ISSN 2070-1292

danube news

Bulletin of the International Association for Danube Research (IAD)
Informationsblatt der Internationalen Arbeitsgemeinschaft Donauforschung (IAD)

donau aktuell

Tributaries of the Danube I: Sava – Waterway and ecosystem?

Editorial

Dear Reader

We all know that the Danube River, second largest river in Europe, is something very special, given the 9 riparian countries and the 19 countries sharing the basin with its unique delta. The Danube is fed not only by its source in the Black Forest, but also by numerous small and large tributaries. In Liepolt's Danube monograph "Limnologie der Donau" (1967), Lászlóffy provides an impressive graph of mean discharge of the Danube and its tributaries. In the Middle Danube, the Sava and Drava, both from the right side, as well as the Tisza from the left side, are by far the most significant tributaries. With respective mean discharges of 1800, 622 and 920 m^3/s, the three rivers contribute about 40%, 28% and 27% to the main river, thus enlarging the Danube considerably. Within about 220km of Danube length, these three tributaries alone double the size of the main river. Therefore, I think it is time to dedicate "Danube News" to the Sava, Drava and Tisza Rivers; starting the trilogy now, No. 24 is featuring the Sava.

When I was traveling for the first time, in 2000, from Novi Sad to Sarajevo, I could visualize the nice old stone bridge over the Drina (Bosnia and Herzegovina, Serbia) that was immortalized by the famous book of Nobel Prize winner Ivo Andrić and now is an UNESCO world cultural heritage *(Figure 1)*. The wild mountainous region was a fascinating experience with regard to inherent natural beauty of the riverine landscape, history and local people. Some hours southeast of Zagreb, the bizarre calcareous tufa formations and the turquoise color of the karstic Plitvice Lakes (Croatia) offer another breathtaking highlight. The nature reserves in the Sava River Basin provide still intact large floodplains and high biodiversity. The majesty of the Lower Sava River can be felt when seeing a beautiful sunset from the "castle hill" of Belgrade. Could all this and much more be a sign of the great potential for transboundary ecotourism in the Sava Basin – and a truly sustainable alternative to economic pressures such as navigation and hydropower?

Figure 1. *The famous Bridge over the Drina, a major tributary to the Sava River (Višegrad, BiH). It became immortal through the book of Ivo Andrić and still is a strong symbol of transboundary conflicts and cooperation. Photo from Internet by j.budissin (Julian Nitzsche), 20 August 2007*

The conflict of interest between protecting ecosystems and promoting water use and economy is particularly important in near natural riverine landscapes such as the Sava River Basin. Since 2005, this basin is managed by the International Sava River Basin Commission (ISRBC) as the coordinating and implementing body in the framework of the ICPDR and EU WFD. A major issue is the harmonization of national regulation and transboundary cooperation to balance nature protection and use. However, the illustrated harmony may not properly reflect the real situation of threatened ecosystems. The articles dealing with biodiversity, management, navigation, nature reserves and pollution may help readers develop their own opinion about progress and success of the implementation of the Sava River Basin Management Plan. Some skepticism is justified with regard to preventing/mitigating human impacts in the large and valuable floodplains with their outstanding ecosystem services.

Jürg Bloesch, Editor
e-mail: bloesch@eawag.ch

Overview of the Sava River Basin (SRB)

Momir Paunović: University of Belgrade, Institute for Biological Research, Belgrade, Serbia; e-mail: mpaunovi@ibiss.bg.ac.rs
Samo Grošelj: International Sava River Basin Commission, Zagreb, Croatia; e-mail: sgroselj@savacommission.org

Introduction

The Sava River Basin (SRB) covers an area of 95,719 km^2 and is situated in the southern part of the Danube Basin *(Figure 1).* Together with its tributaries, this 940 km long watercourse represents a mighty river system. The Sava flows from western mountains in Slovenia, throughout lowlands of Croatia, Bosnia and Herzegovina, and Serbia, joining the Danube in Belgrade (river km 1171, elevation about 71 m a.s.l.). According to average discharge (1,513 m^3/s at station Sremska Mitrovica, about 100 km from the confluence to the Danube – ISRBC 2009), it is the largest tributary of the Danube. Further, by catchment area, the Sava is the second largest sub-basin of the Danube after the Tisa River Basin. The SRB is shared by Bosnia and Herzegovina (40.0 % of the basin area), Croatia (26.0 %), Serbia (15.4 %), Slovenia (11.0 %), Montenegro (7.5 %), and Albania (0.1 %). About 8.8 million people live in the basin. Navigation is possible on > 50 % of the Sava River, from the mouth up to the Kupa confluence (Croatian section).

Basic characteristics of the SRB – the diversity of natural features

The SRB is heterogeneous concerning overall environmental conditions. Due to the geographic position, diverse climate, petrographic and pedological variety, and orographic characteristics, it is one of the most complex regions in Europe concerning the distribution of plants and animals (Lopatin & Matvejev 1995). (Palaeo)historical factors strongly influenced the migration of flora and fauna in glaciation/interglaciation periods.

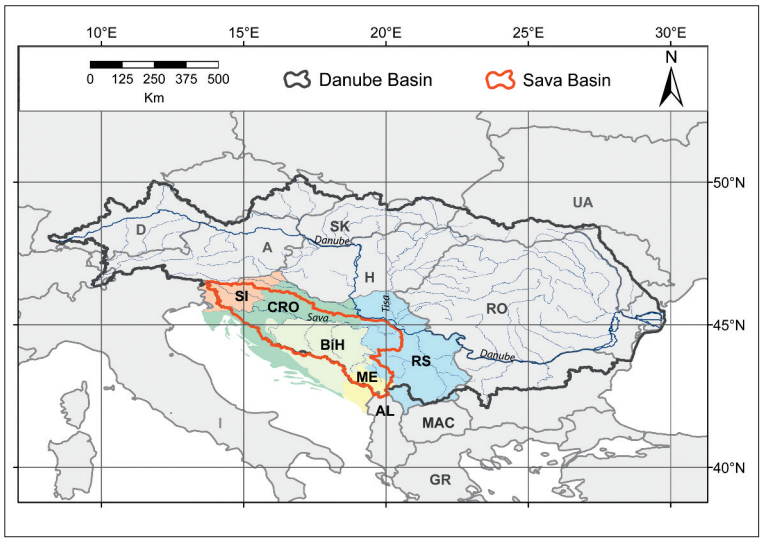
The Sava River catchment is characterized by the dominant moderate climate of the northern hemisphere with distinct mountainous climate zones. In general, the region features pronounced cold and hot seasons. Average annual air temperature for the whole Sava Basin is about 9.5°C, with mean monthly temperatures between –1.5 (January) and 20°C (July). Precipitation shows variable temporal and spatial distribution. Average annual rainfall over the SRB was estimated at about 1,100 mm.

The elevation of the SRB with a mean of 545 m a.s.l. ranges between 71 m at the mouth of the Sava River in Belgrade (Serbia) and 2,864 m (Triglav, Julian Alps in Slovenia). The general character of the relief is illustrated in *Figure 2*. Mountainous relief dominates in the upper basin (Slovenia) and in the southern basin. The hilly-mountainous relief is situated in the Dinaric area in Croatia, and Bosnia and Herzegovina, with mountains up to 2,500 m, Montenegro (peaks higher than 2,500 m – Bobotov Kuk, Durmitor Mountain) and Northern Albania. A significant part of the Drina Basin (together with the Lim and the Uvac catchments) in Serbia, Bosnia and Herzegovina, and Montenegro is characterized by a hilly-mountainous relief. The northern part of the Sava Basin is situated in the Pannonian Plain, an area dominated by fertile, agricultural land. According to CLC (Corine Land Cover) database for the SRB, forests and semi-natural areas dominate within the basin (55 %), but agricultural areas are also abundant (42 %).

Due to diverse geological substrate, relief, vegetation cover and climate conditions, the SRB is characterized by different soil types. According to the FAO/UNESCO classification system, Cambisols dominate within the SRB (mostly Eutric Cambisols on limestone and Dystic Cambisols, while Eutric Cambisols on Loess are limited to smaller areas). Leptosols, Luvisols and Podzoluvisols are also abundant, while Pheozems, Fluvisols, Gleysols and Chernozem are restricted to specific parts of the SRB – for details see ISRBC (2009).

The Sava rises from the Sava Dolinka (source at 833 m a.s.l., total length about 45 km) and the Sava Bohinka (source at 805 m a.s.l., total length 31 km). The largest tributaries of the Sava River are the Drina (basin area 20,319.9 km^2, length 335.7 km), the Bosna (10,809.8 km^2, 272 km), the Kupa/Kolpa (10,225.6 km^2, 118.3 km), the Una (9,828.9 km^2, 157.2 km) and the Vrbas (6,273.8 km^2, 235 km) Rivers. Besides, 11 tributaries of the Sava River have a basin area larger than 1,000 km^2 – Ljubljanica, Savinja, Krka, Krap-

Figure 1. The geographical location of the Sava River Basin within the Danube River Basin



ina, Lonja, Ilova, Orljava, Ukrina, Tinja, Drinjača, Bosut and Kolubara.

