

INTERNATIONAL ASSOCIATION FOR DANUBE RESEARCH

38th IAD Conference

Large River Basins – Danube meets Elbe

Challenges – Strategies – Solutions

22–25 June 2010

Dresden, Germany

Book of Abstracts

Organised by:

IAD Germany together with the **German Federal Institute of Hydrology (BfG)** and the **General Secretariat of IAD**

Supported by:

German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), German Federal Ministry of Transport, Building and Urban Development, German National Committee for the International Hydrological Programme (IHP), German Limnological Society (DGL)

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Lectures

Climate-change analyses used for river-basin management in the Rivers Danube and Elbe

BASTIAN KLEIN*, PETER KRAHE, ENNO NILSON, CLAUDIA RACHIMOW, THERESA HORSTEN, THOMAS MAURER, HANS MOSER

*German Federal Institute of Hydrology (BfG), Germany, klein@bafg.de

Increasing global temperatures as indicated by climate projections of the Fourth Assessment Report of the IPCC may lead to changes in the hydrological cycle. This triggered a discussion among experts how aquatic systems and water-resources management practices can be adapted to become “climate proof”. However, an appropriate evaluation of adaptation options requires (1) the assessment of regional climatic and hydrological effects taking into account different sources of uncertainties in data and methods, and (2) the integrated assessment of the main impacts on water quality, water quantity as well as ecological and economic functions of waters.

This contribution shows concepts and preliminary results from ongoing research projects in the Danube and Elbe River Basins (AdaptAlp, KLIWAS and ECCONET). For instance, there is no – and most likely never will be – a single “true” climate-model run in face of an uncertain future. Hence, a “multi-model approach” must be used to account for the uncertainties that lead to a range of possible changes. There is a large span by using various climate projections for one region, different bias-correction methods and diverse hydrological models. Against this background, the present state-of-the-art of climatic and hydrological changes and their impacts on aquatic systems is evaluated.

Hydrological and ecological responses of the Lobau floodplain to climate change

PETER WINKLER¹, MICHAEL TRITTHART², THOMAS HEIN¹

¹Wasser Cluster Lunz – Center for Aquatic Ecosystem Research, Austria, p.winkler@boku.ac.at

²Institut für Wasserwirtschaft, Hydrologie und konstruktiven Wasserbau, Universität für Bodenkultur (BOKU) Wien, Austria

Due to river regulation, flood control measures and intense agricultural activities, most Central European floodplains have been destroyed during the past 150 years. Although most of the remaining floodplain fragments are degraded nowadays, they still fulfil important ecological functions acting as resorts for rare species and purifying river water. Global change factors like temperature increase and meteorological extreme events exert additional pressure on such fragile yet important ecosystems. In the present study, hydrological and ecological responses of the Lobau floodplain downstream of Vienna to changing climatic conditions are investigated. This relies firstly on predicted climate scenarios for the Danube valley and secondly on data from meteorologically extreme periods in the past: 2002, a year with two exceptionally high floods and 2003, an exceptionally dry year. In addition to the altered hydrology, the ecological response of the floodplain ecosystem is studied by considering the shift and/or disappearance of characteristic habitats like deep water, shallow water and semi-aquatic areas. Because of the significant impacts of global change factors on ecosystems, the results of this study are relevant for conservation and restoration measures to be carried out in the Lobau.

Are climate impacts already discernable on European Rivers? The River Danube example

MARTIN T. DOKULIL

University Vienna, Dept. Limnology and Hydrobotany, martin.dokulil@univie.ac.at

Impacts of global warming on the world's major rivers remain uncertain. Decreased precipitation in the mid- and lower latitude will lead to reduced run-off while higher water temperatures might lead to increased evaporation. As a result many rivers could change their run-off regime and may decrease in flow. Long-term water temperature data from the River Danube collected by the Austrian Hydrographic Survey are analysed. To show trends unequivocal, monthly mean water temperature data are investigated from four stations in the Austrian river section covering the period 1901–2006. These data are related to air temperature, precipitation and discharge. Significant relations between air and water temperature are established at all stations. Time trends are analysed using the non-parametric Kendall test and robust regression. All data are pre-whitened to remove noise. Results indicate a highly significant increase of about 1.4°C, equivalent to 0.01°C per year. The increase in water temperature is related to long distance climate signals. Predictions for the time horizon 2050 are developed from multiple regression analyses and scenarios of future changes in air temperature and discharge.

Vulnerability of floodplain areas along middle Elbe river in Germany in view of climate change induced flow alterations – scenarios and adaptability

GEORG RAST¹, LUTZ REICHHOFF², UWE RIEMANN³

¹WWF Germany, Freshwater Unit, Germany, rast@wwf.de

²LPR Landschaftsplanung Dr. Reichhoff GmbH, Germany, info@lpr-landschaftsplanung.com

³FUGRO-HGN GmbH, Office Dessau, Germany, dessau@hgn-online.de

The floodplains along the Elbe River in Saxony-Anhalt are still in a near natural state with vast valuable old floodplain forests and the eldest well-known floodplain meadows. The Elbe River bed has undergone significant alterations by different river training measures (bank reinforcements, groynes) for more than two centuries. One of the main impacts has been severe river bed incision by more than one meter. This process is on-going and water levels at low and mean flow are further decreasing. In consequence, flooding frequency of floodplains is reduced. Hydrological models considering climate change effects indicate further reduction of mean and low flow as well as prolongation of low flow periods. Floodplain habitats are facing changes in their water balance. For a specific floodplain section near Dessau future changes of groundwater table, flooding frequencies and duration of low flow periods are considered in relation to terrain elevation and alluvial layer thickness concerning water balance. Some scenarios on the expected development of floodplain vegetation are described. Finally, adaptability for mitigation of habitat alterations is illustrated.

Consequences of climate change and river bed erosion on the utilization of the Elbe and its flood plain

IRIS BRUNAR¹, ERNST PAUL DÖRFLER²

¹Friends of the Earth Germany (BUND-Elbeprojekt), Germany, i.brunar@gmx.de

²Friends of the Earth Germany (BUND-Elbeprojekt), Germany, epd@gmx.de

During the past two decades, the Elbe has experienced drastic changes which have had an impact on the river and flood plain ecology as well as on their utilization. Verifiable changes in the water level, especially declining discharge, can be attributed to the effects of climate change on the Elbe. Not only have regional temperatures increased, leading to increased evaporation, but this trend has been intensified due to a substantial reduction in air pollution. At the same time, erosion of the river bed has accelerated.

These factors are heavily impacting the water balance of the fluvial landscape. The ever-increasing periods of low water, enhanced by riverbed erosion, influence the river's flood plain, especially during the growing season. The changes in the water level of the Elbe have negatively affected its role as a waterway and the cultural and natural heritage along the river.

Environmental organizations and the German water and shipping authorities are struggling to find a suitable solution to the resulting management problems of sediment and detritus on the Elbe. However, the German Federal Government demands an almost year-round minimum depth of 1.60 metres for shipping. The paper will discuss whether this goal is realistic or not and what alternatives can be proposed.

Towards Risk-Based Management of European River basins: key-messages of the EC FP6 project RISKBASE

Jos BRILS

Deltares, The Netherlands, jos.brils@deltares.nl

RISKBASE (www.riskbase.info) advocates that the actual improvement of the ecological quality of our river basins, and thus sustaining of the ecosystem services they provide, calls for a different management approach. This approach involves the integrated application of the three key-principles to risk-based management: informed, adaptive and participatory.

Informed: a sound understanding of the functioning of the soil-sediment-water (ecological) system and its interaction with the social system is the basis to river basin management. EC projects, like AquaTerra and Modelkey, have delivered new, natural system understanding, relevant to support the achievement of the WFD objectives, i.e. for improving the effectiveness of measures.

Adaptive: we have to learn-by-doing as social/ecological systems are extremely complex and dynamic and can respond in non-linear and unexpected ways.

Participatory: involvement of stakeholders will improve management, e.g. because they may bring in local knowledge. The use of a common language will enable participation. 'Ecosystem services' may provide that language.

Leading initiatives, like the management of the Llonsko-Polje catchment (Sava), already demonstrate some of these aspects. However, more, well coordinated and monitored 'learning catchments' (a.o. aimed at stepwise improvement of the effectiveness of measures) are needed to transform our general framing and develop best practice.

Implementation of the WFD from the Perspective of Nature Conservation: Analysis of the Programmes of Measures and the River Basin Management Plans of the Danube and the Elbe River Basins

JULIANE ALBRECHT

Leibniz Institute of Ecological and Regional Development (IOER), Germany, j.albrecht@ioer.de

In all river basins of the European Union, the 3rd phase of the Water Framework Directive (2000/60/EC, WFD) had to be concluded by the end of 2009. In this course, programmes of measures (Article 11 WFD) and river basin management plans (Article 13 WFD) have been established.

Due to its ecological approach, the WFD interferes with nature conservation in various aspects. This overlap is especially reflected in the content of the programmes of measures and the river basin management plans. Examples are the biological criteria for the assessment of the water status, the list of protected areas and certain measures for achieving the objectives of the WFD.

The present contribution will elaborate the links between WFD and nature conservation in river basin planning. Based on the content of the Danube and Elbe River Basins management plans, it will be investigated which recommendations can be given for emphasizing the aspects of nature conservation in the practical implementation of the plans starting in 2010. Moreover, proposals for strengthening the concerns of nature conservation will be made for the scheduled revision of the plans in 2015.

