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Forthcoming Events: The 40th IAD Conference

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The 40th IAD Conference

The 40th Anniversary IAD Conference *"The Danube and Black Sea Region – Unique Environment and Human Well Being Under Conditions of Global Changes"* will be held on 17–20 June, 2014, in Sofia. Bulgaria. It will be the fourth conference organized in Bulgaria after those held in Varna in 1966, in Sofia in 1976 and again in Varna in 1990. Following the good traditions of the Bulgarian Danube River limnology from the past this scientific event is dedicated to the memory of the eminent and highly respected Bulgarian hydrobiologists Prof. Dr. Wesselin Naidenow, Prof. Dr. Boris Russev and Assoc. Prof. Dr. Milen Vassilev, who as longtime IAD leading scientists devoted much of their efforts and time to the study of the Danube River and who have made valuable contributions in the areas of the Danube zooplankton, macrozoobenthos and fish community composition and dynamics.

The Conference will be co-organized by the Bulgarian Academy of Sciences, the Institute of Biodiversity and Ecosystem Research, the Ministry of Environment and Water of Bulgaria, and the IAD General Secretariat. It will be held within the framework of the Bulgarian Presidency of the International Commission for the Protection of the Danube River (ICPDR) in 2014 which also coincides with the 20th anniversary of the Danube River Protection Convention.

The 40th IAD Conference will provide a forum for the presentation of long-term multidisciplinary research activities and discussions on various topics highlighting the application of ecosystem and sustainable development approaches, which are essential in order to strike a balance between the economic development and protection of the unique environment in the Danube River Basin. The contributions and discussions will cover the following scientific topics:

1. Biodiversity – freshwater, riparian and floodplain flora and fauna, conservation, soil diversity and protection
2. Protection and rehabilitation of Danube sturgeons
3. Ecosystem services, wetlands, sustainable use of biological resources
4. Climate change, habitat change, hydromorphology
5. Invasive alien species – early warning, priority species and pathways, risk assessment and management
6. Water quality elements, ecological status, emerging pollutants, microbiology, ecotoxicology, biomonitoring and saprobic systems
7. Ecological functions and integrated basin management of lotic and lentic ecosystems
8. Riparian landscapes, landuse, flood risk assessment, hydrological modelling and restoration
9. Sustainable development and public participation in the Danube and Black Sea region.

The Program of the Conference will include 11 Scientific Sessions, a Session of the IAD General Assembly, a meeting of the IAD Presidency, national representatives and expert group leaders, as well as a field trip. A joint event with ICPDR members is planned as the ICPDR Standing Working Group meeting will be held at the same time in Sofia.

So far about 70 contributions from almost all IAD countries have been submitted for participation in the Conference. The short abstracts accepted for presentation will be published in a Book of Abstracts (in electronic format). The submitted extended abstracts after peer review will be published in a Supplement of the journal Acta Zoologica Bulgarica, *http://www.acta-zoologica-bulgarica.eu*. After the conference selected contributions will be considered for publishing in a special issue of the journal River Systems, *http://www.schweizerbart.de/journals/rs*.

Figure 1. *Sunset scene in the Danube Delta (Photo: K. Trichkova)*

Connecting young IAD members – 1st international multidisciplinary IAD Danube Camp in Dunasziget for students and young researchers, 2013

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Many scientists investigate along the Danube River and the basin, but despite many attempts of collaboration we are still very often limited in reaching a Danube-wide experience. Today's education system offers many ways of international exchange for students. Within the International Association for Danube Research we try to contribute with a specific Danube Camp to connect the young members among the IAD institutions and to develop the idea of an international, cross-institutional network in the Danube region. This includes linking students of different levels of experience (BSc, MSc, PhD and young researchers), scientific and regional background. The main aim on the long-term perspective is to raise the interest in a holistic approach towards the Danube region.

During the 39th conference "Living Danube" of the International Association for Danube Research in Szentendre, Hungary, in 2012 several young IAD members forwarded the request to the IAD secretariat to provide a platform for the exchange and training of young scientists in the Danube Region. Such a specific event should open opportunities for the development of personal skills as well as future project co-operation. This resulted in the 1st international and multidisciplinary IAD Danube Camp for students and young researchers held in Dunasziget, in July 2013.

Location

Providing travel logistics for participants from a huge area and local infrastructure are both crucial for the decision to find a suitable location for scientific work. The Eco Park in Dunasziget (Dunasziget Ökopark Közösségi Szálláshelyek, *www.pisztrangkor.hu)* offers rich opportunities in the centre of the biggest inner delta of Central Europe to discover natural values by canoe, bicycle and on foot. At the same time the Danube Research Station of the Hungarian Academy of Sciences, long term IAD partner in Hungary, had carried out research in this area for several decades. This position in the middle Danube section of the Carpathian Basin provides good conditions for presenting specific questions of the Danube Region.

Partners

Twenty-six students and young researchers came from sixteen institutions and ten countries: Danube Delta National Institute (Civil engineer, Socio economist), Danube Research

Figure 1. The first IAD Danube camp (July 2013) was connected to the SONDAR project – Soil Strategy Network in the Danube Region, to raise awareness on integrated soil management and protection.

Figure 2. Students from ten countries and ten different scientific backgrounds – collecting experience in the whole Danube Region.

Figure 3. Colleagues from the University of Mosonmagyarovar and from Bioforschung Austria provided practical inputs on field methods in soil science.

Institute – Hungarian Academy of Sciences (PhD student, Landscape planning, Geography, Environmental engineering), „Angel Kanchev" University of Ruse (BSc student, Ecology), Institute of Biology - Romanian Academy of Sciences (Dr. & PhD, Biology), Institute for Biodiversity and Ecosystem Research - Bulgarian Academy of Sciences (PD student, Biology), Kiev National Taras Shevchenko University – Department of Biology (PhD student), Istanbul Commerce University – Landscape Architecture and Planning (PhD student), University of Osijek – Department of Biology (research assistent – MSc student, Biology), University of Belgrade – Department of General Physiology and Biophysics, Faculty of Biology (BSc – MSc student, Biology), Comenius Uni Bratislava (PhD student, Biology), Institute of Geography – Slovak Academy of Siences (PhD student, Geomorphology), University of Ulm (MSc, International Development), Vienna University (BSc student, Physics-Biology), University of Life Sciences Vienna (BSc student, Landscape Architecture and Landscape Planning), University of Applied Arts Vienna (BSc student, Landscape Design). This wide range of interests allowed a well-balanced multi-disciplinary approach for exchange and discussions.