In general, the Sava River can be divided into three geomorphological units: the Upper, the Middle and the Lower Sava. The Upper Sava is characterized by a steep slope, torrential tributaries and domination of coarse fractions in bottom substrate. Hilly mountain terrain dominates. The reach is 265 km long (incl. Sava Dolinka, the longer headwater). The Upper Sava catchment is characterized by diverse environmental conditions and consequently a complex biogeographical feature, which is illustrated by three coexisting ecoregions nos. 4 (Alps), 5 (Dinaric western Balkan), and 11 (Hungarian lowlands) (Illies 1978). The Middle Sava is characterized by a moderate slope and flows through lowland landscape. Pebbles and gravel dominate mostly the bottom substrates. It is the shortest geomorphological unit (129 km long). Further downstream at Sisak, at the confluence of the Una River, general changes in bottom characteristics from gravel to fine sediments determine the border between the Middle and the Lower Sava River. The Lower Sava is the longest (597 km) geomorphological unit. This section of the Sava River is a typical lowland watercourse: it is located within the plains, with a slope of 0.098 ‰; the width of the river corridor is up to 1,000 m with relatively large depositions dominated by small fractions of sand and silt. The Middle and the Lower Sava are situated within ecoregion 11.

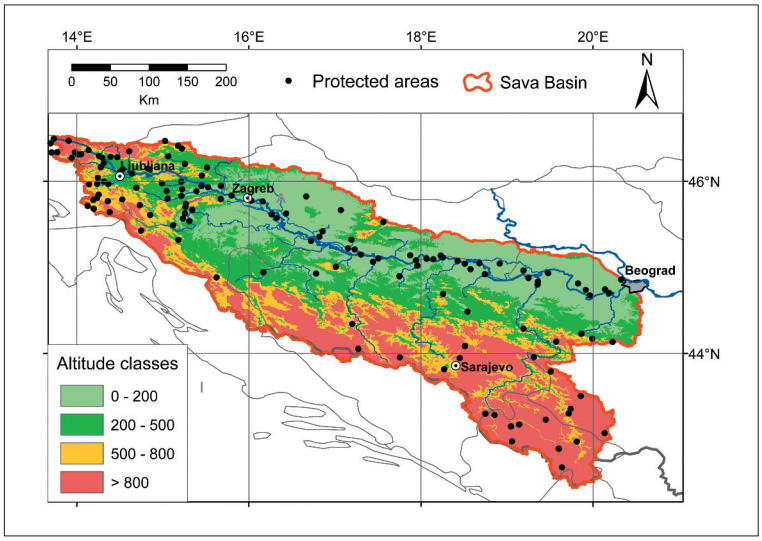


Figure 2. The relief of the Sava River Basin and location of areas/sites designated for biodiversity and habitat conservation

Biodiversity

Despite evident changes and considerable anthropogenic pressure, the SRB still covers large areas with high potential for biodiversity conservation. Floodplains along the Sava River are of major conservational value and one of the hotspots of biodiversity in the region; this can be illustrated by the fact that 49 sites of importance for biodiversity conservation have been identified along the river corridor (Anonymous 2009). Besides, there are eight National Parks within the SRB (Triglav, Plitvice, Sutjeska, Kozara, Una, Tara, Durmitor and Biogradska gora) with a total area of 215,563.5 ha and seven RAMSAR sites (areas designated according to The Convention on Wetlands of International Importance especially as Waterfowl Habitat, RAMSAR 2011): Bardača Wetland (BA), Lonjsko Polje and Crna Mlaka (HR), Obedska Bara, Zasavica and Peštersko polje (RS) and Cerknica Lake (SI), with a total area of 71,673 ha. The Plitvice Lake National Park has been selected for UNESCO World Heritage site in 1979. The preliminary list of water relevant protected areas within the SRB comprise 165 sites larger than 100 ha, with a total area of >18,200 km^2 (*Figure 2*; Paunović 2011).

The significant taxa richness has been documented for fish, aquatic macroinvertebrates and birds (Sommerwerk et al. 2009). More than 55 fishes, including the sterlet *(Acipenser ruthenus),* are found in the Sava (Mrakovčić et al. 2006). For the Serbian river section, 62 macroinvertebrate species have been recorded (Paunović et al. 2008). Thus, only within the Nature Park "Lonjsko Polje" (inundation area in the Middle Sava which is the largest remaining floodplain in the entire Danube Basin – 510 km²) more than 35 fish and 43 dragonfly (Odonata) species have been identified. The Nature Park provides breeding habitats for 22 bird species, among them are rare birds such as the ferruginous duck *(Aythya nyroca),* white-tailed eagle *(Haliaeetus albicilla)* and corncrake *(Crex crex)* (Schneider-Jacoby 1994). The effort of numerous institutions focused on various aspects of biodiversity research and conservation within the SRB (see article by Erg & Dimović).

Main pressures

The key drivers exerting significant pressure on aquatic ecosystems in the SRB are agriculture (agrochemicals, pesticides, and pollution from pig and poultry farms), urbanisation, industry (metallurgical, chemical, leather, textile, food, cellulose and paper industries – Jovičić et al. 1989), solid waste disposals, hydropower, navigation and flood protection. Thermal pollution from conventional power plants (e.g. Nikola Tesla, Obrenovac, Serbia) and a nuclear power plant (Krško in Slovenia) occurs along the Sava. Since 2007, the Waste Water Treatment Plant (WWTP) of Zagreb contributes significantly to reduce pollution (see article by Ahel et al.).

International cooperation and SRB management

Proper understanding of complex large river systems such as the SRB is important for effective water management, including the protection of aquatic ecosystems. Ecosystem services and anthropogenic use must be balanced. In particular, the upstream impacts in the river and landscape will affect downstream sites in a transboundary context.

Numerous efforts were taken to investigate the Sava River and its tributaries (Anonymous 2009, Sommerwerk et al. 2009) and to provide data for effective water and nature conservation management within the region. Among other international initiatives, the Framework Agreement for the Sava River Basin (FASRB) is probably one of the most important. The FASRB was signed in 2002, ratified by the Sava Countries in subsequent years and finally entered into force at the end of 2004. The agreement comprises co-operation in water management, including water protection, and its implementation is coordinated by the International Sava River Basin Commission (ISRBC) with Permanent Secretariat as an executive body (see the following two articles by Komatina). An outstanding example of joint efforts by Sava Countries was the project "Protection of Biodiversity of the Sava River Basin Floodplains" (Anonymous 2009) aimed to support the development of a comprehensive ecological network of protected sites.

The perspective

The SRB is currently in focus of efforts aiming to improve the water related management systems (Anonymous 2009; Sommerwerk et al. 2009; Project "Technical assistance in the preparation and implementation of the Sava River Basin Management Plan" – Ref. No. Europe Aid/128277/ C/SER/Multi). This includes the implementation of the EU Water Framework Directive (WFD 2000) and numerous scientific programs. Hence, improvement of water and biodiversity status can be expected in the future. The pace of improvements strongly depends on the socio-economic situation in the region, and the changes must be monitored systematically. Thus, the River Basin Management Plan, defined by the EU WFD, as well as the national legislation recently adopted by the SRB countries could be an effective tool for successful water related management within the SRB.

References

Anonymous (2009): Protection of Biodiversity of the Sava River Basin Floodplains Sites Important for Biodiversity along the Sava River. LIFE 3rd Countries Project, Swiss SDC, Dutch BBI/Matra and the project partners

Illies J (Ed) (1978): Limnofauna Europaea. Gustav Fischer Verlag, 532 pp

ISRBC (2009): The Sava River Basin Analysis. International Sava River Basin Commission, Zagreb

Jovičić M, Bogdanović B, Popović L, Marjanović Z, Marjanović N (1989): Prognoza kvaliteta vode reke Save, In: Zbornik radova, Savjetovanje "Rijeka Sava- zaštita i korišćenje voda" (Ed. M Mešstrov), 373–377. JAZU, Zagreb

Lopatin IK, Matvejev SD (1995): Kratka zoogeografija sa osnovama biogeografije i ekologije bioma Balkanskog poluostrva. Knjiga 1, Univerzitetski udžbenik, Ljubljana. 166

Mrakovčić M, Brigić A, Buj I, Čaleta M, Mustafić P, Zanella D (2006): Crevena Knjiga Slatkovodnih Riba Hrvatske. Ministarstvo Kulture, Zagreb

Paunović M (2011): Protected areas in the Sava River Basin - Background paper. The results of the Technical assistance in the preparation and implementation of the Sava River Basin Management Plan (Ref. No. EuropeAid/128277/C/SER/Multi)

Paunović M, Borković SS, Pavlović SZ, Saičić ZS, Cakcić PD (2008): Results of the 2006 Sava Survey – aquatic macroinvertebrates. Archives of Biological Science, Belgrade 60(2): 265–271

RAMSAR Site Database: A directory of wetlands of international importance – http://ramsar.wetlands.org/Database/ – last accessed July 4 2011

Schneider-Jacoby M (1994): Sava and Drava – Ecological Value and Future of the Two Main Rivers in Croatia. Periodicum Biologorum, Vol 96, 4, pp. 348-356

Sommerwerk N, Hein T, Schneider-Jacoby M, Baumgartner C, Ostojić A, Paunovic M, Bloesch J, Siber R, Tockner K (2009): Chapter 3, The Danube River Basin, pp. 59–112 In: Tockner K, Uehlinger U, Robinson CT (eds), Rivers of Europe. Elsevier, Academic Press, San Diego

WFD (2000): Water Framework Directive – Directive of European Parliament and of the Council 2000/60/EC – Establishing a Framework for Community Action in the Field of Water Policy

The Framework Agreement on the Sava River Basin – a basis for sustainable development of the region

Dejan Komatina: Secretary of the International Sava River Basin Commission; e-mail: dkomatina@savacommission.org

The Sava River is the richest-in-water tributary of the Danube with an average contribution of 25% to the total Danube flow, and creates the second largest sub-basin sharing 12% of the Danube River Basin. The Sava River Basin (SRB) is known for its high environmental and socio-economic values. On the one hand, it is associated with a natural beauty all over the basin, an outstanding biological and landscape diversity (represented by numerous natural wetlands, nature parks and protected areas) and large retention areas along the river *(Figures 1 and 2).* On the other hand, there is a high potential for development such as waterway transport of cargo and passengers, hydropower generation, tourism and recreation, as well as other activities related to the use of water. A balanced approach to using this potential and preserving these values simultaneously is applied by the International Sava River Basin Commission (ISRBC).