The Implementation of the Water Framework Directive in the Danube River Basin and the Idea of a Danube Biodiversity Strategy from the Perspective of Environmental NGOs

GERHARD NAGL

Danube Environmental Forum (DEF), European River Group, Water Working Group European Environmental Bureau (EEB), Green Heart of Europe, BUND and Bund Naturschutz Water Working Group, NABU River Group, gerhard.nagl@donaufluss.de

Members and member organizations of the Danube Environmental Forum (DEF) are committed to water and biodiversity protection and contribute to the implementation of the Water Framework Directive in the Danube River Basin. They have got different views and experiences compared to responsible authorities. International, national, and regional levels of the development of management plans including programmes of measures are assessed. Positive and negative elements and examples from the viewpoint of environmental NGOs are presented.

The analysis gives hints what is important for realization of the plans and programmes, and what issues should be included and improved in the next cycle. The implementation of plans and programmes gives opportunity to improve public participation and to direct prioritization towards ecology, including biodiversity. A most important issue for further work to implement plans and programmes is the conservation of biodiversity in rivers and wetlands. European biodiversity policy should have a clear focus on the Danube as a lifeline including a coherent network of habitats and protected areas. A Danube Biodiversity Strategy should be an indispensable part of the environmental pillar of the European Danube Strategy. Elements and phases of a possible Danube Biodiversity Strategy are characterized.

2010 – beginning of an new era of water management by river basin management planning

JOERG JANNING

European Union of Water Management Associations, EUWMA, Den Haag, The Netherlands,
jjanning@online.de

EUWMA, the European Union of Water Management Associations, represents public local and regional water authorities from, currently, eight EU member states. EUWMA members are public entities, authorized by national law to perform water management tasks, including water supply, waste water treatment and discharge, flood and coastal protection, water quality management, drainage regulation and irrigation. Based on public interest and available scientific and technical data on both ecological and economic aspects EUWMA contribute to more effective collaboration and design in sustainable water management and identify all potential benefits and costs of action or non-action.

The river basin management plans, describing the programme of measures to realize WFD objectives, starts a new era of water management with obligations in assessment, setting realistic objectives and measurement strategies in 6 year planning cycles.

Organizing enhanced status of water based on biodiversity / ecosystem approaches in bottom up processes is the most efficient way to act sustainable, reflecting affordability and willingness to pay as well as cost recovery by internalizing environment and resource costs.

Cultivated landscapes are a reality in many areas in Europe, which include mostly artificial and heavily modified water bodies – these require an EU-wide coherent procedure for setting normative values for their ecological potential.

The Danube River Basin Management Plan (DRBMP) – challenges of an integrative policy

CRISTINA SANDU¹, JÜRIG BLOESCH²

¹Institute of Biology, Romanian Academy, Splaiul Independentei no. 296 sect.6, Romania, sanducri@yahoo.com

²International Association for Danube Research (IAD), Switzerland, bloesch@eawag.ch

The adoption of WFD (2000/60/EC) was a step forward in the holistic approach of integrated water management. However, its implementation is a real challenge for the stakeholders, especially in the most international Danube River Basin (19 countries) with different economic, cultural, and environmental heritage. Further, non-EU member states must be integrated into the provisions of EU WFD and related directives. The DRBMP (2009) with the Joint Programme of Measures developed by the ICPDR provides a milestone towards the “good ecological status” required by WFD.

Based on our review as stakeholders, we emphasize that topics such as climate change, invasive species, sediments, groundwater, land use (spatial planning), overexploitation of natural resources, wetlands and biodiversity conservation, and ecosystem services should receive increasing attention in the DRB. In the context of EU strategy (EU SDS – COM 2009, 400) the sustainable approach is still biased towards economy, while environmental and social aspects need to be strengthened. Practical aspects such as transposing EU policy into national legislation, filling data gaps, harmonizing methods (monitoring, sampling, data quality, environmental impact assessment, etc.) and evaluating environmental and resource values/costs should follow common guidelines across the whole DRB.

Increased transparency and active involvement of stakeholders in the decision making process play a crucial role in local, regional and national policy.

Intercalibration of biological assessment methods for very large rivers

FRANZ SCHÖLL

Bundesanstalt für Gewässerkunde, Germany, schoell@bafg.de

The European Water Framework Directive stipulates ecological quality assessment against near natural reference conditions specific for each type of water body. For very large rivers with a catchment size larger than 10,000 km², reference biocoenoses can be described only incompletely because of the long-lasting anthropogenic utilization, sometimes over centuries. Although individual countries are in charge of developing new assessment methods concerning fish, macrofauna, macrophytes, benthic algae, and phytoplankton, the quality classification at the European level is harmonized by intercalibration. This guarantees the consistency of quality classifications despite the diverse assessment methods applied by the countries. The presentation shows first results of the “Very Large River Intercalibration Group” that, since April 2009, deals with the specific problems of very large rivers within the EU.

A strategy to enhance migratory fish species in the Weser River Basin according to the aims of the European Water Framework Directive

SIMON CHRISTIAN HENNEBERG¹, MATTHIAS SCHOLTEN²

¹River Basin Commission Weser, Germany, henneberg@fgg-weser.de

²Federal Institute of Hydrology, Department of Fauna and Animal Ecology, Germany, scholten@bafg.de

The Water Framework Directive has revolutionised the European water resource management in the last decade. A milestone has been achieved by the end of 2009 with the river basin management plans containing, amongst other, the programme of measures.

One of the basin wide strategies in the Weser River Basin is the new approach of enhancing the self reproduction of migratory fish species. This strategy, decided by the River Basin Commission in 2009, integrates significant water quality issues with the need for enhancing the river continuity and developing the hydro-morphology. It comprises different elements with special functions. The geographical elements are the main migration route, the connection routes and the spawning and juvenile habitat areas.

To maintain river continuity a transboundary and interdisciplinary approach must be combined with the different interest of users, especially hydropower companies, waterway administration and fishery. In this context, for each barrier in the main River Weser and the lower parts of the two tributaries Fulda and Werra the continuity was investigated and recommendations of better solutions were developed. Each element will be explained with an additional remark on its relevance.

MODELKEY DSS as supporting tool for River Basin Management Plan definition: results from application to Elbe and Danube

ELENA SEMENZIN¹, STEFANIA GOTTARDO^{1,3}, PETER VON DER OHE², JONATHAN RIZZI^{1,3}, ALEX ZABEO¹, ANDREA CRITTO^{1,3}, ANTONIO MARCOMINI^{1,3}

¹Consorzio Venezia Ricerche, Italy, semenzin.cvr@vegapark.ve.it

²Dept. Effect-Directed Analysis, UFZ Leipzig-Halle GmbH, Germany

³Department of Environmental Sciences, University Ca' Foscari of Venice, Italy

Recent definition and submission of WFD-compliant River Basin Management Plans requires large efforts of water managers and highlighted a number of data, knowledge and methodological gaps that need to be fulfilled during the next management cycle. The complexity of the WFD implementation process requires easy-to-use, reliable and scientifically sound decision support tools that help in considering any environmental or socio-economic aspect of the basin of concern. For this purpose, a Decision Support System (DSS) for risk-based assessment and management of river basins was developed within the EU MODELKEY project. The DSS is organized into three separate modules, providing users with multiple functionalities: ecological and chemical status classification, identification of biological communities at risk, key stressors and key toxicants, socio-economic evaluation of water usage and hot spots prioritization. In this paper, main results obtained by DSS application to Elbe and Danube Rivers are presented and discussed. A set of biological, chemical, physico-chemical, and hydromorphological indicators have been evaluated in relation to available reference sites and then integrated according to a set of fuzzy rules implemented in the software system. Results at basin and site-specific scales for both river basins were visualized on GIS maps through the DSS's output visualization interface.

The macrophyte – floodplain habitat relationship: implications on WFD and river restoration

GEORG A. JANAUER, UDO SCHMIDT-MUMM

University of Vienna, Department of Limnology and Hydrobotany, Austria, georg.janauer@univie.ac.at

Aquatic macrophytes in floodplain water bodies are one of the most important structural elements in these environments. Aquatic floodplain habitat types were earlier characterised and classified for several faunal elements as a conceptual "Floodplain Index". A set of different backwater types of the Danube River in Eastern Austria was selected to work out the relationship between the macrophyte vegetation and the five types of water bodies characteristic for this river reach. Indicative species compositions and aspects of biodiversity are presented. Findings are related to requests deduced from WFD requirements and from multi-factorial river restoration demands.

Large Rivers under Stress

KLEMENT TOCKNER

Leibniz-Institute of Freshwater Ecology and Inland Fisheries, IGB, Germany, tockner@igb-berlin.de

Large rivers are human-dominated ecosystems impacted through multiple stressors such as land reclamation, floodplain drainage, navigation, water pollution, and species invasion. Today, large rivers are novel, domesticated ecosystems – with no analogous state in the past. Native aquatic communities are being rapidly replaced by exotic-dominated assemblages leading to a homogenization of the biota.

Because of these drastic alterations it is becoming evident that most management strategies probably do not achieve their goals because of non-linear relationships and time-lags between the causes and the effects of biodiversity change; similar to what is observed for human demographic development and CO² increase. Concurrently, restoration targets compete with other targets and directives implemented at national, continental, and global scales.

In this presentation, I will discuss the formation and establishment of novel large river assemblages and its related ecosystem services. Innovative ideas and concepts are presented on how to potentially manage large rivers as cultural freshwater ecosystems and to develop synergies among presently competing targets such as biodiversity conservation, navigation, water use, and flood control.