Topics

The first IAD Danube camp in July 2013 was connected to the SONDAR project (Soil Strategy Network in the Danube Region), to raise awareness on integrated soil management and protection *(www.sondar.eu)*. This includes three bilateral projects between Lower Austria and Slovakia (SONDAR

Figure 4. Zoltan Füzfa explained the inter-active exhibitions in the Futura museum in Mosonmagyarovar.

Figure 5. Aquatic and terrestrial field trips within the wide Szigetköz area give the opportunity to learn about water management measures and alterations in biodiversity and hydromorphology .

SK-AT: Soil as indicator of flood occurrences), Hungary (SONDAR HU-AT: soil as filter for pollutants, soil as reservoir for carbon) and Czech Republic (SONDAR CZ-AT: Improving quality of soil by raising soil awareness). IAD is represented by the Expert Group "Sustainable Development and Public Participation" and contributed good practice examples from the wider range of Danube countries and organised several dissemination events in the frame of "Danube Day" – the label for information and participation of the International Commission for the Protection of the Danube River (ICPDR). Under the umbrella of the European Land and Soil Alliance (ELSA) the step towards implementation on municipality level has been reached and more than a hundred cities and villages are going to implement soil protection within their administration.

Figure 6. Discussions, lectures and presentations – training for interdisciplinary work in the Danube region .

For the IAD camp four groups of students investigated the relations of "Soil and Water", "Soil and Biodiversity", "Soil and Culture" and "Soil and Land-use/Planning" in this specific area. Field-trips with canoes and bicycles and several lectures gave the background. Àrpád Berczik, Hungarian country representative within IAD board and Gábor Gúti shared their experience with the students. Gábor Kóltai from the University of Mosonmagyaróvár and Wilfried Hartl from Bioforschung Austria gave soil lectures. Ivoneta Diethart presented the mobile soil laboratory in the field. The group work was concluded with posters and the results were presented in a final session in the venue of the Futura Museum. Representatives from Mosonmagyaróvár municipality and IAD gave certificates to the students.

IAD Camp 2014

The 2nd IAD Camp will be held from 29th of July to 3rd of August 2014. The location will be again the Ecopark in Dunasziget, Hungary. The central position in the Carpathian Basin shows a high potential for investigation and future work. Scientific inputs will be given by the Hungarian Danube Research Station and the Bulgarian Academy of Sciences. The topic for this year will be "Changes in Biodiversity – invasive alien species in the Danube region" as a support to the Danube Invasive Alien Species Strategy network (DIAS). This network intends to coordinate research and measures on invasive species in connection to the Priority Area 6 – Biodiversity of the macro-regional European Strategy for the Danube Region (EUSDR). Interested students can apply directly to the IAD secretariat: *kutzenberger@iad.gs.*

Country Representatives

CR Hungary

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Since 2012 the Danube Research Institute is conducting its activities within the frame of the Ecological Research Centre of the Hungarian Academy of Sciences.

Investigations on macro-invertebrates and floodplain connectivity

Questions of lateral connectivity between the main river stem and the floodplain water bodies were the focus of our work since 2013, as part of the extended thematic scope "The Development of the Danube Floodplains in Southern Hungary". The active floodplain of c. 20 000 ha offers especially valuable possibilities for this type of research. Two oxbows were investigated simultaneously: one is situated in the active floodplain and receives up to 9 m of accumulated annual water level changes. The other one is located at a distance of only a few kilometers, but outside the flood protection levee separated from direct lateral connectivity. The influence of connectivity is studied through the com position of the macro-invertebrate communities associated with the macrophytes, and hydrological and water-chemical changes are recorded in parallel.

Aside from this study in Southern Hungary work is continued on the composition of biotopes in the Szigetköz (Small Danube Island, the extended alluvial cone area of the Upper Hungarian Danube).

International co-operation

Following the IAD-39 Conference in Szentendre (Hungary, 2012) collaboration was started between the Bulgarian and the Hungarian Academies of Sciences, involving the Institute of Biodiversity and Ecosystem Research (Bulg. Acad. Sci.; Lead: R. Kalchev) and our Danube Research Institute covering the application area of the "Comparison between Wetland – Danube River systems of Hungary and Bulgaria related to their biodiversity, functioning, services, management and nature conservation".

Figure 1. Confluence of a side channel with the Danube main stem during a flood period (river km 1489, Gemenc floodplain). (Photo: G. Keve, Baja/Hungary)

Figure 2. A side channel receiving constant flow from the Danube main stem only temporarily (Béda-Karapancsa floodplain area, river km 1441). The water surface is totally covered by the protected macrophyte Trapa natans. As a consequence the water body is depleted of light (suppressing submersed water plants) and oxygen availability may be strongly impaired this dense canopy (affecting aquatic fauna, e.g. causing fish kills, as reported from other side channels and oxbows). (Photo: N.Tarjányi, Budapest/Hungary)

Several members of our Institution were successfully involved in sampling and research on spot as well as in processing and analyzing the results which were recorded during the international 'Joint Danube Survey JDS 3' conducted by the International Commission for the Protection of the Danube River (ICPDR, Vienna).

Our institution participated in the SIL-32 Congress held in Budapest (2013), where several posters and lectures covering IAD-topic were presented.

The Hungarian branch of IAD organized one-week of advanced training under the lead of IAD General Secretary H. Kutzenberger in Mosonmagyaróvár (Upper Hungarian Danube reach). This international and multidisciplinary common research and planning camp (IAD Danube Camp, July 2013) was attended by 25 young scientists interested in IAD. Hungary was represented by four participants.

The Danube Research Institute considers it one of its most important tasks to strengthen the present research activities along the Danube, with a focus on the scope of IAD topics.

CR Croatia

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Protection of the Kopački Rit waters – interaction of the Danube and the floodplain.