Framework for cooperation

The political changes in the region of former Yugoslavia in the 1990s, which turned the Sava River from the largest national river into an international river, substantially challenged water management in the SRB by seriously affecting its basic elements (hydrometeorological data exchange system, monitoring and early warning systems, etc.). Hence, the water management was confined to national level of the newly created countries, unlike the integrated river basin management approach emerging in Europe at the same time (EU Water Framework Directive). In the SRB, these changes have also caused a sharp decrease of economic activities such as navigation. In other parts of Europe, inland waterway transport has proven to be a competitive transport mode, being environmentally friendly and capable of reducing congestion on densely used roads. Since then, the Sava River has been hardly used for transport, for a number of reasons, including a lack of infrastructure maintenance and investments.

Figure 1. Mouth of the Drina River. Photo: Miroslav Jeremic

Figure 2. Lonjsko polje - Kratecko. Photo: Boris Krstinic

For these reasons, a new international framework became necessary to ensure sustainable use, protection and management of water resources in the SRB, and thus enable better life conditions and raising living standard in the region. After a process of negotiations, the *Framework Agreement on the Sava River Basin (FASRB 2002),* the first development-oriented multilateral agreement in the post-conflict period concluded in the region after the agreements on peace and succession, has been produced and signed in 2002. After its ratification in 2004, the International Sava River Basin Commission (ISRBC, www.savacommission.org), as an international organization with responsibility to coordinate implementation of the FASRB, has been established in 2005. There are four Parties to the FASRB – Bosnia and Herzegovina, Croatia, Serbia, and Slovenia. Contacts have been made with Montenegro, on possibilities for this country to become a Party, as well.

The overall objective of the FASRB is to establish and maintain the transboundary cooperation to provide conditions for sustainable development within the SRB. The particular objectives of the FASRB include (FASRB 2002):

- establishment of an international regime of navigation on the Sava River and its navigable tributaries;
- establishment of a sustainable water management in the basin including environmental protection, and
- management of hazards, such as floods, droughts, ice or accidents causing water pollution.

The FASRB integrates all aspects of water resources management, i.e. sustainability issues such as protection of water and aquatic ecosystem, as well as development issues associated with water use (navigation, hydropower generation, water supply, sewerage and drainage, fishery, tourism and recreation). Thus, the FASRB provides the ISRBC with the broadest scope of work among European basin organizations, making it responsible for coordination of the following activities:

- preparation and implementation of joint plans for the basin (e.g. river basin management plan, flood risk management plan);
- preparation of development programs for the basin (e.g. for navigation and tourism);
- establishment of integrated systems for the basin (Geographic Information System – GIS, River Information Services – RIS, flood forecasting and warning system, etc.);
- harmonization of national regulation with the EU regulation, and
- development of protocols for regulating specific aspects of the FASRB implementation.

Considerable attention of the ISRBC is paid to the issues of cooperation, public participation and stakeholder involvement. The ISRBC is given the capacity for making decisions in the field of navigation and providing recommendations on all other issues.

Approach to sustainable development

Since the beginning of the FASRB implementation, a wide range of activities have been undertaken or launched. In line with recent processes and initiatives on the Danube level (ICPDR et al. 2008, ICPDR 2009, 2010) and the European level (EC 2010a,b), an updated *Strategy on Implementation of the FASRB* (ISRBC 2011a) and the accompanying *Action Plan for the Period 2011–2015* (ISRBC 2011b) have been developed to govern future implementation.

Based on the *Sava River Basin Analysis Report* (ISRBC 2009), the key activity in **river basin management** (RBM) is the preparation of the first *Sava RBM Plan* in accordance with the *EU Water Framework Directive* and with financial support of the EC. To ensure an integrated approach from the very beginning, issues such as flood management and navigation development were addressed already in the Sava River Basin Analysis. Following the drafting schedule and the public consultation process, the *Sava RBM Plan* is expected to be finalized and adopted in 2012. In addition to these activities, the *Protocol on Sediment Management to the FASRB,* aiming to regulate the sediment management issues in accordance with the *RBM Plan*, has been drafted and entered the process of harmonization by the Parties, while the *Protocol on transboundary impact to the FASRB* is under development on the ISRBC level.

In the field of **flood management**, the *Flood Action Plan* for the SRB has been prepared in accordance with the *Flood Action Programme for the Danube River Basin* of the ICPDR, providing the first program of measures for each Party to achieve the defined targets for flood management in its part of the SRB until 2015. The *Protocol on Flood Protection to the FASRB,* which aims to provide the legal basis for cooperation of the Parties in line with the *EU Flood Directive,* including the preparation of the *Flood Risk Management Plan* for the SRB, has been developed and signed, and is currently under ratification.

For the purpose of an efficient **accident prevention and control** in the SRB, the ISRBC participates in continuous testing of the existing Accident Emergency Warning System of the ICPDR. Efforts are being made to improve the work of the Principal International Alert Centers (PIAC) in the Parties to the FASRB, including the organization of training courses for the operational staff of the PIACs, in cooperation with the ICPDR. The *Protocol on Emergency Situations to the FASRB* has been drafted and entered the process of harmonization by the Parties. As an important future activity, development of a water contingency management plan for the basin is planned.

Significant efforts are being invested into development of **economic activities** in the SRB such as navigation or tourism. **Navigation development** was initiated by the *Protocol on the Navigation Regime to the FASRB* that is the basis to rehabilitate the Sava River waterway in an environment-friendly and navigation-safe way (see article on Sava River navigation). Given that **hydropower development** is considered an important issue in the SRB, the ISRBC joined the process recently launched by the ICPDR with the aim of developing guiding principles on integrating environmental aspects in the use of existing hydropower plants, as well as in the planning and construction of new plants (ICPDR 2011).

Being aware of the great potentials for **development of tourism** in an environmentally friendly manner, the first *Nautical and Tourist Guide of the Sava River* has been developed in cooperation with regional chambers of commerce of the Parties (ISRBC 2011c); the preparation of a master plan for the development of nautical tourism in the basin is planned as the next step. To provide additional support to economic development in the region, the preparation of a project on fostering the **contribution of small and medium enterprises** to sustainable development of the SRB has been initiated, targeting not only river transport and tourism, but also other economic activities (food production, small hydropower plants, fish farming, shipbuilding, etc.).

Considerable attention is paid to **cross-cutting issues** supporting the FASRB implementation – information management, and hydrological and meteorological issues. In the information management, the *Sava GIS Strategy* has been developed taking into account the *EU INSPIRE Directive* and the Water Information System for Europe, and the initial phase of implementation has been launched, with the plan to be finalized in 2012. Advances in the exchange of hydro-meteorological information and data within the basin have been made, including a revival of the *Hydrological Yearbook of the Sava River Basin* after more than 20 years. Two important projects are in a preparatory phase, namely a new *Hydrological Study for the Sava River Basin,* and the development and upgrade of the hydro-meteorological information system and the flood forecasting and warning system in the basin.

Cooperation of the ISRBC with a large number of international organizations and national institutions such as agencies, offices, services, institutes and universities has been established and maintained. The basis for cooperation with the ICPDR and Danube Commission has been strengthened by signing memoranda of understanding on cooperation with each of the two organizations. The EC and UNECE (United Nations Economic Commission for Europe) support to FASRB-related projects is becoming steady and their recognition of several priority projects of the ISRBC in the context of the *EU Strategy for the Danube Region (EUSDR)* indicates a good will for continued support.

To ensure **public participation and stakeholder involvement** in the FASRB implementation, cooperation with NGOs and other institutions and local actors from the SRB has been established by creating a network of observers to the ISRBC. A number of mechanisms for information and consultation of stakeholders and/or wide public are available, including the official web-site (www.savacommission.org), the *Sava NewsFlash* bulletin, publications and promotion material of the ISRBC, celebration of the Sava Day (June 1), press releases, press conferences and media briefings, as well as the organization of consultation workshops, public presentations and other meetings with stakeholders. Keeping in mind that mainly the stakeholders from governmental and non-governmental sectors have been involved so far, the new *Strategy on Implementation of the FASRB* guides to further improve and broaden stakeholder involvement, and to seeking a synergy of a top-down and a bottom-up approach. Thus, special attention will be dedicated to exploring possibilities and elaborating options for the establishment of a multi-stakeholder platform that would facilitate and further strengthen the involvement of the civil, academic and business sectors.

Relevance of the approach

Past experience in the FASRB implementation shows that the ISRBC approach is:

- cohesive, by providing conditions for the cooperation of the countries after a conflict, the implementation of joint, basin-wide projects, as well as the harmonization of national regulation, methodologies and procedures;
- integrated, not only in terms of the geographical scope (covering the whole basin and the ecosystem), but also in

terms of the scope of work (both sustainability and development elements included);
– transparent, as it is based on a number of public participation and stakeholder involvement activities;
– aligned with relevant EU and UNECE regulation;
– sub-regional, offering a "finer resolution" of results that are complementary to those obtained on a regional scale;
– pragmatic and practical, providing concrete "products" to the Parties, such as joint plans, development programs, protocols, harmonized regulation, integrated systems, etc.