Mean residence time (MRT) of baseflow water in the Upper Danube Basin derived from decadal climatic signals in long-term isotope records of river water

DIETER RANK¹, WOLFGANG PAPESCH²

¹Center of Earth Sciences, University of Vienna, Austria, dieter.rank@univie.ac.at

²Austrian Institute of Technology – AIT, Seibersdorf, Austria

Long-term stable isotope records of precipitation water exhibit significant decadal changes in the isotopic composition of H and O. Since evaporation has minor influence on the isotopic composition in river water it can be neglected in most parts of the Danube Basin. Hence, isotopic signals of precipitation water are transmitted through the whole catchment and reflected in the isotopic record of river water. A comparison of long-term stable isotope records of precipitation and river water, therefore, should provide information on the residence time of precipitation water in the catchment. First evaluations show a shift of about 3 years for the climatic signal in Danube water at Vienna, most probably the MRT of base-flow water (groundwater discharge to the river) in the Upper Danube Basin. Typical alpine rivers – e.g. Inn, alpine section of the Rhine – exhibit a more pronounced climatic signal, the time-shift of the signal is similar to that of the Danube (except River Drava). The age distribution – residence time of river water in the catchment area – is responsible for the shape of the signals in river water. Decadal stable isotope signals may be used to determine MRTs of river and ground waters by model calculations in a similar way like tritium input by nuclear weapons in the past.

Flood risk management services in support of the implementation of the EU Flood Directive – First results for test sites in Romania and Bulgaria

MARC MÜLLER¹, VERA KRAFT-HOLZHAUER¹, ANDRÉ ASSMANN²

¹Infoterra GmbH, Germany, marc.mueller@infoterra-global.com, vera.kraft-holzhauser@infoterra-global.com

²geomer GmbH, Germany, aassm@geomer.de

Within the framework of the European initiative “Global Monitoring for Environment and Security” (GMES) several flood related geo-information services have been developed during the past few years. The project “Services and Applications For Emergency Response” (SAFER) contributes to this initiative by providing rapid, reference and thematic mapping services relevant to an effective support for natural disaster management.

This presentation focuses on the further development of a flood risk management service portfolio which is intended to provide up-to-date flood relevant products for test sites in Romania (Timis catchment) and Bulgaria (Rousse region) and which can be transferred to other catchment areas. The products are derived from Earth Observation data, in-situ and ancillary data. The applied methodologies comprise hydrodynamic modelling, assets mapping and damage estimation. By providing flood, hazard and risk maps and a flood information system the service portfolio contributes to the implementation of the EU flood directive.

The substantial benefit of this service portfolio results from the combination of Earth observation data with regional / local data and enhanced modelling techniques. The former enables a European-wide harmonised and cross-border approach, the latter contributes to the provision of tailored solutions considering, e.g., specific geographical / hydrological circumstances of the river basin.

Restoration of River/Floodplain Interconnection and Riparian Habitats along the Embanked Danube between Neuburg and Ingolstadt (Germany)

BARBARA STAMMEL, BERND CYFFKA, FLORIAN HAAS

Aueninstitut Neuburg, Germany, barbara.stammel@aueninstitut-neuburg.de

The Upper Danube was embanked and straightened since the 19th century and disconnected of its floodplain besides high floods. Additionally, in the 1970s hydropower stations disrupting the longitudinal continuum were built. But still, a high biodiversity mainly of species of the hardwood riparian forest could be conserved on the project area of 2,100 ha. The goal of the presented project is to bring back new “controlled” dynamics to the floodplain (water, groundwater and morphological features) which is the key process to vitalize floodplain habitats and species. The project consist of three measures: 1) a permanent flow of water (up to 5 m³/s) bypassing the dam of the upper power station. The new river will develop on the floodplain partly flowing in old oxbows. 2) Controlled flooding (up to 30 m³/s) of parts of the floodplain during peak discharge of the Danube. 3) Temporary drainage of the floodplain in summer, where the groundwater level is constantly high due to the dams. The measures, conducted by the Bavarian Water Authority, were finished in spring 2010. A comprehensive monitoring program including vegetation, fauna, hydrological and morphological data was established and will be presented together with some of the previous results.

Dynamics of trace element pollutants during flood events: Hungarian Tisza and German Mulden Rivers – A comparison

WOLF VON TÜMPLING, MARTINA BABOROWSKI, MARGARETE MAGES

Helmholtz Centre for Environmental Research – UFZ, Germany, wolf.vontuempling@ufz.de

Intensive and long-term mining activities in both river catchments cause heavy metal and arsenic contamination of the river sediments. Extreme events like the cyanide accident in Baia Mare (2000) and/or the extreme flood in 2002 led to relocation of pollutants. Long-term investigations on the Tisza from 2000 to 2005 showed that the dilution effects decreased the pollution in the sediments and/or flood plains. In contrast, still high concentration of characteristic heavy metals and arsenic are observed in the sediments of the Mulden Rivers. Different procedures of the mining industry may account for this discrepancy. Different water use concepts of the mining reservoirs located in the neighbourhood of the rivers show pro and cons of different management strategies in relation to the pollutant dynamics. However, similarities are observed for chemical and physical behaviour of the pollutants. While lead, for example, is transported predominantly in particulate form in both catchments, arsenic is mainly transported in solution. In principle the same is valid for the concentration distributions of all investigated heavy metals in different extraction steps of the BCR procedure.

Contemporary geomorphological-sedimentary consequences of flooding – the Bratislava reach of the Danube River

MILAN LEHOTSKÝ¹, JÁN NOVOTNÝ¹, JACEK B. SZMAŃDA²

¹Institute of Geography, Slovak Academy of Sciences, Slovakia, geogleho@savba.sk

²Institute of Geography, Jan Kochanowski University, Poland

The studied river reach represents the inter-dike area of the Danube River downstream of Bratislava. It has been designated as the “flood way” under the flood protection measures of the town and, hence, stores floodwaters. The floodplain’s vertical accretion was investigated by sedimentological and dendrochronological methods. The lithofacies of three flood deposits (March 2002, August 2002, and September 2007) were examined by analysis of 10 bore-holes and 20 pit exposures. The overbank deposits differ from the older gravels, consisting of a fine-grained alluvium varying in thickness from 0.5 m to 1 m. Three main phases of energy flow changes of floods are recognised and, thus, the complete flood record can be expressed as the set of three layers. Conditions of the overbank sedimentation based on the shape and grain size of sediments were analysed, too. Investigation of landform and floodplain roughness changes and the bank retreat rate is based on the multi-temporal interpretation of aerial photographs (1949, 1969, 1985) and orthophotomaps (1997, 2004) and field work. The bank retreat of about 100 m during 1949–2007 was caused by flood events as well as by artificial channel straightening. The bank shift resulted in the development of the new levee.

Hydromorphology of Mures River (Romania, Hungary)

ULRICH SCHWARZ¹, JÜRIG BLOESCH²

¹FLUVIUS, Floodplain Ecology and River Basin Management, Austria, Ulrich.Schwarz@fluvius.com

²International Association for Danube Research (IAD), Switzerland, bloesch@eawag.ch

The Mures River (largest tributary of the Tisza River, 760 km long, catchment area 28,000 km², mean discharge 180 m³/s) was investigated from its headwaters to the mouth by a CEN conform hydromorphological method (assessment of channel, banks and floodplains). Field work by boat and on surface was supported by excellent historical maps (beginning from 1780) and high resolution satellite images. Moreover, recent river and catchment studies (hydrology, land use, pollution) and WFD assessment were considered.

The Mures is still a relatively natural river and only few dams influence water and sediment regime. The strongest river regulation is in towns (flood protection) and the straightened lower course (70 km in Hungary, navigation). Recent bank reinforcements for flood protection are evident in the middle course (some 50 km). However, the strongest impact is by mostly commercial sediment extraction along the middle and lower sections, potentially favoring channel incision.

In total 15 % of the river are strongly altered (corresponding WFD class 4 and 5), 55 % are moderately changed (class 3) and 30 % are in good or near natural condition (class 1 and 2). The CEN assessment, however, does not respect appropriately the intensive sediment extraction. We discuss how sediment management can be improved to achieve "good ecological status".

Assisting integrative planning on waterways by modelling techniques – the Integrated Floodplain Response Model INFORM

ELMAR FUCHS, MICHAEL SCHLEUTER, STEPHAN ROSENZWEIG

German Federal Institute of Hydrology, Germany, fuchs@bafg.de, schleuter@bafg.de, rosenzweig@bafg.de

Construction and maintenance works on waterways may cause interference with the environment due to functional hydro-ecological interrelations. In an integrative planning a sound expert methodology is needed for involving relevant stakeholders and considering impact related pathways, finally leading to a commonly agreed plan. Modelling techniques can essentially assist this process; especially ecological modelling can provide valuable input for decision making.

The German Federal Institute of Hydrology (BfG) developed the software system INFORM (Integrated Floodplain Response Model). Its main goal is to support the decision process during planning stages of measures along German Waterways. The modelling framework allows to predict impact on habitats of plants and animals due to natural or anthropogenic interference in riverine hydrology and morphology.

Applying INFORM in a stretch at the Middle Elbe affected by river bed erosion will help the Waterways- and Shipping Administration (WSV) for selecting counteracting solutions to mitigate the decline in water levels. Model predicted change in floodplain vegetation or in habitat quality for fish in groyne fields for example will give clear evidence on ecological impact. Evaluation of predicted ecological change will assist the WSV in taking optimum decisions targeting at only weak interference with nature or even promoting nature.