Natural floodplain along the River Danube (river 1383–1410 km) belonging to the Kopački Rit Nature Park (Croatia) represents an internationally important wetland site providing a diversity of biotopes composed of periodic and permanent water biotopes, mostly channels, oxbows and lakes, surrounded by forests and reed stands, hosting thousands of rare and endangered species. Sustained hydrobiological research along the river-floodplain system was carried out from 1997 till nowadays in the frame of the scientific project "Protection of Kopački Rit waters – environmental interactions of the Danube River and the floodplain" (Josip Juraj Strossmayer University of Osijek, Department of Biology; project leadership by prof. dr. sc. Jasna Vidaković). In the focus of research are the structure and dynamics of bacterioplankton, phytoplankton, zooplankton and the invertebrate fauna of the sediment (nematofauna, chironomids), as well as periphytic communities (bacterial, algal and faunistic components). Special attention is given to the monitoring of spreading of invasive species Dreissena polymorpha and Limnomysis benedeni, recently found in the floodplain habitats (Stević et al. 2013).

Our results demonstrate that flooding has crucial influence on the development of investigated aquatic biocenoses. Depending on the time scale occurrence, flood pulses can be a stimulating or a disturbance factor for phytoplankton development and significantly influence spatial differences in phytoplankton composition across a horizontal gradient river-floodplain (Mihaljević et al. 2014). Fluctuating hydrological regime influences the colonization of periphytic algae (Mihaljević, Žuna Pfeiffer 2012) and also abundance and community structure of periphytic invertebrate communities (Vidaković et al. 2012).

However, altered intensity and frequency of flood events will have pronounced effects on the stable states in the floodplain. The major forces driving the cyclic shift between state of turbid water, characterized by high phytoplankton biomass and a state of clear water with very low phytoplankton biomass were closely related to extremely high and long-lasting flood events. It seems that the tendency to cyanobacterial equilibrium with dominance of *Cylindrospermopsis raciborskii,* an invasive species in the European waters, is pronounced after such extreme events (Mihaljević, Stević 2011). Relating to all given results, management objectives should be focused on qualifications of changes in hydrology and projecting those effects for the floodplain conservation.

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Figure 1. Drava – Danube confluence – Drava: left; Danube: right.
Located at the SE corner of the Kopacki rit wetland area (Picture: Mario Rumolić)

Expert Group Leaders

EG Chemistry / Physics

Water quality and biomonitoring – the way forward

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Physical and chemical parameters play a decisive role in the life of aquatic biocenoses: light, temperature, flow velocity, oxygen content, nutrients or xenobiotics have the potential to shape the structure and functionality of aquatic communities, from favoring the development of certain groups/species or inhibiting completely the growth of others, to inducing adaptations to allow their survival even in harsh conditions (e.g. in extreme environments). On their turn, the living organisms influence the chemical composition of the aquatic environment as a result of their metabolic activity (photosynthesis, respiration, excreta, decay, decomposition, etc.). Consequently, water quality represents the result of all the interactions occurred at microscopic scale in the aquatic environment. In normal state, natural ecosystems have the capacity to counteract temporary anthropogenic pressures such as pollution, presence of invasive species, exploitation of natural resources, etc. However, when the pressures are too severe or persist over a long time, they may overcome the natural buffering capacity of the ecosystems which start to degrade rapidly, losing their functionality and capacity to provide multiple benefits in support of human society (drinking water, fish, game, oxygen provisioning, regulation of atmospheric composition or climate, etc).

The monitoring of physical and chemical parameters, as required by the Water Framework Directive, provides basic tools to assess water quality. However, despite the fact that analytical techniques become more and more accurate, improving the detection limits or providing real-time information (remote sensing, biosensors), new generations of pollutants are emerging (neurotoxic pesticides, pharmaceuticals, endocrine disruptors, nanoparticles), posing new threats and requiring permanent adaptation of the monitoring program in order to identify their presence in the environment. In addition, only a very limited number of parameters are monitored and the cumulative impact of pollutants on the aquatic ecosystems is usually overlooked. Therefore, although the content of pollutants may be well below the maximum admitted concentration (MAC) in water or sediment, through bioaccumulation and biomagnification along the trophic networks, the content of pollutants may increase by several orders of magnitude, reaching dangerous concentrations at higher levels and representing health hazard for ecosystems and human society. Ecotoxicological studies assessing the impact of environmental contamination on aquatic communities have emphasized that, additional investigations, such as biomarkers analyses and histopathology, should complement the current monitoring program in order to evaluate the ecosystem health (Köhler et al., 2007; Sandu et al., 2008).

The IAD expertise gathered in several expert groups (Chemistry/physics, Ecotoxicology, Biotic processes, Fishery, Macrophytes, Microbiology, etc.) could help adjusting the current monitoring program in the Danube River Basin to answer the new challenges raised by the anthropogenic pressures and support the achievement of WFD objective to reach "good ecological status" of the water bodies. Considering the impossibility to monitor the content of thousands of chemical substances in daily use, evaluating the health of aquatic ecosystems by focusing on biomonitoring and the health of the biological communities they shelter, should become an integrative part of water quality assessment – they represent valuable "alarm signals", being inextricably linked to the good functionality of the aquatic ecosystems.

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EG Delta / Fore-Delta

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Measuring and modeling morpho-hydrological dynamics: Impact on quality of different Danube Delta ecosystems and hydrology. Setup of methodology.

Morpho-hydrological changes having taken place over the last decades are affecting the natural and sensitive environment in many ways and have stressed the land characteristics, delta landscape, general climatic conditions, hydric balance, natural drainage capacity, direction of water circulation, and the evolution tendency of the Danube Delta especially. The problem analysis requires reliable and sufficiently detailed information about the morpho-hydrographical configuration and its dynamics, as well as know-

ledge about the causes, chronology and effects of human interventions. Hydrological and geomatic measurements are essential for the interpretation of hydrological change processes, but variations in hydrological conditions also have important effects on morphology. In rivers such factors as the discharge, the velocity of flow, turbulence and depth influence the morphological configuration.

By cutting meanders on St.George Branch of the Danube for navigation purpose, which significantly reduced its length of 108.2km to 69.7km, flow distribution was affected in all the three Delta arms. In the period of low discharge (Danube flow at Ceatal Izmail: 2459m3s-1; Date: 31.08.2012) flows are distributed as follows: Chilia Branch takes 45.50% (1119 m3s-1), Tulcea Branch takes 54.50% (1340m3s-1), and this is distributed as of 38.95% (522m3s-1) on Sulina Canal, 59.33% (795m3s-1) on St.George Branch, and 1.72% (23m3s-1) on Channel Mila 35.