The approach is considered relevant to the processes on a wider (Danube and EU) scale, such as those associated with *EUSDR and EU 2020 Strategy* (EC 2010b), for several reasons:

– the overall objective of the EUSDR and FASRB is identical: sustainable development of the region;
– there is an obvious conformity of the ISRBC approach and its priority projects with the EUSDR priorities, and a high potential for synergy, as the implementation of the ISRBC projects within the EUSDR framework can contribute to the implementation of both EUSDR and FASRB;
– the sub-regional level, such as the SRB level, is likely to be the most effective level from the viewpoint of the EUSDR implementation;
– a majority of the ongoing activities of the ISRBC fully match the three main priorities of the *EU 2020 Strategy,* i.e. sustainable, smart and inclusive growth.

The approach seems also to be relevant to other regions (other parts of South-Eastern Europe, Mediterranean region, Western Europe, Central Asia), given their interest in the Sava model of cooperation.

Although the FASRB has proven to be a good platform for intensified contacts and improved cooperation among the Parties, a number of challenges and (existing or potential) obstacles for the FASRB implementation have been identified. These are, generally, associated with:

– differences between the countries (i.e. status with respect to EU, eligibility for approaching funds, level of economic development, organizational structure in decision-making process, environmental awareness of the public);
– financing of priority projects, strategic studies, and the establishment of integrated systems for the basin;
– resolving conflicts of interests of different users of water, especially as they are likely to increase in future due to climate change.

Despite of these challenges, the FASRB provides a solid basis for the integrated water resources management in the SRB, and its implementation is making a steady progress toward the key objective – a sustainable development of the region within the basin.

References

EC (2010a): *EU Strategy for the Danube Region,* http://ec.europa.eu/regional_policy/cooperation/danube/index_en.htm

EC (2010b): *Europe 2020 – A European Strategy for Smart, Sustainable and Inclusive Growth,* http://europa.eu/press_room/pdf/complet_en_barroso___007_-_europe_2020_-_en_version.pdf

FASRB (2002): *Framework Agreement on the Sava River Basin,* http://www.savacommission.org/basic_docs

ICPDR (2009): *Danube River Basin Management Plan,* http://www.icpdr.org/icpdr-pages/danube_rbm_plan_ready.htm

ICPDR (2010): *Danube Basin: Shared waters – Joint responsibilities,* Danube Declaration adopted by the Ministers of Environment on 16 February 2010, http://www.icpdr.org/icpdr-pages/mm2010.htm

ICPDR (2011): Assessment Report on Hydropower in the Danube Region. Draft paper 24.5.2011, in preparation

ICPDR, Danube Commission, ISRBC (2008): *Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin,* http://www.savacommission.org/basic_docs

ISRBC (2009): *Sava River Basin Analysis Report,* http://www.savacommission.org/publication

ISRBC (2011a): *Strategy on Implementation of the FASRB,* http://www.savacommission.org/basic_docs

ISRBC (2011b): *Action Plan for the Period 2011–2015,* http://www.savacommission.org/basic_docs

ISRBC (2011c): *Nautical and Tourist Guide of the Sava River,* http://www.savacommission.org/publication

Development of navigation on the Sava River – an integrated approach

Dejan Komatina: *Secretary of the International Sava River Basin Commission; e-mail: dkomatina@savacommission.org*

The Sava River contributes almost 600 km of waterway to the Danube transport network *(Figure 1).* After the fall of former Yugoslavia, the ratification of the *Framework Agreement on the Sava River Basin (FASRB)* in 2004, and the establishment of the International Sava River Basin Commission (ISRBC, www.savacommission.org) in 2005 provided the basis for transboundary cooperation and sustainable development of the region within the basin (FASRB 2002). In particular, the ruined navigation needed an economic impulse. The establishment of an international navigation regime on the Sava River, while respecting, at the same time, the other objectives of the FASRB, requires an integrated and sustainable approach, balancing the needs for navigation development against the needs of other water sub-sectors (i.e. other kinds of water use, protection against detrimental effects of water, and protection of water and aquatic ecosystem).

Background

Until the 1990s, the Sava River used to be the largest national river of former Yugoslavia, and the Sava water resources were managed in an integrated manner. Transport on the river, which was around 10 million tons in 1982, decreased to 5.7 million tons in 1990. The war from 1991

Figure 1. Navigation on the Sava River (in Belgrade). Photo: Dragan M. Babovic

to 1995 significantly influenced economic activities in the region as well as waterway and port infrastructure, and consequently cargo traffic dropped to less than 1 million tons. Since then, the Sava River has been hardly used for transport, primarily due to a lack of maintenance and investments, which resulted in a poor quality of the infrastructure, low level of navigation safety due to unexploded ordnances, and poor intermodal road and railway connections. Navigation conditions have been unfavourable due to a limited draft during long periods, a limited width of the fairway and a limited height for passages under some bridges, as well as insufficient marking. Navigability of the waterway, which used to be a class IV waterway in the past, was reduced to class III at many sections of the river. In other parts of Europe, on the contrary, inland waterway transport has proven to be a competitive transport mode, being considered as the safest and the most environmentally friendly land transport mode, and capable of reducing congestion on densely used roads (EC 2006).

Given such an initial situation, the ratification of the FASRB and establishment of the ISRBC provided a good basis for rehabilitation and development of navigation on the Sava River, which was further strengthened by a simultaneous ratification of the *Protocol on Navigation Regime to the FASRB.* The FASRB declares the Sava River waterway open, and the entrance to the ports free, for merchant vessels of any state. It also provides the ISRBC, in the field of navigation, with the legal capacity of making decisions that are obligatory for the Parties. With the intention to ensure the application of an integrated approach to develop navigation, the ISRBC has been actively involved in the process of development and implementation of the *Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin* (ICPDR et al. 2008), led jointly by the ICPDR, Danube Commission and the ISRBC, where the issue is continuously discussed by a variety of stakeholders from the navigation and environmental sectors.

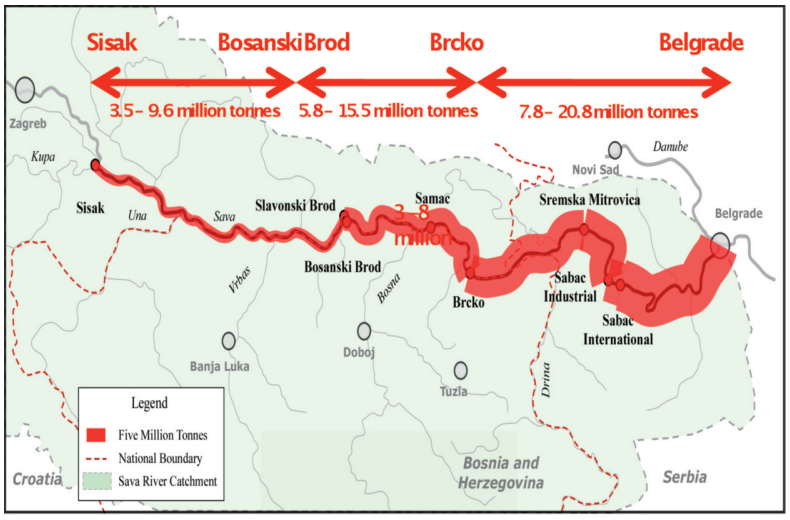


Figure 2. Estimation of minimum and maximum traffic volume on the Sava River for the year 2027 (ISRBC 2008)

Integrated approach to navigation development

Since the beginning of the FASRB implementation, considerable efforts have been invested by the ISRBC and the Parties to provide conditions necessary for the Sava River to become an important, environment-friendly and navigation-safe lifeline for inland transport (ISRBC 2009). The undertaken activities have been focused on two major issues: (a) planning for rehabilitation and development of the Sava River waterway infrastructure, and (b) improvement of technical standards and safety of navigation, with the aim to prevent environmental risks such as oil pollution.

With regard to **rehabilitation and development of the Sava River waterway infrastructure,** a preliminary documentation has been developed and future steps have been agreed by the Parties (ISRBC 2011a,b). Several studies have been conducted to assess project feasibility and transport demand *(Figure 2),* and estimate construction costs, for two options: (a) rehabilitation of the whole waterway to class IV, and (b) establishment of a class Va waterway at the whole length (from Belgrade to Sisak). According to the feasibility study, the upgrade of the whole waterway to class Va is feasible, while the difference of the costs between the two options is within 10 %. However, to minimize negative environmental impacts of the construction works, the ISRBC has decided to develop the waterway to class Va only at 40 % of the total length (section Belgrade – Brčko), while the waterway will be rehabilitated to Class IV at the rest part (section Brčko – Sisak). For the same reason, no changes of the present watercourse (no straightening) have been planned, so that, in sharp bends, only one-way navigation is foreseen.

Although the planning process has been launched and largely executed before approval of the *Joint Statement,* a variety of mechanisms for information and consultation of stakeholders and/or broad public has been applied by the ISRBC from the very beginning to ensure transparency (see article on FASRB). The project progress is regularly reported within the *Joint Statement* implementation process. With the aim to ensure environmental sustainability and further align

the project with the principles of the *Joint Statement* and the *Manual on Good Practices in Sustainable Waterway Planning,* developed within the EU FP7 project PLATINA (2010), a review of the preliminary documentation was conducted by the EC. For coordination of further activities, the ISRBC is establishing a body of multidisciplinary character intended to be open for stakeholders, including NGOs. The remaining part of the planning phase, for which EC funding has been approved, is expected to be finalized in 2013.