Spatio-temporal patterns of zooplankton densities according to water chemical characteristics and hydrological events in a river-floodplain system at the Danube (rkm 1498–1469)

KÁROLY SCHÖLL, A. KISS, M. DINKA, E. ÁGOSTON-SZABÓ, Á. BERCZIK

Hungarian Danube Research Station of the H.A.S., Hungary, scholl.karoly@gmail.com

The Gemenc is the largest active floodplain in Europe with an area of 180 km². The various characteristic side arms and backwaters provide a great opportunity to investigate the dynamics of hydro-ecological interactions of an intact river-floodplain system. The aim of the study was to explore the links between different functional units (eu-, para-, plesio- and paleopotamal), hydro-ecological events, water chemical characteristics and patterns of zooplankton densities. The densities of all examined zooplankton groups (Cladocera, Copepoda, Rotifera) in the main arm were always lower than in the side arms. Differences were found between the density patterns of Crustaceans and Rotifers among the functional units, which correlated with the water retention time. Specific hydrological events (increasing and decreasing flow, flood peaks) affected the density of Crustaceans and Rotifers differently. The main factors influencing the densities of different zooplankton groups were flow intensity, water retention time, frequency of flood events and predation by planktivorous fish. Most of these factors depend on the hydrological conditions of the side arms or backwaters.

Modeling hydrological processes to evaluate alternatives for ecological reconstruction in the Danube floodplain near Braila, Romania

FLORIAN BODESCU¹, VIRGIL IORDACHE²

¹Research Centre for Ecological Services (CESEC), Faculty of Biology, University of Bucharest, Romania, florian.bodescu@cesec.ro

²Department of Systems Ecology, University of Bucharest, Romania, virgil.iordache@g.unibuc.ro

Hydrological modeling is a current and future objective of the interdisciplinary research of complex ecosystems. A mathematical approach is needed to quantify transport processes of particulate matter in rivers. Specific models using cellular automata, such as CAESAR and TRACER, allowed the numerical modeling of hydrological processes such as erosion and deposition, important in complex dynamic wetland systems. For a specific sector of Fundu Mare Island (near Braila, Romania), we tested two hypotheses: the first one implies an increase of erosion near the shallow lakes and channels, achieved by opening connection channels with the upstream Danube arms; the second hypothesis implies that natural erosion and deposition will balance the retention and mobilization of heavy metals. The extension and intensity of hydrological processes was validated by numerical modeling of historical flood events and multispectral satellite images of LANDSAT ETM type. Measured heavy metal concentrations were used to calibrate the model. The first hypothesis was validated and was recommended for reconstruction. The second hypothesis will need more attention, we will need more data for complete testing and it remains subject of our future research.

This study was supported by the MECOTER project; project no 271, CNCSIS (www.mecoter.cesec.ro).

Long-term prognosis of discharge in selected rivers of the Danube and Elbe basins

PAVLA PEKÁROVÁ¹, PAVOL MIKLÁNEK¹, JAN PEKÁR²

¹Institute of Hydrology SAS, Slovakia, pekarova@uh.savba.sk

²Department of Applied Mathematics and Statistics, FMPI, CU Bratislava, pekar@fmph.uniba.sk

Since the very inception of hydrology as a scientific discipline, hydrologists and climatologists around the world have been trying to make science-based prediction of future development in the hydrosphere. Long-term predictions for 10–20 years must be based on detailed statistical analyses of time-series recorded in historical annals. First, we performed a statistical analysis of the monthly and yearly discharge time-series of the Elbe River (at Decin and Dresden stations), and of the Danube River (at Bratislava and Orsova stations, as well as of other Slovak tributaries of the Danube). We used the time-series analysis, the auto-correlation analysis and the spectral analysis to identify inter- as well as intra-annual variability of selected discharge series. The second part of this study is devoted to the long-term prediction of the yearly discharge of the Danube River, and Elbe River by applying stochastic methods.

Nutrient dynamics in complex river floodplain systems: effects of restoration

THOMAS HEIN¹, ELISABETH BONDAR-KUNZE¹, GILLES PINAY³, MICHAEL TRITTHART⁴, NINA WELTI^{1,2}

¹Institute of Hydrobiology and Aquatic Ecosystem Management, Department of Water, Atmosphere and Environment, University of Natural Resources and Applied Life Sciences Vienna, WasserCluster Lunz – Interuniversity Center for Aquatic Ecosystem Research, Austria

²University of Vienna, Faculty of Life Sciences, Department of Limnology and Hydrobotany, Austria

³University of Birmingham, School of Geography, Earth & Environ. Sciences, UK

⁴Institute of Water Management, Hydrology and Hydraulic Engineering, Department of Water, Atmosphere and Environment, University of Natural Resources and Applied Life Sciences Vienna, Austria

Floodplains are key components within river ecosystems controlling nutrient cycling by promoting transformation processes and thus, act as biogeochemical hot spots. The deterioration of these systems due to regulation and land use change has prompted restoration measures aiming to improve the ecological conditions at landscape scale. At this scale, three interrelated principles of hydromorphological dynamics can be formulated regarding the cycling and transfer of carbon and nutrients in large rivers: a) The mode of carbon and nitrogen delivery affects ecosystem function; b) Increasing residence time and contact area impact nutrient transformation; c) Floods and droughts are natural events that strongly influence the pathways of carbon and nutrients. All three factors can be affected by natural disturbances or anthropogenic impacts including restoration, through a change in either water regime or geomorphologic setting. These changes in turn will affect the biogeochemistry of riparian zones and floodplains.

The paper analyses the effects of river side-arm restoration on ecosystem functions in a large river, the Danube River. We demonstrate that principles of hydromorphological dynamics control potential gas emissions and nutrient status in the water column and sediment compartments and can be used as proxies to assess environmental changes.

Groyne modifications – an appropriate approach to support riparian species?

MEIKE KLEINWÄCHTER¹, TOBIAS MÜNCHENBERG²

¹Bundesanstalt für Gewässerkunde (BfG), Germany, kleinwaechter@bafg.de

²TU Braunschweig, Germany

At the River Elbe in Germany the Federal Waterways Engineering and Research Institute (BAW) and the German Federal Institute of Hydrology (BfG) have developed two groyne modifications to induce higher hydro-morphological dynamics at the riverbanks compared to the standard inclined construction. To assess if groyne modification is an appropriate approach to support riparian species, the ground beetle *Bembidion velox* (L., 1761) was chosen as target species and has been studied from 2000 to 2008.

Habitat analysis and laboratory experiments with immature stages show that the population development of *B. velox* is not only adapted to, but also dependent on, hydro-morphological processes. High sand content, sparse vegetation and proximity to the water line are the key habitat factors for successful offspring performance. Based on these findings the habitat availability for *B. velox* was simulated with digital maps considering different discharges and groyne forms. Results show that groyne modifications with clefts can form scours and small sand banks, which lead to an extension of the shoreline and increase the habitat availability for *B. velox*.

Riparian Forests and Riverine Vegetation – Risk Factors in Case of Flooding?

HANS HELMUT BERNHART¹, HUBERT WEIGER²

¹Karlsruher Institut für Technologie (KIT), Germany, hhbernhardt@web.de

²Bund Naturschutz in Bayern e.V., Germany

One of the objectives of the European Water Framework Directive is to achieve a good ecological status of surface water bodies. Ecological status refers to the quality of the structure and functioning of the aquatic ecosystems. In this context the development of riverine vegetation and riparian forests is a most important factor for the ecological improvement of our regulated and modified rivers. Since an uncontrolled development of vegetation might result in higher water levels in case of flooding it is often argued that the development of riverine vegetation can not be tolerated.

Therefore, riparian trees and bushes are often cut down although this is expected to have little or no effect on the water levels. Such actions actually took and take place not only on the Elbe and the Danube River but also on smaller rivers. To find the balance between flood control and ecological needs competent analysis of the given boundary conditions is necessary. The causal connections and the hydraulic requirements will be discussed on the basis of mathematical modelling of flow conditions including results and examples. Finally, conclusions for a better understanding of the discharge behaviour will be given and an approach concerning the mathematical modelling will be presented.

Sediment origin and dispersal dynamics in the lower Danube Basin

GRAHAM BIRD¹, PAUL A. BREWER¹, MARK G. MACKLIN¹, MARIANA NIKOLOVA², TSVETAN KOTSEV², MIHAELA SIMA³, MIHAIL MOLLOV⁴

¹Centre for Catchment and Coastal Research, Institute of Geography and Earth Sciences, Aberystwyth University, United Kingdom, grb@aber.ac.uk

²Institute of Geography, Bulgarian Academy of Sciences, Bulgaria

³Institute of Geography, Romanian Academy, Romania

⁴Executive Environmental Agency – Ministry of Environment and Waters, Bulgaria

The dispersal of contaminant metal-bearing sediment through the lower Danube Basin is of key concern for basin management and the implementation of the EU WFD. We report on the use of Pb isotopes and multi-element geochemical data to track the source of metal-enriched sediments in the Lower Danube and on the use of mixing models to quantify sediment contributions from Serbian, Romanian and Bulgarian tributaries to River Danube channel and floodplains. It is possible to differentiate between metal ore deposits within the Danube Basin based upon $^{208/207}\text{Pb}$, $^{207/206}\text{Pb}$, $^{208/204}\text{Pb}$ and $^{206/204}\text{Pb}$ signatures and therefore track sediments in catchments draining differing mineralization types. For example, 31–95 % of river channel sediment within the lower reaches of the Rivers Ogosta and Iskar are sourced from mining-affected tributaries within these catchments. In the Lower Danube, enriched Cu concentrations (250–280 mg kg⁻¹) mirror peaks in sediment contribution from two key tributaries, Rivers Timok and Iskar, with multivariate mixing model data indicating sediment delivery from these catchments contribute 10–24 % of the channel sediment load of the Lower Danube. Here Pb isotopic data is used not simply for identifying potential contaminant sources, but for the quantification of sediment-associated metal dispersal at the catchment scale.