Sinuosity coefficient decreased on St.George Branch from 1.6590 to 1.0689, and the fractal dimension from 1.26 to 1.18. The implications are felt by silting of the Dunavat-Dranov hydrological complex and Lake Razim, due to increased water flow velocity in St. George Branch. Also, most of the old meanders, which are still connected to the deeper shortcut channel of the main stem at their upstream and downstream end, and the mouth of St. George Branch are heavily silted. For improving the monitoring and modelling of morpho-hydrographical processes of landscape changes, which were earlier based on mapping techniques, spatial metrics and spatial dynamic modeling, both high-resolution (HR) data and medium-resolution (MR) satellite time series images were used recently together with data taken with drones, which were integrated either separately or in combination with the other information. This is clearly illustrated by the example of the hysteresis effect in river suspended sediments during storm events on Sacalin Island in April 2013, when the island was broken over a length of 2.5 km (Fig. 2).

One of the main objectives is to examine how spatial metrics, derived from fractal geometry, may lead to more objective descriptions of river macroforms that may be used for intra-morpho-hydrography and inter-morpho-hydrography comparison, as well as for morpho-hydrography changes and 4D connection (longitudinal, lateral, vertical and temporal) analysis. Morpho-hydrography metrics are based on aggregation of the mapping of river banks and hydrological cross-sections, considering not only two-dimensional structure.

Figure 2. Danube – Sulina Branch Mouth from drone

Detailed information on morpho-hydrological configuration as obtained from time series of data, as well as future river plan form patterns, linked to data assimilation approach, will be used as input for spatially distributed modeling and a different development of alternative planning scenarios. The Danube river system supports the delta ecosystems. Interactions amongst drivers, processes and feedbacks, and thresholds leading to system changes need to be investigated. Morpho-hydrological changes, at the local scale and as regards its impacts are so rapid that current models have limited predictive capacity and proper interpretation of the significance of processes has to integrate Payments for Ecosystem Services (PES) approach.

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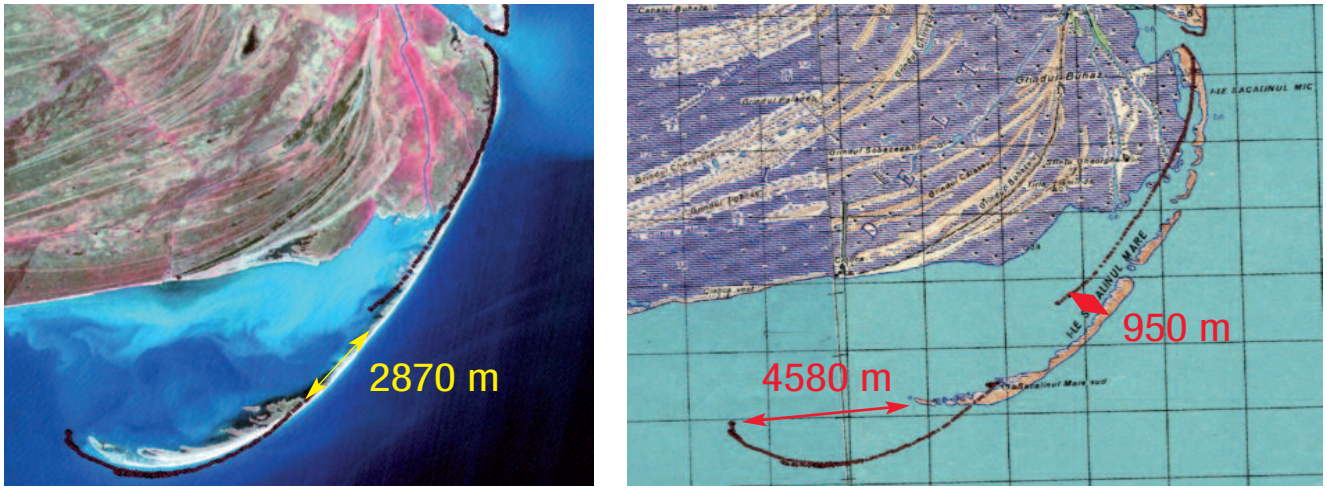

Figure 1. Danube – St.George Branch Mouth and Sacalin Island evolution
Actual position and configuration of Sacalin Island overlap into 2002 ASTER satellite image (left) and Topographical Map 1985 (right)

The next step at the Danube east of Vienna – Scientific monitoring of the Pilot Project Bad Deutsch Altenburg

The research project and its expected outcomes

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Introduction and general project aims

River systems are life lines for humans and thus provide multiple uses and services including fundamental ones such as drinking water and food production and uses related to the present economic development such as navigation, power production and industrial use of water. In consequence throughout the world, intense use has also led to multiple anthropogenic impacts regarding the hydromorphological conditions of rivers such as impoundments, levees and dams, which lead to distinct alterations of the discharge regime and water flow (Robertson et al, 2001). Loss of floodplain area (e.g. more than 90% in the upper Danube River – Sommerwerk et al. 2009) and a high degree of damming and reservoir conditions are a consequence in many river systems globally (Nilsson et al., 2005). At reach scale these measures include bank morphology modifications such as bank stabilization which are widely-used in regulated rivers (especially in navigable reaches). Natural gravel bars and shallow areas have been removed and replaced by groyne fields or rip-rap protected banks, leading at its extreme to straightened canals without any riparian structures. Also the hydrological connectivity to the adjacent floodplains and, therefore, the hydrological interactions and matter exchange between river and floodplain is disturbed. Furthermore in some cases also the exchange with the adjacent groundwater might be affected.

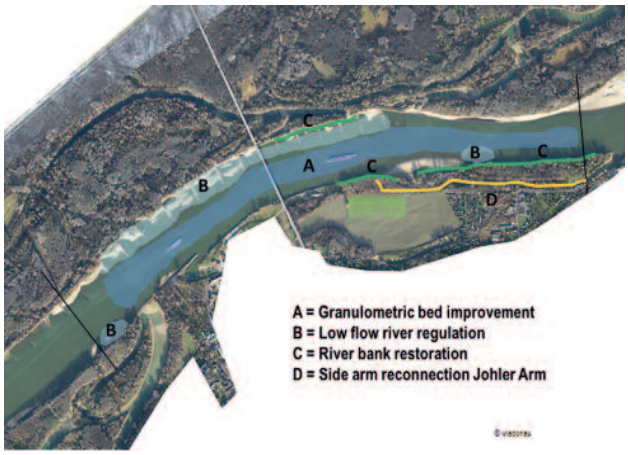

Figure 1. Project area of the Pilot Project Bad Deutsch-Altenburg between river km 1887.5 to 1884.5 (3 km) The different river restoration measures are drawn in the aerial picture and marked with capital letters (A-D).

