve retention capacity at the level of river basin by creating polders and small retention reservoirs (made in the upper part of the river basin)
		TISZA_M10	Measures to improve retention capacity at the level river basin by increasing the safety of existing large dams / increasing the attenuation capacity of reservoirs towards projected capacity
		TISZA_M11	Structural protection measures (planning and accomplishing)
	Measures for increasing population resilience	TISZA_M12	Measures for increasing resilience of population (Implementation and adaptation of protection measures at multiple objectives - buildings, constructions)
	Inspection measures and maintenance of watercourses and of the hydraulic flood defence infrastructure	TISZA_M13	Surveillance, behaviour monitoring, expertise, strengthening interventions, rehabilitation and maintenance of watercourses and hydraulic flood defence infrastructure
	Adapting of the existing defence structures at climate change conditions	TISZA_M14	Adapting of the construction, infrastructure and existing defence structures in terms of climate change
Public awareness	Measures to increase community awareness	TISZA_M15	Activities regarding adequate public information and promotion of the public participation
		TISZA_M16	Education / training activities of the population
Preparedness	Preparedness measures /Improvement preparedness to reduce the adverse effects of	TISZA_M17	Measures for monitoring, forecasting and flood warning
		TISZA_M18	Development / reviewing of the flood defence plans in correlation with other

	floods		emergency situation management plans General Inspectorate for Emergency Situations (GIES)
		TISZA_M19	Simulation exercises activities involving interinstitutional parties
		TISZA_M20	Providing the human, financial and materials needed in emergency situation and stimulating the voluntary
Response and Recovery/ Reconstruction	Post event recovery measures	TISZA_M21	Response actions in case of emergency situations
		TISZA_M22	Damage assessment and restoration
		TISZA_M23	Documentation and Analysis

There is a graphical representation with the number of measures proposed by each country according to measure code types established in the catalogue of potential measures (Fig. 2).

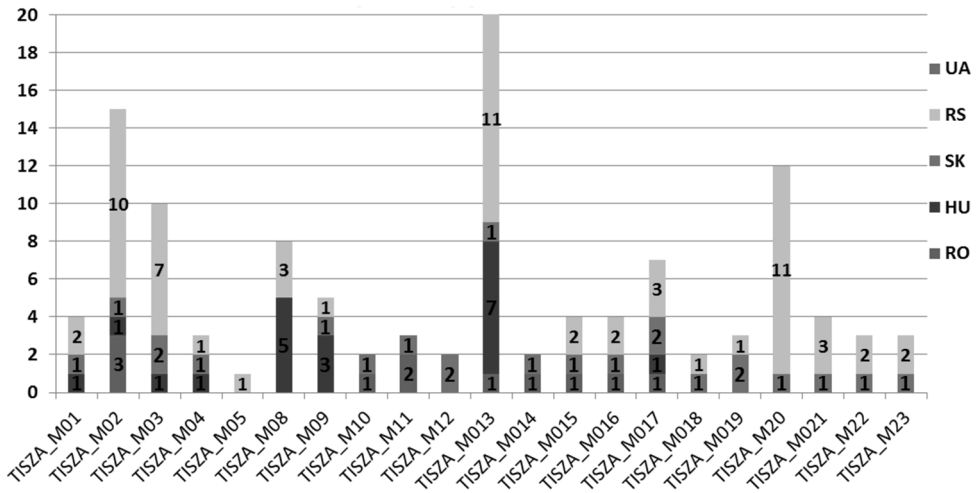

Fig. 2. ***Number of measures proposed by each country according to measure code types***

The outcomes regarding flood management at Tisza basin level will be issued in the framework of the Working Package 5 and then will be included in the Synthesis (Working Package 6) for the main output of the project, the 2-nd Tisza Integrated River Basin Management Plan.

REFERENCES

1. http://www.interreg-danube.eu/approved-projects/jointisza
2. Jointisza - Application Form submitted in 2016;
3. Jointisza Working Package 5 reports (made from countries reports)
4. Jointisza project Leaflet;
5. 1st Integrated Tisza River Basin Management Plan -2010