Selecting the appropriate set of methods for evaluating ecosystem functions and services in ecological risk assessment. Lessons learned from the River Tamis (Danube River Basin)

IVANA TEODOROVIC

University of Novi Sad Faculty of Sciences, Department of Biology and Ecology, Serbia,
teodorovic@beocity.net

Ecological risk assessment, focused on individual level toxicity data, has been widely criticised, which in turn stimulated the development of an alternative risk assessment approach – the integrative evaluation of ecosystem functions, which would be supportive of many services aquatic ecosystems are expected to provide to humans. This paper aims at evaluating the current state of methods for determining the effects of various stressors on biodiversity and ecosystem functions, and at predicting the relevance for ecosystem services, taking the River Tamis as a case study.

The transboundary Tamis River (Romania/Serbia), one of the larger tributaries (359 km long) of the Danube River was not covered by the recent ICPDR JDS 2. Furthermore, monitoring programmes of the two countries have not been harmonised yet, so data are lacking even for the traditional environmental risk assessment. One of the objectives of the EU funded Neighbouring Programme Romania/Serbia was, therefore, sound environmental risk assessment, necessary for scientifically based decision making in water management. Hydromorphological, chemical (including WFD but also the River Danube specific priority pollutants), biological and ecotoxicological methods have been combined to identify major pressures and to evaluate their individual and combined impact to ecosystem functions, and consequently, ecosystem services.

Hydrographical Network of the Danube Delta Biosphere Reserve – Modelling the Morphological Dynamics

EUGENIA CIOACA¹, CONSTANTIN BONDAR², CONSTANTIN BORCIA³

¹Danube Delta National Institute Tulcea, Romania, eugenia@indd.tim.ro

²National Institute of Marine Geology and Geo-ecology, Romania, cbondar@geoecomar.ro

³National Institute of Hydrology and Water Management, Romania, cborcia@hidro.ro

The paper presents the Danube Delta Biosphere Reserve (DDBR) hydrographical network (canals, brooks, and lakes) morphological dynamics. This is investigated and presented as geospatial data which result from field measurements. Subsequently these data are modelled in a 3D mathematical model using the Delft3D hydraulic program (DELTA3D), a product of The Netherlands Hydraulic Institute. Based on morphological parameters, hydro-morphological changes can be evaluated by analyzing the DDBR hydrographical network zones where fluvial processes, erosion and, especially alluvial sedimentation, are active. The DDBR hydro-morphological (bathymetric and topo-hydrographical), as well as hydrological regime measurements were performed by the Danube Delta National Institute, Tulcea, during 1998–2009 by using research equipments of high accuracy, compatible with GIS. Numerical /geospatial maps visualize the state of the DDBR aquatic ecosystems, mostly dependent on the Danube River hydrological regime, and how these changes generate ecological disequilibrium with negative impact on some flora and fauna species. The gained knowledge on ecosystem function provides a scientific tool for decision making on a sound management of a complex environment. The aim is to improve the quality of aquatic life by restoration of habitats and hydrographical network and overall ecological reconstruction.

Sediment Management in the Elbe from the Perspective of the Port of Hamburg

AXEL NETZBAND

Hamburg Port Authority, Germany, axel.netzband@hpa.hamburg.de

Continuous maintenance dredging is necessary in the Port of Hamburg to safeguard water depths for navigation. In the last year the annual amount of dredged sediments was about 6 Million cubic meters. The challenges for sediment management are manifold: contamination of Elbe sediments decreased over the last decades; nevertheless, sediment quality still needs to be improved. On the other hand, nature protection regulations and marine policy requirements demand management plans and limit placement of dredged sediments in open water. Although Hamburg safely disposes annually 1 Million cubic meters of contaminated Elbe sediments on land most dredged sediments have to be brought back to the aquatic system. The presentation will give an overview of these challenges and the concepts developed to manage sediments in the port and the estuary. This takes into account also international and European experience.

Danube meets Elbe meets ...: homogenization of the freshwater fish fauna across Europe

NIKE SOMMERWERK^{1,2}, JÖRG FREYHOF¹, KLEMENT TOCKNER^{1,2}

¹Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany, sommerwerk@igb-berlin.de

²Institute of Biology, Free University Berlin, Germany

A network of > 28,000 km of navigable rivers and canals connects all major European rivers. Moreover, most European rivers are heavily fragmented, canalized, and polluted, leading to a higher extinction rate of freshwater than of terrestrial or marine species. Within this new “meta-catchment” non-native species may rapidly spread across the continent forming novel communities and leading to faunal homogenization. We quantified the former and present distribution of the freshwater fish fauna of 167 European river catchments covering 75 % of the European continent.

Up to 25 % of the native fish species disappeared per catchment. This loss has often been compensated by a rapid increase in non-native species; their proportion can be as high as 40 % of the total species richness and is often caused by widespread, cosmopolitan species. Concurrently, long-distance migrating species such as sturgeons (*Acipenseridae*), allis shad (*Alosa alosa*) and lampreys (*Petromyzontidae*) got lost at the catchment scale. Increased total species numbers (gains > losses of species) are rare, while homogenization across catchments has increased.

We conclude that the frequently observed gain of species at spatial scales smaller than primary catchments can be misleading. The catchment scale enables to detect losses of native species although faunal homogenization took place.

Integrated planning of waterways as a tool to better protect rivers

ALEXANDER ZINKE

ICPDR, Austria, Alexander.zinke@unvienna.org

Inland waterway transport (IWT) is one of the strongest drivers exerting new pressures on large rivers, notably the Danube. While various waterways in western Europe have been developed in the 20th century into an intensively used network, the Danube and some of its tributaries (Sava, Tisza) are still largely underdeveloped and ecologically intact. Beside some well-known conflict cases of the Upper Danube (Straubing-Vilshofen, east of Vienna), several major IWT projects are currently under preparation (Hungarian Danube, middle and lower Sava, Romanian-Bulgarian Danube, Ukrainian delta).

Even though waterway transport is a rather environment-friendly transport mode, these plans are expected to conflict with the Water Framework Directive and the growing Natura 2000 network. As a response, the concept of integrated planning was jointly discussed and endorsed in 2007 by Danube basin governments and various stakeholders in form of the *“Joint Statement on guiding principles for navigation and environment protection”*.

The further illustration of integrated planning is provided in the *“Manual on Good Practises in Sustainable Waterway Planning”* (EU PLATINA project, 2010). This new guide explains the needed scope, organisation and implementation of this planning process that aims at providing security for waterway planners and river protection managers at local and international levels.

Identifying key pollutants in the Elbe and Danube by applying new assessment tools on monitoring data

ERIC DE DECKERE¹, WERNER BRACK², STEFANIA GOTTARDO³, CLAUDIA SCHMITT¹, ELENA SEMENZIN³, BRAM VAN BALLAER¹, PETER VON DER OHE²

¹University of Antwerp, Belgium, eric.dedeckere@ua.ac.be

²Helmholtz Centre for Environmental Research - UFZ, Germany

³Consorzio Venezia Ricerche, Italy

The complexity of current monitoring programs as outcome of the Common Implementation Strategy is very basic with respect to frequency, number of stations, matrices and parameters, compared to previous national or regional monitoring programs. This favours the success of method intercalibration, but reduces the overall ambition. Within the MODELKEY project, new assessment tools were tested and applied to existing monitoring data from four river basins including Elbe and Danube. The SPEAR index, the Toxic Unit approach for contaminants in water and sediment, and the integration of biotic and chemical assessment tools enable to identify the major stressors and key pollutants that affect different trophic levels used as ecological quality indicators in the WFD. Both biotic and chemical data indicate the high organic load as one of the major stressors in the Danube River Basin, but the biotic community seems to be affected also by nutrients, which is not reflected by their concentrations. In the Elbe nutrient concentrations are much higher and it is clear that eutrophication is an important stressor here. The impact of contaminants is in both river basins clearly reflected by the biotic community, and several key pollutants can be identified that have an impact either on algae, macro-invertebrates or fish.

Selected measures towards integrated land and water management on Upper Tisza, Ukraine – local community involvement to support implementation of ITRBMP

OLENA MARUSHEVSKA¹, VASYL MANIVCHUK², GEORG RAST³

¹Kyiv, Ukraine, blu-rivers@utel.net.ua

²Uzhgorod, Zakarpattya Oblast, Ukraine

³WWF Germany, Freshwater Unit, Germany, rast@wwf.de

In the framework of a micro-scale project funding of UNDP/GEF/ICPDR different community-based projects for improved land and water management along the whole Tisza River Basin are in implementation. In the Upper Tisza Basin in Ukraine and Romania specific attention is focused on pollution reduction and solid waste management. Numerous uncontrolled disposal sites of plastic waste along mountain river banks and Tisza floodplains are the most visible indicator of poor waste management, traditional habits and new socio-economic developments. The paper describes practical examples of cooperation with the local population via communal institutions and regional state administration to increase awareness, clean-up uncontrolled disposals, establish separate collection of waste, and to initiate recycling facilities. The main result achieved is treating PET bottles not as a general waste but as a resource to be sold and further reused.