These anthropogenic impacts are also major threats for the last free-flowing stretches of the Austrian Danube River and stimulate river bed incision due to a massive deficit in bed load downstream the chain of hydropower dams and leading to a degradation of riverine and riparian habitats (Bretschko 1992, Hary & Nachtnebel 1989). The free-flowing stretch between Vienna and the Slovakian border is one of the last remnants exhibiting an extensive river floodplain and quality assessments have shown that the zone still is of high ecological value. This stretch is also designated as a National Park since 1996 (Reckendorfer et al. 2005). Therefore a management concept for the free-flowing Austrian Danube was developed to address the major problems and reconcile the interests of the different stakeholders (nature conservation, navigation, flood protection). This concept led to the "Integrated River Engineering Project" (IREP) for the Danube east of Vienna of the Austrian Federal Waterway Agency (viadonau) (Reckendorfer et al. 2005).

Within the frame of the management concept IREP, the Pilot Project Bad Deutsch-Altenburg (PP BDA) was developed. It is the sixth pilot project in the Alluvial Zone National Park. The project started in the period 2005 to 2007 with the filing of the project documentation for getting the necessary allowances and for carrying out the investigation of the status quo. The measures were implemented since 2012 and are planned to be finalized by 2014. This project mainly addresses improvements of the morphology and the spatial and temporal development of flow reduced areas in bank zones and permanently reconnected backwater systems *(Fig. 1)*. The set of measures combined in this pilot project aims at testign not only separate measures as in prior pilot projects, but also to combine these and analyse the interacting effects of these measures. It aims to (1) stop riverbed incision by testing the measure "granulometric bed improvement" (an adaptive input of coarse gravel in deep

areas and in those parts of the river bed which are intensively exposed to the flow) in a three km stretch (2) improve navigation conditions in critical ford sections of the Danube River by low flow river regulation (modification, reduction and construction of new groynes) and ford dredging to adjust the river bed, (3) improve fluvial dynamics within the inshore zones by river bank restoration and permanent side arm reconnection, (4) enhance the lateral connectivity between the river and its floodplain and (5) reduce water levels during extreme flood events. The core planning principles focus on testing the potential to decrease the extent of the river bed incision rate by an adaptive, step by step implementation and should benefit both the nature values of the area and the navigation purposes (Reckendorfer et al. 2005).

These river engineering measures were implemented for the first time collectively in the 3 km long project area and serve also as a test for future implementation in the whole Danube stretch between the hydropower plant Freudenau and the Slovak border. The PP BDA serves not only as a test for the implementation of different river engineering measures, another important component of the whole project is the scientific standard and the detailed monitoring and research, analysing the effects of the measures and thus, providing inputs for the adaptive planning process. Furthermore, the monitoring also supports the optimization and adaptation of the technical and ecological assessment approach and provides answers to key scientific questions for large modified river systems.

Restoration measures conducted in the pilot project

Granulometric bed improvement

To counteract and stop river bed incision, particularly at currently exposed areas of the river bed coarser Danube gravel was added. The used material is coarser than average sizes but smaller than the largest grain of the natural Danube sediment in the project reach. The sizes used are the result of optimization processes, considering both ecological and navigation issues. The coarsening of the river bed should protect it from excessive erosion and should lead to a reduction of bed load export.

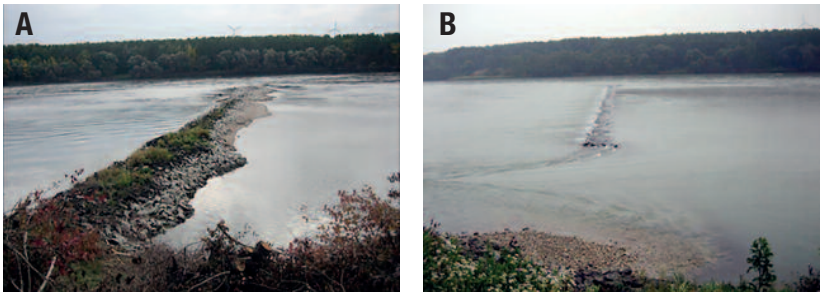

Figure 2. A = old groyne at low flow water level (LFW) +0.5 m. B = new groyne with declinant shape at LFW +0.3 m. In the front the lowered groyne base can be seen, which is now constantly overflown. *(Fotos: © viadonau)*

Low flow river regulation (modification and construction of additional groynes)

In the 3 km long project area the low flow regulation was optimized with respect to ecological and navigational criteria. In total 19 groynes were removed, four groynes were lowered to 30 cm above the water level at regulated low flow, and 10 groynes were newly constructed. The new groyne shapes are declinant and raise low water levels for navigation more efficiently than the old structures. Additionally the groyne base was lowered and is therefore constantly overflown. Thus, this constructed secondary instream flow channel (= 'Hinterrinner') provides new habitats for riverine species in aquatic and semi-aquatic habitats such as nursery grounds for juvenile fish along shallow water areas close to the river banks.

River bank restoration

The removal of rip-rap contractions over a length of 1.2 km enabled the River Danube to design natural river bank structures *(Fig. 3).* This river bank restoration led also to a slight lowering of the flood water level. For a length of 900 m the river bank protection was totally removed and side erosion was allowed again.

Side arm reconnection Johler Arm

The 1350 m long Johler side arm was reconnected to the Danube and now receives a minimum discharge of 10 m^3 s^{-1} even at low flow conditions. The inflow area and the whole side channel bed were lowered below low flow water level and therefore connection with the main river stem is assured almost over the entire year (more than 300 days p.a.). This reconnected side arm is expected to provide valuable habitats for rheophilic species such as spawning grounds and sheltered areas for several riverine fish species.