For the purpose of rehabilitation and development of navigation on the Sava River, several other activities have been performed, including full restoration of the waterway marking system, removal of unexploded ordnances from the river banks, and establishment of the River Information Services (RIS) on the Sava River, in accordance with the *EU RIS Directive.*

The sustainability of the approach is expected to be additionally improved by a climate adaptation plan for the Sava River Basin (SRB), which is aiming to assess possible impacts of climate change in the basin and to provide guidelines for different water sub-sectors, including navigation and environmental protection.

The **administrative and legal framework** has been strengthened by development of a set of rules and other documents related to technical issues and safety of navigation, harmonized with the corresponding EU and UNECE regulations. The *Protocol on Prevention of Water Pollution caused by Navigation to the FASRB* has been signed and is currently undergoing ratification. The *Protocol on Sediment Management to the FASRB,* aiming to regulate, *inter alia,* the issue of exploitation of sand and gravel from the river bed, in accordance with the *Sava River Basin Management Plan (Sava RBM Plan),* is in process of final harmonization by the Parties.

Efforts have also been made to develop **other economic activities** that can benefit from the use of waterway infrastructure. Being aware of the great potential for an environment-friendly tourism in the SRB, the first *Nautical and Tourist Guide of the Sava River* (ISRBC 2011c) has been developed in cooperation with regional chambers of commerce of the Parties, while the preparation of a master plan for development of nautical tourism in the basin is planned as the next step. A project on fostering the contribution of small and medium enterprises to sustainable development of the SRB, which has recently been initiated, targets not only river transport and tourism, but also other economic activities, including shipbuilding.

Partly as a consequence of the above mentioned political achievements, several indicators of development in traffic and opening of new cargo flows on the Sava River are evident such as transport of oil products from Brod/Bosanski Brod, new developments in Serbian ports (Sremska Mitrovica, Šabac), as well as the first passenger cruise along the whole Sava waterway after 150 years.

Conclusion

In accordance with the broad scope of the FASRB, the ISRBC makes efforts to balance needs for development of navigation and requirements for environmental protection, by applying an integrated approach. The issue of navigation development is considered as an integral part of the *Sava RBM Plan,* which is being developed in accordance with the *EU Water Framework Directive.* Technical standards and safety of navigation are being improved, and the administrative and legal framework is being strengthened, fully in line with the corresponding EU and UNECE regulations, while planning of the new waterway tends to minimize negative environmental impacts of the rehabilitation works. The approach is believed to provide a crucial contribution to sustainable development of the SRB, thus matching the strategic goal of the FASRB.

References

EC (2006): *NAIADES – An Integrated European Action Programme for Inland Waterway Transport,* http://ec.europa.eu/transport/inland/promotion/promotion_en.htm

FASRB (2002): *Framework Agreement on the Sava River Basin,* http://www.savacommission.org/basic_docs

ICPDR, Danube Commission, ISRBC (2008): *Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin,* http://www.savacommission.org/basic_docs

ISRBC (2008): *Feasibility Study and Project Documentation for the Rehabilitation and Development of Transport and Navigation on the Sava River Waterway,* http://www.savacommission.org/project

ISRBC (2009): *Rehabilitation and Development of Navigation in the Sava River Basin,* an ISRBC publication, 24 pp

ISRBC (2011a): *Strategy on Implementation of the FASRB,* http://www.savacommission.org/basic_docs

ISRBC (2011b): *Action Plan for the Period 2011–2015,* http://www.savacommission.org/basic_docs

ISRBC (2011c): *Nautical and Tourist Guide of the Sava River,* http://www.savacommission.org/publication

PLATINA (2010): Manual on good practices in sustainable waterway planning. ICPDR, SWP 5.3 Project, TREN/FP7/TR/218362, July 2010, 107 pp

Protected Areas along the Sava River

Boris Erg: *IUCN Programme Office for South-Eastern Europe, Belgrade, Serbia, e-mail: boris.erg@iucn.org*

Duška Dimović: *WWF Danube-Carpathian Programme, Belgrade, Serbia, e-mail: ddimovic@wwfdcp.org*

Features of the Sava River

Due to the variety of habitats the river spans from its source to the confluence, from high mountains to lowland wetlands, the Sava River is host to an exceptional range of biodiversity. While the alpine headwaters and Upper Sava provide valuable near-natural aquatic ecosystems, the lowland floodplains are characterized by typical hydro-morphological features of a lowland river with associated species and habitats. Certainly the most important landscape characteristics are found in the Central Sava Basin with a mosaic of natural floodplains and cultural landscapes formed by tra-

ditional land-use patterns, in the past typical to the river valleys of Central Europe (IUCN 2010).

The Central Sava River is a unique example how floodplains can diminish flood waves and how flood control could be combined with landscape and biodiversity conservation. With an area of 109,000 hectares it is the largest floodplain ecosystem in the Danube River Basin and an important nutrient-sink for the Upper and Central Sava Basin (Schneider-Jacoby 2005). With its great self-purification potential and a high ecological value, the alluvial wetlands of the Sava River are the basis for sustainable flood control along the river. Taking all this into account, there is no surprise that the Sava floodplains have been selected as a focal region in the Pan European Biological and Landscape Diversity Strategy (PEBLDS) of the Council of Europe, and listed as a river corridor of European importance for preserving biological heritage. Overall, the Sava River represents one of the biodiversity hotspots in south-eastern Europe and is of great importance for biodiversity conservation.

The Sava River features the largest floodplain area in the Danube River Basin (except for the Danube Delta) as well as the largest complex of alluvial floodplain wetlands. It is known for its species and habitat diversity. Five Ramsar sites have been designated along the Sava River thus far: Lonjsko and Mokro Polje in Croatia, Bardaca in BiH and Obedska Bara and Zasavica in Serbia. The area of Lonjsko and Mokro Polje is one of the largest alluvial wetlands in Europe including floodplains of seasonally flooded *Quercus* and *Populus* woodlands, marshes, meadows and fishponds. The site is home to 236 bird species and is especially important for breeding birds, of which 33 are threatened species, such as the spoonbill *Platalea leucorodia,* the ferruginous duck *Aythya nyroca* and the corncrake *Crex crex.* These alluvial wetlands of the Sava River located in Croatia are also listed as an Important Bird Area with special importance for breeding stocks and raptors and where especially the ferruginous duck, the imperial eagle *Aquila heliaca* and the white-tailed eagle *Haliaeetus albicilla* are listed as species of global conservation concern.

Many of these important bird species are also on the IUCN Red List of threatened species. Birds are invaluable bioindicators of the quality of wetlands. E.g., the breeding success of the white stork *Ciconia ciconia* and the number of nests per village are related to the size of the alluvial wetlands nearby. Spoonbill feed when the water level decreases in the alluvial wetlands (Schneider-Jacoby et al. 2001). Wetlands are cradles of biological diversity, providing the water and primary productivity on which countless species of plants and animals depend for survival. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important storehouses of plant genetic material. These functions, values and attributes can only be maintained if the ecological processes of wetlands are kept functioning. Unfortunately, and in spite of important progress made in recent decades, wetlands continue to be among the most threatened ecosystems, owing mainly to on-going drainage, conversion, pollution, and overexploitation of their resources. That's what most of wetlands in Europe have in common, including the Sava River floodplains. Certainly one of the main challenges for the management of the Sava River is to reconcile economic development with the protection of its biodiversity (Zingstra et al. 2006).

Protected areas along the Sava River

Protected areas (PA) along the Sava River are defined by various legal frameworks: EU *acquis communautaire,* national laws and international conservation standards. Different conservation frameworks apply primarily due to the difference in the political status of the Sava River countries in relation to EU. What the four countries have in common is that the IUCN protected area management system is applied across borders. The system provides the definition of a PA and describes six categories of protected areas, namely: Strict nature reserve/Wilderness area, National park, Natural monument or feature, Habitat/species management area, Protected landscape/seascape, and Protected area with sustainable use of natural resources. According to the guidelines for protected area management categories developed by the IUCN's World Commission on Protected Areas (IUCN WCPA) in 2008, a protected area is defined as: "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008). Apart from the difference in the type of protected areas designated along the Sava River, there is a difference in terms of the PA coverage from country to country, management structures, available resources and management effectiveness. Being a member to EU, Slovenia has introduced the Natura 2000 network in addition to PAs designated according to the IUCN PA categorization system. The Natura 2000 network is under development in Croatia as the country is approaching the EU with expected accession in 2013. In Bosnia and Herzegovina, and Serbia, only PAs designated following the IUCN categorisation system are in place, even though significant steps towards the designation of national Emerald networks have been done. Some initial steps on the elaboration of the Natura 2000 network in Serbia have been undertaken since 2010 and future activities in that respect are expected to commence in BiH. When it comes to ecological networks, two important national processes have taken place recently in the Sava countries. Croatia designated its national ecological network CRO-NEN in 2007, while Serbia embarked on a similar process in 2010 by passing a Decree on Ecological Network.

The coverage of protected areas in Slovenia according to the IUCN PA management categories system is 12.5 % while the Natura 2000 sites cover 36 % of the territory of Slovenia (Bizjak et al. 2008). Protected area categories in Slovenia include: National park, Regional park, Nature reserve, Natural monument, and Landscape park. The Nature Conservation

Act in Croatia recognizes the following nine protected area categories: Strict reserve, Special reserve, National park, Nature park, Regional park, Nature monument, Significant landscape, Park forest, and Park architecture monument. The total coverage of protected areas in Croatia is 9.5 % (Ministarstvo kulture Republike Hrvatske 2011). In Serbia, the coverage of protected areas is 5.86 % whereas protected areas include the following categories: Strict nature reserve, Special nature reserve, National park, Nature monument, Protected habitat, Landscape of exceptional features (Protected landscape), and Nature park (Radović 2011).