The ecological value of natural and near natural floodplain habitats along the Lower Danube and their importance for the European Natura 2000 Network and recent planning processes

ERIKA SCHNEIDER, EMIL DISTER

KIT-Karlsruhe Institute for Technology / University of Land Baden-Württemberg, Germany,
erika.schneider@iwg.uka.de

Despite of the large loss of floodplains beginning from the 1960s, the Lower Danube still presents, in the remained recent floodplain areas subject to regular floods, numerous site- typical habitats with a high biodiversity. These habitats located on still natural river stretches with natural banks and near natural islands are of outstanding importance for the ecological network Natura 2000 and for the sustainable development along the Lower Danube.

The site-typical habitats of community interest are analysed for their biodiversity and importance for a natural and sound functioning floodplain ecosystem. Studied were also the possibilities for habitat improvement and restoration in relation with flood protection measures. The needed conservation and sustainable development measures are analysed in the context of the European Natura 2000 network, the Water Framework Directive and in relation to the planned navigation projects in the Green Corridor. The latter causes severe problems in stretches with sites of high ecological value. Possibilities to find a way for different user interest are discussed.

Challenge in inferring causality between exposure and impact in river biomonitoring – Trait-based methods and advanced statistics can help

MIKHAIL A. BEKETOV

Helmholtz Centre for Environmental Research – UFZ, Dept. System Ecotoxicology, Germany,
mikhail.beketov@ufz.de

In biomonitoring inferring causality of exposure and biological impairment is difficult because of the pronounced natural variability that is especially high at large spatial scales (e.g. species composition differs between ecoregions), and also natural and anthropogenic confounding factors (e.g. hydromorphological alterations mask contaminants effects). The promising solutions for this challenge include trait-based methods and sophisticated statistical techniques. Statistical techniques developed for ecological research at large spatial scales include multivariate methods designed to isolate factors of interest non-experimentally. These techniques include, e.g. variance partitioning, path analysis, partial ordinations, and forward selection of predictors. The trait-based methods represent techniques describing and analysing biological systems. Traits are ecological, biological, and other attributes of species and higher taxonomic categories (e.g. breathing type, feeding type, life-cycle duration). Describing of biological communities in terms of traits represents the basically ecological view on such systems, that is, in comparison to taxonomic view, can provide more complete and rather simplified description of the systems. In biomonitoring the use of traits provided a wide range of tools and indices that are stressor-specific and independent of geographical and geomorphological factors. Examples demonstrating applicability and efficiency of these methods and future needs will be discussed.

Specific organic pollutants in Serbian rivers-current state and actions required

IVANA IVANČEV-TUMBAS¹, E. MALJEVIĆ², J. TRIČKOVIĆ¹, A. TUBIĆ¹, J. MOLNAR¹, B. GAVRIĆ², Z. STOJANOVIĆ²

¹Department for Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Serbia, ivana.ivancev-tumbas@dh.uns.ac.rs

²Republic Hydrometeorological Service of Serbia, Serbia, emira.maljevic@hidmet.gov.rs

Specific pollutants are all priority substances and other substances identified as being discharged in significant quantities into water bodies in accordance with the WFD (2000/60/EC). The list has to be identified during development of the River Basin Management Plan. Although the WFD has still not been implemented in Serbia, a certain amount of data relating to specific pollutants is obtained by official monitoring programmes of the Republic Hydrometeorological Service of Serbia (RHMS) and GC/MS surveys performed in recent years by the Faculty of Sciences, University of Novi Sad.

This paper presents results relating to the specific organic pollutants officially obtained in the period 2004–2008. During 2009, the official monitoring programme was changed and new additional parameters introduced: pentachlorophenol, octylphenol, nonylphenol, hexachlorobutadiene, pentachlorobenzene, terbutryne, prometryne, desethylatrazine, desisopropylatrazine, chlorphenvinphos, chlorpyriphos, alachlor, diuron, linuron, monuron, isoproturon, α -endosulphane, β -endosulphane, isodrin and trifluralin. Additionally, the results of several GC/MS screening surveys will be presented.

In conclusion, further revision of the Serbian list as well as the frequency and objectives of the monitoring program is needed in accordance with EU lists and EU water policy.

Prioritisation of Emerging Substances as River Basin Specific Pollutants to support River Basin Management Plans for the Elbe and Danube

PETER VON DER OHE¹, ERIC DE DECKERE², RALF SCHÄFER³, GERRIT SCHÜÜRMAN¹, JAROSLAV SLOBODNIK⁴, WERNER BRACK¹

¹Helmholtz Centre for Environmental Research – UFZ, Germany, peter.vonderohe@ufz.de

²University of Antwerp, Belgium

³School of Applied Sciences, RMIT University, Australia

⁴Environmental Institute, Slovak Republic

Besides the 33 priority substances representing chemical status of European river basins, an undefined number of River Basin Specific Pollutants (RBSP) is considered for the assessment of ecological status. The lists of RBSPs naturally differ between river basins and will be subject to change. It is expected that many emerging substances will be added to the lists.

In this paper, we analyzed the detection frequencies for a total of 420 organic compounds measured in the Elbe and Danube Basins. We evaluated their potential risk for the aquatic fauna using experimental and predicted acute toxicity data for the green algae *Selenastrum capricornutum*, the crustacean *Daphnia magna* and the fish *Pimephales promelas*. For the Elbe, polycyclic aromatic hydrocarbons (PAHs) were most frequently detected, while pesticides were the most important chemical group concerning toxicity for the test organisms. Many of the compounds responsible for potential adverse effects in both basins are currently not considered as RBSP, while priority pollutants were not relevant in terms of toxicity for the selected test organisms. We conclude that the management of pesticide input and other organic toxicants should play an important role during the next cycle of RBMPs.

The impact of chemical stressors on the invertebrate communities of a heavily polluted river in central Europe (River Bílina, Czech Republic)

CLAUS ORENDT¹, G. WOLFRAM², S. HÖSS³, W. TRAUNSPURGER⁴, Z. ADÁMEK⁵, P. JURAJDA⁵, G. STRECK⁶, P. VON DER OHE⁶, D. DE ZWART⁷

¹Orendt-Hydrobiologie, Germany, orendt@hydro-bio.de

²DWS Hydro-Ökologie, Austria

³Ecoffa, Germany

⁴University of Bielefeld, Dep. of Animal Ecology, Germany

⁵Dept. of Fish Ecology, Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Czech Republic

⁶Dept. Effect-Directed Analysis, UFZ Leipzig-Halle GmbH, Germany

⁷National Institute for Public Health and the Environment, The Netherlands

The River Bilina is a tributary of the River Elbe and is considered to be the most polluted stream in the Czech Republic (urban waste waters and industrial effluents). In order to find indicators for certain stressors (hydromorphology, organic waste, toxic and geochemical compounds) and to evaluate their contributions in determining the ecological status of the river, a multidisciplinary study was performed in 2006–2008 (EU project MODELKEY 511237-GOCE). Along a stretch of 80 km, two reference sites and six impacted sites were investigated using a wide range of metrics for aquatic macro- and meiobenthic invertebrates including ecotoxicological indices such as SPEAR. In this study, the effects of anthropogenic pollutants on community structure and ecological functions (feeding type, dweller type) are elaborated, looking at priority pollutants and other relevant substances that might be responsible for the community response apart from organic or background pollution.

An obvious drop of the biological quality was indicated by clearly changed communities downstream of the inflow of industrial sewage. We discuss which substances and to what extent chemical contaminants affect the biota and which tools might be helpful for their description and prediction.

Effects of environmental variables on mussel assemblages along a second order stream – large river continuum in North Hungary

ERIKA BÓDIS, JÁNOS N. NOSEK, NÁNDOR OERTEL, BENCE TÓTH

Hungarian Danube Research Station IEB of the Hungarian Academy of Sciences, Hungary,
bodiserk@gmail.com

The longitudinal distribution of mussel fauna in relation to environmental variables was investigated along a second and third order stream – medium-sized river (Ipoly) – large river (Danube) continuum at 15 sites in 2007. In total 1662 specimens from 22 species were identified, which presents 79 % of the nationwide fauna. Two species (*Pseudoanodonta complanata*, *Unio crassus*) are protected, three species (*Pisidium amnicum*, *Sphaerium rivicola*, *S. solidum*) are rare, and five species (*Dreissena polymorpha*, *D. rostriformis bugensis*, *Corbicula fluminea*, *C. fluminalis*, *Anodonta woodiana*) are invasive in Hungary.

Canonical correspondence analysis was performed to investigate the relationship between the mussel fauna, sampling sites and environmental variables (river continuum, physicochemical parameters, organic matter content and grain size characteristics of sediment, current velocity and bottom texture). Bottom texture and current velocity mainly determine the spatial pattern of mussel assemblages, but the longitudinal gradient and sediment grain size were also significant abiotic factors. Based on species composition three water types along the studied longitudinal profile can be distinguished: the streams; the River Ipoly and the Ráckevei-Soroksári side-arm characterized by similar water discharge; and the main arm of the River Danube. In accordance with mussel composition sections in the main arm of the River Danube cannot be detected, which contributes to the discontinuity concept of large rivers.

Thymallus thymallus (Linnaeus, 1758) threats and conservation in the Romanian Carpathians

DORU BĂNĂDUC, ANGELA CURTEAN-BĂNĂDUC

“Lucian Blaga” University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Romania, banaduc@yahoo.com

The main Romanian hydrographic basins have a long history of human impact. Especially during the last seven decades, they have been affected mainly by water pollution, hydro-technical works, overexploitation of mineral resources and poaching. This has occurred even in those geographical areas which are considered wildlife sanctuaries, owing to their special characteristics, such as the Romanian Carpathians.