Monitoring and work packages

The monitoring program has a modular structure and consists of various abiotic and biotic work packages (Fig. 4). The essential issue in this monitoring project is the permanent interaction between these work packages. This enables, through intensive spatial-temporal coordination and data exchange between the individual investigations, optimal synergism crucial for the development of tools (models) to predict the reaction of the ecosystem to river engineering measures (Schabuss et al., 2007). The scientific monitoring consists of a temporal and spatial design allowing to address the major issue of the program for testing the efficiency of implemented measures to reach the aims, how long lasting the effects are and to what extent different measures affect the river ecosystem. The temporal design is based on an investigation phase prior to the implementation of the measures,

Figure 3. Riverbank restoration and rip-rap removal. A = typical rip-rap construction for river bank fixation. B = natural river bank with gravel bar after rip-rap removal. *(Fotos: © viadonau)*

a phase during the construction works and three phases of investigations after the construction period is finished allowing for addressing long term effects of the measures over a time span of 10 years, lasting until 2025. The spatial design includes a before and after-control of impact design in various work packages using unaffected sites to clearly show effects of the measures in a highly complex environment.

The monitoring is run by a team of experts covering engineering, hydrological, morphological, landscape, biogeochemical and ecological aspects. The coordination of the scientific team is guaranteed by BOKU Vienna and Wasser-Cluster Lunz and the Technical University of Vienna, the University of Vienna, and three companies are also involved in close collaboration with the scientific institutions.

Major research objectives of the monitoring programme

The monitoring program aims to answer the question what are the effects of the different measures on specific organisms, processes and environmental conditions at different time scales. Extending the perspectives further, the following research questions are of interest:

(I) In which way will the measures stabilize the stream bed, counteract incision rates, increase the connectivity with the floodplain sites and the habitat turnover at the local scale within the river section and which species will benefit most in the first years and over longer time spans?

(II) To what extent can the set of measures improve the overall conditions of highly endangered rheophilic communities and characteristic species?

(III) To what extent will the set of measures change different ecosystems functions of the investigated river stretch and to what degree can the overall ecosystem quality be improved?

Abiotic monitoring work packages

The abiotic monitoring task is split into 5 work packages covering the main abiotic monitoring themes (Fig. 4). As an overarching interaction and collaboration between the different working groups is defined within the concept, not only the abiotic work packages but also the biotic investigations are interrelated to enable integrative conclusions. The first work package is called *Hydrology and Hydraulics* and covers fundamental parameters like water levels, flow velocity, discharge and shear stress. Different devices including ADVs with a sampling rate of up to 64 Hz to cover turbulent flows are combined for velocity measurements to get a full picture of the 3D flow conditions. Furthermore a device, measuring bed shear stress in a direct way is developed to gain insights on the temporal variation of shear stresses. Another emphasis of this work package lies in numerical simulation, extrapolating point information to the entire flow domain. Therefore the three-dimensional numerical model RSim-3D (Tritthart, 2005) is employed for obtaining full coverage of water surface elevations, flow fields, bed shear stresses, etc. for eight characteristic runoff values in the range of 915 m^3s^{-1} to 5030 m^3s^{-1}. It solves the Reynolds-averaged Navier-Stokes equations in three spatial dimensions with a finite volume approach on a mesh consisting of arbitrarily shaped polyhedra. The model is calibrated and validated using separate data sets of velocity and turbulence measurements obtained from ADCP and ADV instrumentation, bed grain size distributions and gauging information. The results are used for assessing the impact of the measures taken within the framework of the Project, but they are also important prerequisites for the simulation of sediment trans-

Abiotic Monitoring	Integrative Adaptation	Biotic Monitoring
A1: Hydrology / Hydraulics		B1: Ecological Functions and Processes
A2: Hydrology / Hydraulics Groundwater	Primary functional correlation	B2: Landscape Dynamics
A3: Sediment Budget and Transport	Secondary feedbacks	B3: Habitat Diversity
A4: Changes in Morphology		B4: Biodiversity / Bioindication
A5: Navigation		

Figure 4. Structure and work packages of the monitoring program (modified after Schabuss et al. 2007)

port, for habitat modelling and serve as a basis for integrative research in numerous biotic work packages.

The work package *Hydrology and Hydraulics Ground Water* addresses all issues referring the project induced changes in the ground water level. Water level measurements are used to record prevailing conditions and numerical models serve as a tool to extrapolate the point information to the entire project area and to simulate the temporal und spatial situation. Additionally soil permeability is monitored with infiltration tests and the water quality is observed over the entire monitoring time.

Transport Rates and Budget of Bed Load and Suspended Sediment are surveyed in the third work package. Bed load transport is one of the most important parameters to be monitored in order to evaluate the functionality of the granulometric bed improvement. Innovative methods have been developed for being able to measure sediment transport parameters at large rivers. A basket sampler was adapted to be applicable at the high flow velocities of the Danube and was used for 37 cross-section measurements covering the whole discharge spectrum up to a more than 100 years flood event. A method for tracing artificial gravel pebbles was developed for the Danube to observe the particle paths and answer research questions like the initiation of motion and medium transport lengths (Liedermann et al., 2013). These measurements aim at quantifying the sediment budget and at understanding the ongoing processes to evaluate the measures and to predict future developments. A pre and post impact monitoring is performed to observe changes in sediment size distributions including 150 large scale sediment samples (0.4 m³ each) and undisturbed sediment samples taken by using Freeze Core Sampling. For this method an iron tube is driven 1 m into the river bed and is cooled down with liquid Nitrogen to -196°C. The sediment freezes to the tube subsequently, can be lifted out of the water and is cut into slices of 10 cm thickness to be analysed separately. The extracted material is used both for the determination of benthic fauna and for sediment analysis. The monitoring in this work package also includes an extensive program to observe suspended sediments. A combination of direct (multi point water samples) and indirect devices (turbidity sensors) is used to describe the temporal and spatial variability of suspended sediment transport and to calculate the yearly loads.

The measures undertaken in the project will affect sediment budget and transport conditions. By adding coarser material (granulometric bed improvement) a dynamic state of equilibrium is envisaged which reduces bedload transport but allows relocation of sediment which is important for biotic processes. The emphasis of the work package *Morphodynamics* lies on the observation of these morphological changes. Frequent echo sounding measurements using both single and multi-beam devices are performed by viadonau. The data is analysed to see long term trends and short term reactions of the measures applied to the reach. These measurements are coupled with laser scans and geodetic surveying to obtain a complete digital terrain model which is used as input for the numerical models and serves as a basis for other research groups. Other parts of this work package include investigations regarding side erosion processes. Suitable riparian regions are selected for comprehensive investigation of soil parameters like water permeability, dry density, erodibility, matrix potential and porosity. In addition to this the hydrological situation and the ongoing erosion on the spot are surveyed. Computational models will then assist in predicting impact quantity and quality to support the sediment budget model. Furthermore the changes in habitat suitability for fish species will be surveyed by using computational models. The hydraulic simulation results will be linked with suitability indices in order to obtain information about habitat quality.