In terms of the coverage of protected areas, Bosnia and Herzegovina falls behind with only 2.2 %. This is way below scientific and international standards and insufficient for the proper conservation of the country's rich biodiversity, in particular bearing in mind that some 2/3 of BiH lies in the Sava River Basin. Bardaca Wetland, situated at the confluence of the Vrbas River to the Sava River, that counts among the most important wetlands in BiH, is only in the process of designation according to national law. However, the site was enlisted in the wetlands of international importance according to the Ramsar Convention back in 2007. Apart from Bardaca Wetland, several other sites along the Sava River in BiH would qualify as a protected area (e.g. Modrac, Raca, Prnjavor fishpond, etc.), yet the process of official designation is delayed. In Slovenia, protected areas along the Sava River mainly include habitats and species as part of the national Natura 2000 network. The central part of the Sava River hosts some of the most important wetlands in the whole Danube River Basin, spanning Turopolje, Odransko Polje Protected Landscape, Lonjsko Polje Nature Park, as well as Mokro and Sunjsko Polje. With its total size of 506.5 km^2, Lonjsko Polje is the largest intact wetland in the Danube River Basin. Together with the adjacent Morko Polje it was proclaimed a Ramsar site in 1993 (Gugic & Cosic-Flajsig 2004). At the national level, Lonjsko Polje is designated as a Nature Park. Other important protected areas along the Sava in Croatia include Odransko Polje and Gajna Protected Landscape, both good examples of natural floodplains interspersed with wet meadows and pastures. Both protected areas provide excellent conditions for the maintenance of traditional land use practices that include extensive grazing of autochthonous breeds in natural environments. These practices were once widely spread along the Sava River and instrumental to shaping the landscapes of today. Luckily, they still can be found along the river; good examples of maintained traditional land use are Odransko Polje, Lonjsko Polje, Gajna, and Zasavica. Further downstream a vast transboundary forest area shared by Croatia and Serbia, Spacva basin and Morovicko-bosutske sume, respectively, represents the largest common oak lowland forest in the Sava River Basin covering more than 60,000 ha. The process of assessing conservation potential as well as socio-economic features as a necessary step in the process of protected area designation is on-going both in Croatia and Serbia. At the moment, only a few small forest nature reserves are designated within this vast forest area.

Country	No.	Site name
Bosnia and Herzegovina	1.	Rača (Bijeljina) (border with Serbian site 37)
	2.	Lončari (Brčko)
	3.	Žabar (Modriča)
	4.	Modrac
	5.	Lješće (Bos. Brod)
	6.	Patkovača i Ukrima River (Derventa)
	7.	Velika i Mala Tisina
	8.	Donji Svilaj (Bos. Šamac)
	9.	Bardača
	10.	Srbac
	11.	Bosanska Gradiška
	12.	Trnopolje i Sanicani (Prijedor)
	13.	Spreca i Klokotnica
	14.	Plivska jezera
	15.	Ribnjak Prnjavor
	16.	Odžak – Vojskova
Croatia	17.	Sava
	18.	Sava – Hruscice
	19.	Savica
	20.	Turopolje
	21.	Odransko polje
	22.	Lonjsko polje
	23.	Sunjsko polje
	24.	Ribnjaci Lipovljani
	25.	Ribnjaci Slobostina
	26.	Prasnik
	27.	Jelas polje
	28.	Dvorina
	29.	Gajna
	30.	Spacvanski bazen (border with Serbian site 41)
	31.	Sava – Podsused
	32.	Zutica
Serbia	33.	Veliko Ratko Ostrvo – Usce
	34.	Crni Lug – Ribnjak Zivaca
	35.	Bojcinska suma
	36.	Orlaca
	37.	Usce Drine (border with BiH site 1)
	38.	Obedska bara
	39.	Zasavica
	40.	Trskovaca
	41.	Morovicko–Bosutske sume (border with Croatian site 30)
Slovenia	42.	Zelenci in Ledine pod Ratečami
	43.	Sava Bohinjka z Mostnico in Ribnico
	44.	Sava Dolinka od Zelencev do Hrušice
	45.	Sava od Mavčič do Save
	46.	Sava od Radovljice do Kranja
	47.	Sava Bohinjka in Sava Dolinka
	48.	Julijske Alpe
	49.	Sava od Radeč do državne meje.

Table 1. Important sites for biodiversity along the Sava River according to the EU Birds and Habitats Directives, as defined by the Sava Floodplains Protection LIFE project (IUCN 2010)

Apart from Morovicko-bosutske sume, the most important protected areas in Serbia are Obedska bara and Zasavica Special Nature Reserves. Both sites are not only designated according to national law but also recognized as Ramsar sites. Obedska bara, in most part a naturally flooded area, is known for its diverse wetland habitats and old-growth oak forests and is regarded as one of the biodiversity hotspots

along the entire Sava River. At the confluence of the Sava River to the Danube River at Belgrade lies Veliko Ratno ostrvo, a naturally flooded river island protected as a Landscape of Outstanding Features.

Governance types and PA management effectiveness vary greatly from country to country. Governance encompasses two IUCN governance types – protected areas governed by government and private governance. PAs governed by state include those managed by public institutions with a particular mandate to manage a PA (e.g. Public Institution Lonjsko Polje Nature Park) or public enterprises responsible for the management of natural resources (e.g. Public Forest Enterprise Vojvodinasume), whereas an example of a private governed PA is Zasavica SNR that is managed by a civil society. The governance type in part defines the management effectiveness: PAs managed by public institutions and civil societies are the most effective ones. Some involvement of local communities in the management of PAs is observed, although community-conserved protected areas are not typical for the Sava River.

Overarching regional initiatives and projects

The International Sava River Basin Commission (ISRBC), coordinating the implementation of the Framework Agreement on the Sava River Basin (FASRB), elaborates an Integrated River Basin Management (ISRBM) Plan to meet the requirements of the EU Water Framework Directive and other relevant European legislation and ensure transboundary sustainable water management. One of the main tasks of the conservation community is to make sure that biodiversity concerns and protected areas are properly recognized and dealt with in the future Sava River Basin Management Plan.

On the side of biodiversity research and protected areas, an international project led by IUCN has been launched in 2007 in order to support the Sava River countries in identifying, designating and managing the ecological and landscape diversity along the Sava River. The project was aimed at supporting the implementation of the EU Birds and Habitats Directives by identifying key biodiversity sites along the Sava River following the requirements of the two EU directives. Its long-term objective was protection of species and habitats of the Sava floodplains as well as the designiation of a coherent ecological network of protected areas, ecological corridors and buffer zones along the Sava River. As a result, 49 sites in four countries have been identified as sites important for biodiversity conservation along the Sava River *(Table 1).* The Sava River itself functions as the connecting backbone for the network of sites. The project has proposed to include the selected 49 sites in a trans-border ecological network along the Sava River.

There was a number of preceding activities that have put the Sava River in the spotlight and brought it to the attention of the international conservation community for its biodiversity and landscape values. In 1995 IUCN selected seven areas as the case studies for the "Best practices for Conservation Planning in Rural Areas: Biological and Landscape Diversity in Central and Eastern Europe". According to this study, Lonjsko Polje Nature Park was defined as an "outstanding example of a floodplain ecosystem which has been created by the interaction between long standing agricultural practices and maintained by flood controls for water retention" (IUCN European Programme 2005). Apart from this, there were a number of pan-regional, transboundary and site-based activities taking place along the Sava River aimed at enhancing biodiversity research, designating new and improving the management of the existing protected areas, such as those led by ECNC (Pan-European Ecological Network), Wageningen University (Sava ecological network), EuroNatur (extensive research of Sava biodiversity and hydro-morphology), WWF (observers to the ISRBC), and others. An important role in the conservation of biological and landscape features of the Sava River lies with numerous NGOs who relentlessly work and campaign for the Sava River.

Conclusion

The status of protected areas along the Sava River varies from country to country with the prevalence of protected landscapes and nature reserves category wise. No national parks are being designated along the river. The actual recognition of the IUCN Protected Area management categories system and the harmonization of national Natura 2000 networks are crucial for the future conservation status of Sava wetlands. The Sava River and its floodplains serve manifold purposes that all have to be taken into account while planning future conservation action, be it on national level or in a transboundary context. A careful designation of new protected areas, improvement of the management effectiveness of the existing ones with high level of public participation, as well as the establishment of a coherent ecological network along the Sava River rank among the main conservation objectives in the future. All this implies further research, support to conservation planning at local and national level with active involvement of all stakeholder groups, and smooth transboundary and regional cooperation. Well-functioning protected areas along the Sava River are as much important for the conservation of species and habitats as for the wealth of landscapes, local communities and their economies.