The most reliable assessment of the actual situation is provided by bioindicators. One of the fish species present in the most fragmented/protected Carpathian habitats is *Thymallus thymallus* (Linnaeus, 1758). Seemingly protected in these remote river systems, this species should be at least in a steady state of conservation, but it is not.

Some populations from Gutâi, Maramureș, Harghita, Retezat and Apuseni mountains were analyzed in terms of their habitat and trophic resources status in the last decade, revealing an obvious decreasing trend where human impact is present and where no mitigation and restoration activities were carried out for conservation of the habitat of this species.

Mitigation, restoration, monitoring and management elements are proposed for each of the identified sites where grayling are suffering lately a significant decline.

Functional diversity of heterotrophic flagellates (protozoa) in the plankton of the river Danube at Göd (Hungary)

ÁRON KEVE KISS*, ÉVA ÁCS, KEVE TIHAMÉR KISS

*Hungarian Academy of Sciences, Institute of Ecology and Botany, Hungarian Danube Research Station, Hungary, aronkevekiss@yahoo.co.uk

We studied the local functional diversity of the probably most important planktonic protozoan consumer group of the River Danube, the heterotrophic flagellates. Flagellates were observed during 37 days by high resolution video micrography following the microbial succession of a single unchanged plankton net sample. Altogether 130 heterotrophic flagellate and other nano-eukaryotic species were found. Instead of grouping species according to their feeding strategies, we measured 7 functional variables for each species from the videos, which determine the utilised resources or influence the method of resource utilization. According to the utilized resources, 15 groups belonging to different realized niches could be found. If the method of resource utilization is also taken into account, 27 guilds could be *a posteriori* differentiated. This huge number of different coexisting functional groups expands our view about the functional diversity of heterotrophic flagellates and confirms that they cannot be handled as a simple 'bacterivorous'-tagged black box in ecosystem research. The detailed analysis of the functional traits of species revealed some novel interesting strategies, some of which seems to be hardly advantageous and adaptive for the species.

Sterlet (*Acipenser ruthenus* L.) as an object of research, fishery and aquaculture in Serbia

MIRJANA LENHARDT¹, I. JARIĆ², G. CVIJANOVIĆ², M. SMEDEREVAC-LALIĆ², Z. GAČIĆ², B. MIČKOVIĆ², M. NIKČEVIĆ²

¹Institute for Biological Research, Serbia, lenhardt@ibiss.bg.ac.rs

²Institute for Multidisciplinary Research, Serbia

This paper represents a review of research conducted on wild sterlet populations in Serbian waters, the commercial sterlet fishery and the efforts to develop sterlet aquaculture in Serbia. More thorough scientific investigation of sterlet commenced in the early 1950s, focusing mostly on growth, diet and reproductive cycle of this species. While further research was performed less regularly, new research projects on sterlet were initiated at the beginning of the 21st century focusing mostly on its use as bioindicator of freshwater ecosystems. Data concerning sterlet commercial fishery are relatively reliable for the period 1965–1998, but the following period of political and economic transition led to significant changes in holders of fishing rights, with negative consequences on fish catch statistics that have remained unresolved until today. With the market demand for sterlet that is present throughout the year, and the sterlet fishery that is only seasonal, there is a need for the development of sterlet aquaculture in Serbia. Even with the increased attention given to this valuable species in Serbia during the last few years, there are still many problems that have to be solved to achieve good status and sustainable use of sterlet natural populations.

Status, distribution and infection rate of the invasive crayfish species, *Orconectes limosus*, in the River Danube and its tributaries in Hungary

MIKLÓS PUKY¹, EVA KOZUBIKOVA², ADAM PETRUSEK²

¹Hungarian Danube Research Station, Institute of Ecology and Botany, HAS, Hungary, h7949puk@ella.hu

²Department of Ecology, Faculty of Science, Charles University in Prague, Czech Republic

Large rivers such as the Danube or the Elbe function as natural migration corridors for freshwater invasive species. *Orconectes limosus* had been introduced to Hungary for farming purposes in the 1950s but the first wild population was only found in 1985 in the River Danube in the northern part of Budapest. Since then, it has spread with considerable speed and colonized several hundred kilometres of the Danube downstream reaching Serbia and Romania, and at least 70 km upstream of Budapest. It can be also found in backwaters, side arms, lower parts of some of the Danube tributaries (such as Rivers Ipoly and Tisza) and canals. Besides good competitive abilities against indigenous species, *O. limosus* is a natural host of the oomycete *Aphanomyces astaci* Schikora, 1903, which causes crayfish plague, a fatal disease for European crayfish. Infection rates considerably varied at different sites; the highest was detected south of the Danube Bend, close to the site of the first record of the country.

Posters

Topic 1
**Climate change affecting the ecology of
big rivers, especially biodiversity**

Gastropoda populations in the Danube-Carpathian hydrographic space: possible impact of climate change

OLIVIA CIOBOIU

The Oltenia Museum Craiova, Romania, cioboiuolivia@yahoo.com

The hydrographic space between the Danube and the Carpathians includes all the aquatic ecosystems within the lower river basin. This area neighbours the arid zones of the Near East, which may expand to the north due to global warming and, hence, change future trends of evolution and patterns of aquatic ecosystem structure.

Presently, 135 species of Gastropoda within the Danube-Carpathian hydrographic space have been identified.

We hypothesize that global climate change will lead to significant alteration of the structure of Gastropoda populations, as some species may disappear, while others may increase in number and frequency. For example, cryophilic and aerophilous species such as *Bythinella austriaca*, *B. cylindrica*, *Stagnicola palustris* ssp. *flavida* adapted to clean water may be limited in space or may disappear. In contrast, ubiquitous species, *Lymnaea stagnalis*, *Radix ampla*, *Planorbis planorbis*, *Planorbarius corneus*, adapted to highly eutrophic and poly-saprobic water, may spread and become abundant since an increase in temperature will change hydrological features and water quality. If brackish waters extend the species *Theodoxus (Th.) euxinus*, *Pseudamnicola razelmiana*, *Turricaspia (Laevicaspia) lincta*, *T. dimidiata* tolerant to salt water will be favoured and become more frequent.

Investigation of the isotopic composition of Danube water as indicator for hydroclimatic changes in the Danube Basin. Establishment of a representative isotope monitoring near the mouth of the river

WOLFGANG PAPESCH¹, DIETER RANK²

¹Austrian Institute of Technology – AIT, Seibersdorf, Austria

²Center of Earth Sciences, University of Vienna, Austria

Isotopes of particular interest for hydrological studies in general include the stable isotopes of water (¹⁸O, ²H). They are incorporated within the water molecule and exhibit systematic variations in the water cycle as a result of isotope fractionation that accompanies phase changes and diffusion. Precipitation variability is related mainly to air-mass source and evolution including temperature-dependant equilibrium fractionation effects. River discharge signatures provide insight into the basin-integrated hydroclimate forcings on water cycling such as precipitation variability (e.g. changes in condensation temperature, latitude/altitude of precipitation, air mass mixing and recycling, distance from ocean source, and seasonality) and evaporation from the catchment by rivers, soil water, wetlands, lakes, and reservoirs. Since evaporation has little effects on the isotopic composition of river water within the Danube Basin, the isotopic composition in Danube water reflects mainly the isotopic composition of precipitation in the whole basin and so provides an integrated isotope signal for hydroclimatic conditions and changes in the whole basin. A 40-years record from the Upper Danube exhibits decadal changes in the isotopic composition of river water. It is intended to establish a routine isotope monitoring of river water in the delta region, representative for the whole Danube Basin.

The effects of climate change on Danubian phytoplankton communities in Hungary

CSABA SIPKAY¹, KEVE TIHAMÉR KISS¹, CSABA VADADI-FÜLÖP², LEVENTE HUFNAGEL³

¹Hungarian Danube Research Station, Hungarian Academy of Sciences, Hungary, csaba.sipkay@uni-corvinus.hu

²Eötvös Loránd University, Institute of Biology, Department of Systematic Zoology and Ecology, Hungary

³Adaptation to Climate Change Research Group of Hungarian Academy of Sciences, Hungary

Based on the results of international studies, increased global warming is expected by the end of this century. This change might seriously affect aquatic ecosystems. One possible approach to this problem might be the simulation modelling of aquatic community which depends on meteorological factors. The basis of our work was the long-term (24 years) phytoplankton database of the Hungarian Danube Research Station, collected in the Danube at Göd. This database that was based on frequent (weekly) sample collection has given a great opportunity for the modelling of seasonal dynamics. When establishing the model we supposed that the seasonal dynamics of the phytoplankton in the Danube can be described based on daily temperature and the availability of the light. The seasonal phytoplankton changes were simulated by a linear combination of theoretical species characterized by different temperature optima. According to our field data set from 1979–2002, the model has generated patterns similar to the ones observed. The model was run with the daily temperature data series projected by climate change scenarios for the period of 2070–2100. This way, an estimation of the direction of the changes of phytoplankton in the Danube – as a reaction to global warming – has become possible.