The integrated river engineering project affects the Danube River as one of the most important west-east navigation corridors in Europe. That's why one of the aims of the monitoring concept is to detect*cChanges in Navigation Conditions.* Granulometric bed improvement must not affect marine propellers but should provide competitive navigation conditions at low flow periods. The effects of these measures on the shipping pathway are monitored. A woody debris monitoring campaign is performed to survey the enhancement of floating wood as a result of sidearm reconnections. Analyses of the changes in secondary flows are conducted to sort out if the new groyne shapes have a negative impact on the navigation conditions. Additionally the impact of ship induced waves on different shore types is observed within the monitoring task. Therefore a wave gauge was exposed over several weeks and the data was coupled with the DoRIS (Danube River Information System) data of viadonau to link the observed impacts to parameters like ship type, vessel speed, distance to shore and different morphological situations (Liedermann et al., 2014).

Biotik monitoring work packages

The first biotic work package B1 addresses the *Ecological Functions and Processes.* Key ecological processes as carbon and nutrient cycling are in the centre of this program and the main drivers/indicators are microphytobenthos, bacteria and phytoplankton. They are mainly influenced by the physical habitat heterogeneity and retention efficiency of subsystems within the riverine landscapes. The ecosystem functioning is also affected by the mode of carbon and nutrient delivery. Thorp and Delong (2002) hypothesized in the revision of the riverine productivity model (RPM), that the major source of organic matter, which is used from the food web, is derived from autochthonous autotrophic production in the river channel.

Therefore, the measures of river bank reconstruction and side arm reconnection affect the development and productivity of microphytobenthos, the interaction with phytoplank-

ton and bacterial communities and thus, the carbon, and nutrient cycling of the whole river corridor. The guiding questions of this work package are as follows: (I) To what extent affect a change in morphology of the river bank structure and the initiation of more dynamic conditions along the river bank the structure and function of the microphytobenthos community and thus, the organic matter contribution to the overall system? (II) How does a change in flow conditions and morphology affect the sediment composition, the microbial processing associated to the sediments and in consequence the associated carbon and nutrient cycling in the riparian structures of the Danube River? (III) What effects has an increase in connectivity of the restored side-arm systems on the main primary producers (microphytobenthos and phytoplankton) and on the interactions between these primary producers?

The second biotic work package covers issues concerning *Landscape Characteristics, Landscape Structure and Landscape Dynamics.* The landscape structure part deals with the effect of river bank reconstruction and changed spatial distribution of vegetation associations (terrestrial and aquatic areas). A second topic is the evaluation of the (negative/positive) effects of river bank tree removal on the landscape characteristics. For the landscape dynamics hydromorphological parameter will be collected to document the current state with the historical situation (historical reference conditions, "Leitbild") of the riverine landscape. This will evaluate, if the restoration measures lead to an approach of floodplain typical characteristics in the project area.

Habitat Diversity is the third biotic work package. The intersection of morphology and hydrology causes in a high degree the distribution, shape and overall characteristic of different habitats. Changes in morphology and hydrology, e.g. caused by river bank reconstruction, but also processes of erosion and sedimentation, lead to changes in habitat composition. These shifts in habitat diversity are related to aquatic organism but also to organisms of the aquatic-terrestrial interface, an ecotonal zone of key importance in riverine landscapes. The investigations of the work package B3 will evaluate the shifts and changes in habitat diversity and can draw conclusions for relevant species.

The biotic work package 4 deals with *Biodiversity and Bioindicators.* In this work package key indicator groups for riverine landscapes are investigated including aquatic vegetation, river bank vegetation, terrestrial river bank fauna, benthic macro invertebrates, fish and different group of birds.

The major questions targeted can be summarized for all sub-work packages and the specific measures as follows:

(I) Which positive effects can be observed for riparian communities (river bank vegetation, terrestrial river bank fauna, different group of birds) along the river margins, (II) what is the response of rheophilic communities and floodplain communities to the permanent re-opening of a side arm (aquatic vegetation, benthic macro invertebrates, fish) and (III) to what extent react the benthic communities (benthic macro invertebrates) in the river bottom to changes in grain size distribution?

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Distribution of the macrozoobenthos and composition of the fish communities along the Bulgarian stretch of the Danube River in relation to the environment

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The Bulgarian stretch of the Danube River is subject to various anthropogenic pressures such as discharge of organic substances and nutrients, continuity interruption, sediments/gravel extraction, rip-rap armoring etc., which affect the aquatic communities. The macrozoobenthos and fish are well recognized indicators for different types of pressure. The project "Survey of the pollution of the Danube River with heavy metals and organic matter with a view to long-term improvement of the status of fish populations in the Bulgarian Danube stretch" was funded by the Executive Agency of Fisheries and Aquaculture under the Operational Program for Development of the Fisheries, co-funded by the "Investment in the Sustainable Fisheries" European Fund of Fisheries of the EC. It was conducted in 2013. Sampling and analyzing were performed for several integral parts of the project: the mandatory Biological Quality Elements: macrozoobenthos and fish (WFD 60/2000); microbiology; physical and chemical testing of the environment. Hereby, the results for the macrozoobenthos and fish coenoses are given.

Macrozoobenthos

The results of the concentrations of heavy metals and nutrients provisionally separated the Bulgarian stretch of the Danube in two parts with a dividing point at the Iskar River mouth.

As a whole, the content of Ni, Fe and Pb in both sediment and water were higher at the sites along the lower part (downstream the Iskar River mouth), while higher concentrations of Cu and As were found at the sites upstream the Iskar River. The concentration of nutrients in water and sediment, especially PO4-P, total P and NH4-N also increased in the downstream part. The upstream part could be considered as less loaded with nutrients and heavy metals than the downstream one. An exception is the sampling site Timok, which is the most upstream location of the investigated stretch. This site was highly affected by the right tributary the Timok River, which carries polluted water generated by the mining industry in the Republic of Serbia.