References

Bizjak J, Vidic J, Berginc M, Hladnik J, Zupanc Hrastar S, Groznik Zeiler K, Kristanc J, Vičar A (2008): Zavarovana območja v Sloveniji. Ministarstvo za okolje in prostor Republike Slovenije

Dudley N (ed) (2008): Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland

Gugić G, Ćosić-Flajsig G (2004): The development plan for Lonjsko Polje Ramsar site – ways towards integrated river basin management. 5th European Regional Meeting on the implementation and effectiveness of the Ramsar Convention. Yerevan, Armenia. http://www.ramsar.org/pdf/mtg/mtg_reg_europe2004_docs1h2.pdf Accessed on 28 August 2011

International Sava River Basin Commission (2009): Sava River Basin Analysis Report. International Sava River Basin Commission (ISRBC) in cooperation with the Parties to the Framework Agreement on the Sava River Basin. Zagreb

IUCN European Programme (2005): Best practices for Conservation Planning in Rural Areas: Biological and Landscape Diversity in Central and Eastern Europe. IUCN, Warsaw
IUCN (2010): Protection of Biodiversity of the Sava River Basin Floodplains. Project Results (CD)
Ministarstvo kulture Republike Hrvatske (2011): Zaštićena područaja. http://www.min-kulture.hr/default.aspx?id=232. Accessed on 11 July 2011
Radović I (ed) (2011): Strategija biološke raznovrsnosti Republike Srbije za period od 2011. do 2018. godine. Ministarstvo životne sredine i prostornog planiranja, Beograd
Schneider-Jacoby M, Mikuska T, Kovačić D, Mikuska J, Šetina M, Tadić Z (2001): Dispersal by accident – the Spoonbill population, *Platalea leucorodia,* in Croatia. Acrocephalus 22: 191–204
Schneider-Jacoby M (2005): The Sava and Drava Flood Plains: Threatened Ecosystems of International Importance. Large Rivers 16/1-2, Arch. Hydrobiol. Suppl. 158/1–2: 249–288
Zingstra H, Hoogerwerf M, Jongamn R, Kitnaes K (2006): Development of an Ecological Network along the Sava. Final Report. Wageningen International, The Netherlands

Water resources and wastewater management in the Sava River Basin

Marijan Ahel, Nevenka Mikac, Tvrtko Smital: *Division for Marine and Environmental Research, Rudjer Boskovic Institute, Zagreb, Croatia;*
e-mails: ahel@irb.hr, mikac@irb.hr, smital@irb.hr

The Sava River and its tributaries represent the largest reservoir of renewable water in the Danube River Basin. Therefore, securing protection and proper management of these water resources is a strategic priority for Croatia and all other riparian countries. Recent advances in wastewater management in the Sava River Basin, in particular completing the mechanical-biological wastewater treatment plant (WWTP) of the city of Zagreb, have contributed to a significant improvement of the water quality of the Sava River and can be regarded as the key step towards achieving the proclaimed objectives of the EU Water Framework Directive (WFD).

Introduction

Most of Croatia's renewable water resources, reaching respectable 45 billion cubic meters a year, originate from surface waters (39 billion cubic meters a year). A large percentage of available surface water belongs to the Sava River Basin. Sava River is the Danube's second longest tributary, being by far the largest in terms of water quantity (average annual discharge of 1209 m^3/s). After the breakdown of former Yugoslavia in 1991, it has become an important transboundary watercourse, connecting four riparian countries: Slovenia, Croatia, Bosnia and Herzegovina, and Serbia. The Sava River Basin (95.719 km^2) represents about 40 % of their land area and, more importantly, the source of more than 80 % of their total available water. The river length and drainage area within the Croatian territory are 518 km and 25.100 km^2, respectively, with 2,340,000 inhabitants representing more than 50 % of the total population. Moreover, the alluvial aquifer of the Sava River is a rich reservoir of high quality groundwater, which plays an essential role as a source for drinking water supply of riparian cities, including Croatia's capital, the city of Zagreb. Therefore, a proper management of these valuable resources is of strategic importance for the national economy, public health, environmental protection and wetland habitat preservation.

Due to the transboundary character of the surface waters in the Sava River Basin and associated groundwater reserves, activities concerning environmental protection and regulation of the water regime to mitigate devastating consequences of extreme floods are of high concern for all neighbouring countries. These issues have been gaining importance in the last decade and led to several international initiatives, recognizing the geostrategic and economic importance of the Sava River Basin. As a consequence, several international initiatives have been launched, the most significant one being the Stability Pact Sava River Basin Initiative launched in June 2001 (http://www.seerecon.org/infrastructure/sectors/environment/ri/sava.htm). The Initiative was followed by the creation of the International Sava River Basin Commission (http://www.savacommission.org/index.php?lang=eng) in fall 2002. Moreover, numerous international projects have been supported by various international agencies, including the UNDP Global Environmental Facility project, aimed at developing the Sava River Basin Management Plan, and two major European Union FP6 research projects: SARIB (Sava River Basin: Sustainable Use, Management and Protection of Resources; http://www.sarib.net/) and EMCO (Reduction of environmental risks, posed by emerging contaminants, through advanced treatment of municipal and industrial wastes; http://www.cid.csic.es/emco/). However, despite all these valuable initiatives the expert and institutional framework needed for identification, evaluation and control of hazardous chemical contamination in the river basin is still not fully developed.

Anthropogenic pressures and impacts

The Sava River is exposed to significant anthropogenic pressure from various sources, including urban areas, industry, agriculture and traffic. It flows through some densely populated and highly industrialized areas and directly affects as much as 5.000 km^2 of fertile agricultural land. The Sava River is navigable from Sisak to Belgrade (total 593 km), while the Sava Valley represents a natural route for regional land traffic, including railway and highway Ljubljana-Zagreb-Belgrade as well as regional routes of oil and gas pipelines from Croatia to Serbia. As a consequence, securing the good ecological status of all ambient waters in the Sava River Basin, as defined by the WFD, and complying with the targeted water quality criteria will require a significant reduction of the con-

taminant inputs, in particular the organic load, and strict implementation of the adopted mitigation measures.

An issue of special concern, in this regard, is the management of municipal and industrial wastewaters. Municipal wastewaters are well-known as one of the main sources of various organic and inorganic contaminants into the aquatic environment, and their relative contribution to the overall contaminant loads in ambient waters is especially high in countries in transition such as Croatia. Until recently such countries were characterized by poor wastewater management practices (Kaštelan-Macan et al. 2007). Although significant improvements have been achieved over the past few years, the situation is still far from being satisfactory. As compared to the situation in Western Europe, the key environmental problem common for all transition countries in the Sava and Danube River Basins is the release of contaminated untreated effluents from municipalities and industrial facilities that are greatly dominated by old and environmentally unfriendly technologies. A comprehensive assessment of possible adverse effects of hazardous chemical contamination is therefore of great importance.

Assessment of hazardous chemical contamination

Despite continuous efforts to establish an effective monitoring in the Sava River Basin to assess hazardous chemical contamination, this goal has been only partially achieved. Due to the limited capacities of analytical laboratories, monitoring activities are often restricted to a comparatively small number of possibly hazardous contaminants through targeted analysis. As a consequence, the occurrence of potentially toxic substances other than priority pollutants at the sites exposed to chemical contamination is frequently overlooked and the potential hazard posed to the environment and human health widely underestimated.

Compound	RW	SE	Sava River
Petroleum hydrocarbons	100-1000	10-100	10-100
Linear alkylbenzenes C10-C14 (LAB)	0.1-1	0.01-0.1	0.01-0.1
Polycyclic aromatic hydrocarbons (PAH)	0.01-0.1	0.001-0.01	0.001-0.01
Nonylphenol	0.01-0.1	0.01-0.1	0.01-0.1
Benzophenone	1-10	0.1-1	0.01-0.1
Coprostanol	10-100	1-10	1-10
Galaxolide	1-100	1-10	0.1-1
Diethylhexylphthalate	1-100	1-10	0.1-10
Terbutylazine	0.1-1	0.01-1	0.01-0.1
Metholachlor	1-10	0.1-1	0.01-0.1
Caffeine	10-100	0.1-1	0.01-0.1
Sulfamethoxazole	0.1-1	0.1-1	0.01-0.1
Azithromycin	0.1-10	0.1-10	0.01-1
Benzoylecgonine	0.1-1	0.1-1	0.01-0.1
Linearalkylbenzene sulfonates (LAS)	>1000	10-100	10-100
Linear alcohol polyethoxylates (LAEO)	>1000	10-100	1-100

Table 1. Typical specific organic contaminants identified in wastewater effluents of the city of Zagreb (RW = raw wastewater; SE = secondary effluent) and in the Sava River (concentration ranges in µg/L)

The recently completed NATO Science for Peace project on assessment of hazardous chemical contamination in the Sava River Basin (http://www.irb.hr/nato-savariver/) addressed this issue in detail by implementing a state-of-the-art Effects-Directed Analysis (EDA) approach customized for this basin. The overall goal of the project was a comprehensive assessment of the main sources of hazardous chemical contamination on the most densely populated and heavily industrialized section of the Sava River Basin between the cities of Zagreb and Sisak as a key tool for scientifically-based and cost-effective management of water resources. A special emphasis was on the relationship between wastewater discharges of the city of Zagreb and quality of the Sava River water and sediments.

The composition of municipal wastewater of the city of Zagreb is very complex, containing a large number of regulated and non-regulated contaminants (Terzić & Ahel 2006). A recent study by Terzić at al. (2008), carried out within the EU FP 6 Project EMCO, reported on a comprehensive reconnaissance of over seventy individual wastewater contaminants in the region of Western Balkan and showed the widespread occurrence of emerging contaminants in municipal wastewaters of the region. These included some prominent classes such as pharmaceuticals and personal care products, surfactants and their degradation products, plasticizers, pesticides, insect repellents, and flame retardants. A detailed EDA study of the untreated wastewater of the city of Zagreb showed that most of the toxic effects, associated with specific organic contaminants remained unexplained. *Table 1* shows the list of the most prominent representatives of anthropogenic contaminants in the wastewater effluents and Sava River.