The primary aquatic macroinvertebrates (oligochaets, freshwater snails, clams and amphipods) combined with the nonbiting midges (Chironomidae) were well presented and abundant at all sampling sites, while aquatic taxa of lesser importance (Trichoptera, Heteroptera, Ephemeroptera,

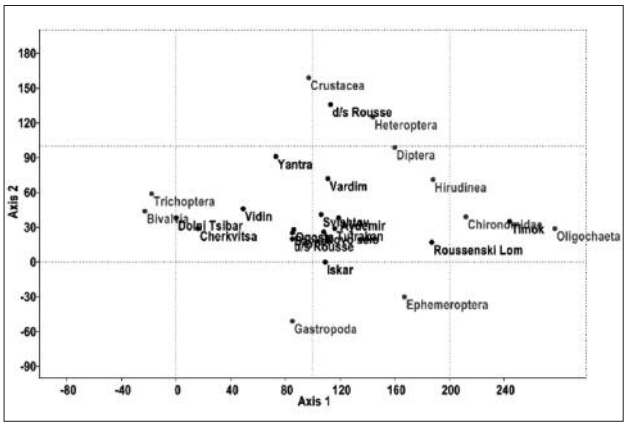

Figure 1. DCA of the macroinvertebrates taxa groups

Diptera, Coleoptera and Odonata) were present in much smaller number of individuals or even absent at some of the study sites. Nevertheless a higher diversity of insect larvae at sampling sites Timok and Roussenski Lom *(Fig. 1)* was observed, due to heterogeneity of the habitats, including the development of macrophytes.

The results revealed the Timok, Iskar, Roussenski Lom and Tutrakan sites as the most loaded among all sites investigated in the present study along the Bulgarian Danube stretch. These sites are located downstream of the confluences of tributaries highly polluted from industrial and communal untreated waste waters (Hamchevici, Craciun 2008). The environmental conditions, formed at the sites mentioned and characterized by permanent sources of

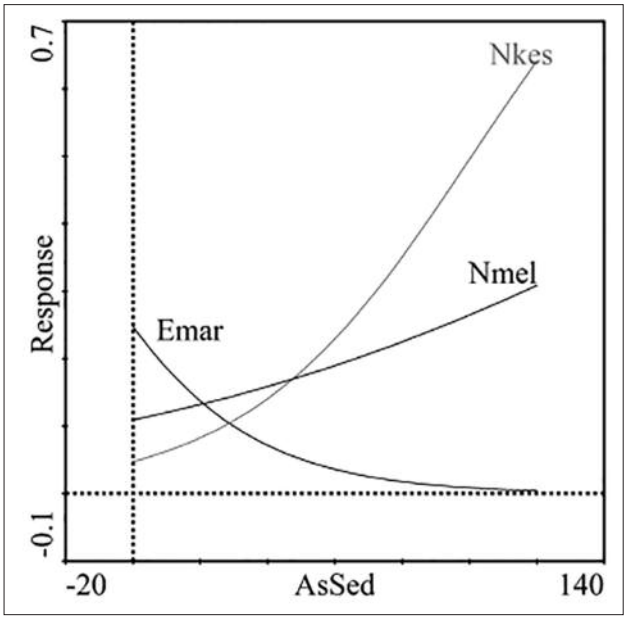

Figure 2. Response curves for three fish species (Emar – Eudontomyzon mariae, Nmel – Neogobio melanostomus, Nkes – N. kessleri) fitted using generalized additive models for the As concentration in the substrate (AsSed).

pollution favored the development of tolerant and more resistant benthic taxa. This corresponds to the observed abundance of Oligochaeta and Chironomidae. On the other hand the sampling sites more heavily loaded with nutrients, were also rich in macrophytes and periphython. The heterogeneity of the habitats created a diverse environment for the development of an abundant benthic community.

The distribution pattern of the main benthic groups in relation to the assessed environmental factors (concentration of heavy metals and nutrients) is probably a result of their tolerance to a certain level, and different kind, of human impact. The correlations found should not be considered only in the context of direct interactions between benthic groups and parameters of the environment. The relationship could be explained by feeding preferences and the effects could be passed on through the trophic chain.

Fish

Twenty two fish species from eight families were recorded. Bleak, Roach, Bighead Goby, and Monkey Goby were the most frequent species. The Neogobius spp. group was represented at all the sample sites. Significant abundance and frequency of occurrence of the Bighead Goby, Round Goby, Racer Goby, and Monkey Goby were found. Abundance increased downstream, and the main dominant species detected was Round Goby.

According to the partial dominance curve method (Clarke 1990) there were no sites even close to the reference conditions for fish fauna confined to the riparian area. Therefore it was assumed that there is a prevalence of the anthropogenic factors over the natural ones.

A significant part of the fish species demonstrated patterns of spatial distribution strongly related to high concentration of trace metals in the sediments *(Fig. 2)*.

The bottom substrate is considered the leading natural environmental factor for the distribution of the fish community in the riparian zone as far as there are no significant hydromorphological changes along the Bulgarian Danube section. The population characteristics of the fish fauna in the riparian area indicate a significant anthropogenic impact.

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News and Notes

The DIANET International School

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The macro-regional Danube-Region-Strategy encompasses all countries of the Danube Basin, a region where differences in income are as large as differences in the contributions to international research. This impairs joint research on collective problems.

Two Conferences of Presidents represent the largest institutionalised actor in the field of scholarly production of knowledge in the Region – the Universities. More than 120 Schools of Higher Education are represented in the Alps-Adriatic-Rector's Conference and the Danube Rector's Conference. These two institutions launched the flagship-Project *"Danube-Future"*, which is coordinated by the Alpen-Adria-Universitaet Klagenfurt, together with the Universities of Novi Sad and Trieste and the University of Natural Resources and Life Sciences, Vienna.

Danube-Future attempts to link and support protagonists in the field of sustainable development. With an interdisciplinary focus and by studying the role of the natural and cultural heritage as a means of sustainable development in the Danube Region, *Danube-Future* offers a specific perspective within sustainability research.

Young academics are particularly important. The DIANET International Schools, which are supported by the European Social-Fund, and held in 2013 and 2014 in Gorizia (IT), are dedicated to promote them: International and interdisciplinary groups of PhD-students and Junior Post-Docs practise cooperation and develop common ideas for projects, which are converted into initial proposals for projects during the school. In 2014 we focussed on natural heritage, the University of Natural Resources and Applied Life Sciences had the school lead. In 2015, the University at Novi Sad will take the lead and cultural heritage will be the focus of this interdisciplinary advanced training. Participants from both Conferences of Rectors are welcome. For further information, see *www.danubefuture.eu.*

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Hydrological catchment of the River Danube

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