Improvements of water and sediment quality by state-of-the-art wastewater treatment

In the past 25 years, water quality criteria for the recipient ambient waters in Croatia have always been fairly well-developed and timely harmonized with similar legislation adopted in Western Europe and USA. However, the strict implementation of these criteria was not sustainable due to the very limited wastewater management. Until recently, only a very small percentage of wastewater was biologically treated before discharge (Kaštelan-Macan et al. 2007), which led to very high loads of the various classes of anthropogenic contaminants in the Sava River (Terzić & Ahel 2006). For example, it was estimated that the loads of some common wastewater contaminants, such as major classes of synthetic surfactants, from the sewer system of the city of Zagreb reached approximately 1 ton per day in the 1980s. Since January 2008, mixed municipal and industrial wastewaters, collected in the wider area of the city of Zagreb, have been subjected to full, state-of-the-art mechanical and biological treatment, based on conventional activated sludge

Sample/Location	Water		Sediment	
	Algal Tox	EROD	Algal Tox	EROD
Raw wastewater – Zagreb WWTP	83	32	n.a.	n.a.
Secondary effluent – Zagreb WWTP	66	10	n.a.	n.a.
Sava River – 10 km upstream of Zagreb WWTP	16	1.7	15	34
Sava River – 15 km downstream of Zagreb WWTP	20	2.8	28	17
Sava River – 2 km downstream of Sisak	33	1.7	49	93
Confluence of the Una River	30	1.8	54	94

Table 2. Hazard profiles of water and sediment samples collected on the Sava River section, covering wider areas of the cities of Zagreb and Sisak, Croatia, in relation to wastewater effluents of the city of Zagreb as a major point source. The numbers indicate relative bioassay responses in comparison to the maximal response, determined as plateau of the sigmoid dose-response curve, set at 100 %. The threshold value between good/acceptable (low percentages) and bad quality (high percentages) cannot yet be determined. Algal Tox – Algal toxicity determined using freshwater green algae Desmodesmus subspicatus; EROD – CYP1A induction potential determined as EROD activity of 7-ethoxy-resorufin-O-deethylase (EROD)

process. The WWTP currently serves about 650,000 inhabitants, while the treatment steps include grit removal, primary clarifier, activated sludge treatment and secondary clarifier.

Under typical operating conditions, this treatment reduces the organic load of raw wastewater, expressed as chemical oxygen demand (COD), by more than 90 %. The concentration of most abundant categories of specific wastewater contaminants in secondary effluents were also dramatically reduced, in particular surfactants and hydrocarbons (Smital et al. 2011a). Nevertheless, some categories of emerging contaminants, such as pharmaceuticals and pesticides, showed a rather modest elimination (Terzić et al. 2008; Smital et al. 2011a). As a consequence, compared to the previous situation, the mass loads of some typical contaminants in the Sava River decreased more than 10 times (Smital et al. 2011b). Regarding organic contaminants, the removal was mainly associated with the biological transformations during secondary treatment.

Metals are also ubiquitous constituents of municipal wastewaters, reaching sometimes rather high levels in untreated wastewater. This was the reason for occasionally high levels of some toxic metals in the Sava River (e.g., Pb, 2.3-19.3 µg/L) in the periods before the WWTP of the city of Zagreb became fully operational (Mikac & Branica 1994). Despite the fact that the metals cannot be eliminated via biodegradation, their removal in the WWTP was very efficient for those metals, which exhibit a strong adsorption onto sewage sludge *(Figure 1),* leading to about 10 times reduced emissions into the Sava River for most of the ecotoxic metals (e.g., Pb, 0.98 ± 0.38 µg/L).

As a consequence of reduced inputs of various contaminants via treated wastewater discharges, the current longitudinal gradients of pollution in the Sava River, as reflected by different ecotoxic effects, do not indicate anymore the expected conspicuous impact of municipal wastewaters of the city of Zagreb *(Table 2).* The most important feature of the pollution profiles in the river sediments is prevalence of the refinery in the city of Sisak as the major source of toxic hydrocarbon pollution (Krča et al. 2007).

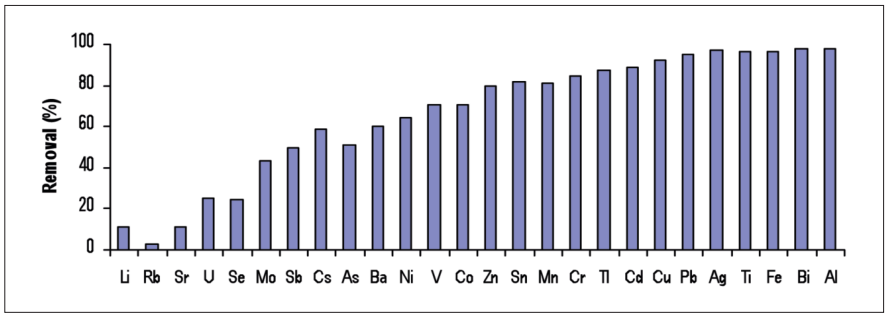


Figure 1. Removal of metals in the WWTP of the city of Zagreb (based on a study conducted in 2009; Mikac et al. unpublished data)

References

Kaštelan-Macan M, Ahel M, Horvat AJM, Jabučar D, Jovančić P (2007): Water resources and waste water management in Bosnia and Herzegovina, Croatia and the State Union of Serbia and Montenegro. Water Policy 9, 319–343

Krča S, Zaja R, Čalić V, Terzic S, Grubešić MS, Ahel M, Smital T (2007): Hepatic biomarker responses to organic contaminants in feral chub *(Leuciscus cephalus)* – laboratory characterization and field study in the Sava River, Croatia. Environ. Toxicol. Chem. 26, 2620–2633

Mikac N, Branica M (1994): Input of ionic alkyllead compounds to surface waters. Sci. Tot. Environ. 154, 39–46

Smital T, Terzić S, Lončar J, Senta I, Žaja R, Popović M, Mikac I, Tollefsen KE, Thomas KV, Ahel M (2011b): Prioritisation of organic contaminants in a river basin using chemical analyses and bioassays. Environ. Sci. & Pollut. Res., submitted

Smital T, Terzić S, Žaja R, Senta I, Pivčević B, Popović M, Mikac I, Tollefsen KE, Thomas KV, Ahel M (2011a): Assessment of toxicological profiles of the municipal wastewater effluents using chemical analyses and bioassays. Ecotox. Environ. Safety 74, 844–851

Terzić S, Ahel M (2006): Organic contaminants in Croatian municipal wastewaters. Arh hig rada toksikol 57, 297–306

Terzić S, Senta I, Ahel M, Gros M, Petrović M, Barcelo D, Müller J, Knepper T, Martí I, Ventura F, Jovančić P, Jabučar D (2008): Occurrence and fate of emerging wastewater contaminants in Western Balkan Region. Sci. Tot. Environ. 399, 66–77

ISSN 2070-1292

danube news

donau aktuell

Bulletin of the International Association for Danube Research (IAD)
Informationsblatt der Internationalen Arbeitsgemeinschaft Donauforschung (IAD)

International Association for Danube Research (IAD)

Presidium

President	Vice-President	General Secretary
Dr. Thomas HEIN	Dr. Ivana TEODOROVIC	Dr. Harald KUTZENBERGER

Member Country Representatives

D	CH	A	CZ	SK	H	HR
Dr. Fritz KOHMANN	Dr. Armin RIST	Dr. Maria LEICHTFRIED	Dr. Jan HELESIC	Dr. Eva BULANKOVA	Prof. Dr. Arpàd BERCZIK	Dr. Goran KLOBUCAR

SLO	BiH	SRB	RO	BG	MD	UA
N.N.	N.N.	Dr. Snezana RADULOVIC	Prof. Dr. Marian Trajan GOMOIU	Dr. Roumen KALCHEV	Dr. Dumitru DRUMEA	Dr. Artem LYASHENKO

Expert Groups

Chemistry/Physics	Biotic processes	Microbiology / Hygienics	Phytoplankton / Phytobenthos	Macrophytes	Floodplain-ecology
Dr. Cristina SANDU	Dr. Thomas HEIN	Dr. Gerhard KAVKA	Dr. Katrin TEUBNER	Prof. Dr. Georg JANAUER	Dr. Ulrich SCHWARZ

Zoobenthos	Fish Biology / Fishery	Saprobiology	Ecotoxicology	Delta / Fore-Delta	Sustainable Development & Public Participation
Dr. Nàndor OERTEL	Dr. Mirjana LENHARDT	Dr. Gunther SEITZ	Dipl.-Biol. Willi KOPF	Dr. Julian NICHERSU	Dr. Harald KUTZENBERGER

Hydrological catchment of the River Danube

Address / General Secretary:

International Association for Danube Research
Internationale Arbeitsgemeinschaft Donauforschung (IAD)
Am Zunderfeld 12, A-4073 Wilhering
Tel.: 0043 727478881 Fax: 0043 727478884
E-mail: kutzenberger@iad.gs

IAD-Homepage: http://www.iad.gs

Editor:

Dr. Jürg Bloesch
Stauffacherstrasse 159
CH-8004 Zürich
Tel. 0041 (0)44 241 11 19
E-mail: bloesch@eawag

Layout:
Diener + Bachmann GmbH
Winterthurerstr. 58, 8006 Zürich
Tel. 0041 (0)44 440 11 50

Printing:
FUTURA – Petrovaradin, Serbia