Topic 2
**Implementation of the EC Water
Framework Directive (WFD), scientific,
practical and political problems**

Spatial variability of heavy metal pollution in groyne fields of the middle Elbe – implication for sediment monitoring and risk assessment

MARTINA BABOROWSKI¹, P. MORGENSTERN¹, TH. JANCKE², B. WESTRICH²

¹Helmholtz Centre for Environmental Research – UFZ, Dept's River Ecology and Analytics, Germany, martina.baborowski@ufz.de

²Institute of Hydraulic Engineering, University of Stuttgart, Germany

Many European rivers like Danube, Elbe and Rhine have been regulated by training works for navigation and bank erosion protection. Such near bank structures (so called groyne fields) are shallow areas which exhibit high sediment trapping efficiency. Depending on the river discharge these still water zones act as temporary sinks or sources of suspended particulate matter. In the past organic and inorganic pollutants have been discharged to the river system and are still present in deposited sediments due to industrial and municipal activities and development in the river basin. To implement remediation projects required by the EC Water Framework Directive (WFD), appropriate monitoring is necessary for assessing the effect of countermeasures. As for the monitoring, the spatial distribution of deposited sediments and contaminants has to be considered. Therefore, the heavy metal contamination of sediments of a groyne field in the middle part of the River Elbe was investigated. In June 2008, within an area of about 1034 m², sediment cores up to 50 cm depth were taken at 12 locations. Depth profiles of the critical erosion shear stress and heavy metal concentrations were determined. Sediment stability and contaminant inventory generate consequences for monitoring and environmental risk assessment that will be discussed.

The WFD as a tool for sustainable development in the Danube River Basin

ERIC DE DECKERE¹, KRISTOF BLOCKX¹, ANDREAS BLUM², IOSIF BOTETZAGIAS³, SHEILA FRANCL⁴,
SU-MA KABA, REMONA KERSSIES¹, VERONIKA RIGÓ, CHRISTIAN SCHULZE², CHRISTIAN TERS,
THEANO THEODORIDOU, BRAM VAN KEER¹, LAURENS VAN DEN BORN¹, SARAH VERBERECKMOES¹

¹University of Antwerp, Belgium, eric.dedeckere@ua.ac.be

²Fernuniversity Hagen, Germany

³University of the Aegean, Greece

⁴Open University, The Netherlands

An international multidisciplinary group of students is analysing whether the implementation of the WFD in the Danube River Basin is in line with the principles of sustainable development. This analysis is done within the European Virtual Seminar on Sustainable Development (EVS), an international course with students from all over Europe. As integrated water management is the translation of sustainable development in river basins aiming for the protection of all goods and services provided, this should be reflected in the river basin management plans and the program of measures that have been developed. Especially in the transboundary river basin district of the Danube with so many countries involved, the most downstream country, Romania, depends strongly on the management upstream. The analysis is focusing on the sustainability of the RBMP and especially of the program of measures and on the specific difficulties Romania is confronted with and the way how the overall program of measures will have its impact on these difficulties. Based upon this recommendations will be made for the different stakeholders involved.

Implementation of EC Nitrate Directive in the Czech Republic

ANNA HRABÁNKOVÁ, MARTA MARTÍNKOVÁ

T.G. Masaryk Water Research Institute, p.r.i., Czech Republic, anna_hrabankova@vuv.cz, marta_martinkova@vuv.cz

The Council Directive 91/676/EEC (Nitrate Directive) as part of the WFD aims to reduce and prevent water pollution caused by nitrates from agricultural sources. To implement respective requirements the vulnerable zones were designated in the Czech Republic (2003). Vulnerable zones represent diffuse sources of nitrate. The measures to reduce nitrate concentrations in water are implemented in the vulnerable zones. In particular, fertilisation practice was modified – maximum limits for adding nitrogen fertilisers, limits for the individual crops and unfertilized 3 m wide strips along water courses were introduced. The vulnerable zones are revised regularly in four years intervals.

Ecohydrological modeling was carried out to assess the effect of various measures and changes in fertilization regime under the conditions of climate change in the meso-scale basin Jizera (Czech Republic). The model SWIM (Soil and Water Integrated Model) simulates water and nutrient fluxes in soil and vegetation, as well as their transport to and within the river network. The regional climate change model was used for the assessment of the climate change impact.

Room for the river in cat's bend – application of the Sketchmatch Method in Romania

IULIAN NICHERSU, EUGENIA MARIN, FLORENTINA SELA, CRISTIAN TRIFANOV, MARIAN MIERLĂ

Danube Delta National Institute for Research and Development, Romania, iuli@indd.tim.ro

The project *“Room for the River in Cat's Bend, Romania”* is a pilot-project, initiated by the Romanian Ministry of Environment and financed by the Dutch Government. In an interactive process together with regional partners (i.e. policymakers and other stakeholders), this project aims to draw up integrated regional plans for the Cat's Bend region, based on the flood protection strategy as defined in the Romanian REELD feasibility study – carried out by the Danube Delta National Institute in 2007 and 2008 – and using the Dutch “Room for the Rivers” approach. This project works out spatial concepts, i.e., the space needed by the Danube River in the Cat's Bend region by combining diverse methods: socio-anthropological research (stakeholder interviews), SketchMatch (interactive design) workshop, hydraulic modeling and 3-D GIS visualizations. One of the main goals of this project was to stimulate support and involvement from stakeholders for the implementation of flood protection measures in the Cat's Bend region by consulting and involving these people in the design process and making use of a coherent package of interactive methods.

Critical review of floodplain restoration projects in the Elbe River Basin, future challenges and opportunities in the framework of WFD, Flood Risk Directive and other biodiversity objectives

GEORG RAST

WWF Germany, Germany, rast@wwf.de

The German Elbe River section is one of the few regions in Europe where several large-scale restoration projects have been or are being implemented. Together with other flood protection or risk management measures which require access to former floodplain areas (i.e. polder or retention basins) all projects are listed in the flood action plan of the International Commission for the Protection of the Elbe River (ICPER/MKOL). Furthermore, the effects of all spatial measures on hydrology and flood wave propagation were investigated. The presentation illustrates how many of the nature oriented measures have been selected by pragmatic reasons or specific nature conservation interest. Based on this background additional aspects will be described from the nature conservation point of view as well as how far these measures affect other objectives set, e.g., by WFD, Flora-Fauna-Habitat Directive (FFH), Flood Risk Directive (FRD), and Convention on Biological Diversity (CBD). Subsequently, opportunities and challenges for a long-term restoration strategy for the German Elbe section are elaborated.

Defining biological benchmarks for the intercalibration of the Danube River

LEON VAN KOUWEN¹, SEBASTIAN BIRK²

¹Delft, The Netherlands, leon.vankouwen@deltares.nl

²University of Duisburg-Essen, Germany

According to the WFD, European member states are obliged to harmonize their definitions of good ecological status for similar types of aquatic ecosystems. Status classification is based on the deviation from reference conditions and as it is rather obvious that these conditions no longer exist for very large rivers, other methods have to be developed. This paper provides an important contribution to the international discussion on intercalibration of large rivers by defining biological benchmarks for the Danube River.

We generated a complex gradient of anthropogenic disturbance using abiotic data from the Second Joint Danube Survey (JDS2) and set a threshold on this gradient based on chemical and hydromorphological quality. This allowed for the assignment of sites in Least Disturbed Conditions (LDC). Based on biological data (phytoplankton, phytobenthos, macrophytes and macroinvertebrates) and currently existing typologies, we then identified four Danube Intercalibration Stretches. The pressure gradient appeared to be significantly influencing the macrozoobenthos and macrophyte communities. Within each stretch, we identified biological metrics that showed significant differences between LDC and non-LDC sites. We also developed a macrophyte sensitivity metric composed of 13 macrophyte indicators for the Southern Pannonian Danube Intercalibration Stretch. These metrics provide an essential tool for intercalibration within the Danube River.

Topic 3

Flooding, meadows, floodplains, actual conditions and restoration measures (riparian landscapes), hydrological modelling, risk assessment

Actual status of biota of the Beregove transboundary polder system (the Tisa River Basin) as instrument for ecological status/potential assessment

SERGEY AFANASYEV, LIUDMYLA GULEIKOVA, OLENA LIETYTSKA, OKSANA MANTUROVA, OLEKSANDR SAVITSKIY, EUGEN SAVCHENKO, OLEKSANDR USOV

Institute of Hydrobiology, NAS of Ukraine, Ukraine, omanturova@ukr.net

Actual status of biota in the Beregove transboundary polder system, located between the Tisa and Latoriza Rivers, at the Ukrainian-Hungarian border, was investigated. Water bodies were overgrown by macrophytes dependently on their genesis and exploitation. At some stretches occurred wetland complexes comprising 142 plant species. 126 algae species were found, the most diverse were Bacillariophyta (53 species). Zooplankton was poorly developed, 71 species were found (Rotatoria – 31, Copepoda – 14 and Cladocera – 26). Bottom fauna was presented by 82 species, mostly Chironomidae larvae (40 species). Molluska were also quite diverse (20 species). 15 fish species were registered; most abundant were *Rutilus rutilus*, *Scardinius erythrophthalmus* and *Ictalurus nebulosus*. Four invasive fish species were found (*Percottus glenii*, *Ictalurus nebulosus*, *Lepomis gibbosus* and *Carassius auratus*). On the whole, aquatic communities were well developed and quite diverse. By biological parameters channels connected with Tisa achieved good ecological potential, rivers' ecological status varied between moderate and poor, Charonda former riverbed was in good status.

Leaching losses from five leaf litter species in a side arm of the Danube at Gemenc floodplain, Hungary

EDIT ÁGOSTON-SZABÓ, M. DINKA, K. SCHÖLL, A. KISS, Á. BERCZIK

Institute of Ecology and Botany of the Hungarian Academy of Sciences, Hungarian Danube Research Station, Hungary, edit@botanika.hu

Leaf litter from floodplain vegetation represents an important energy input for aquatic organisms. Its breakdown involves two main phases: leaching of soluble compounds and decomposition of structural components.

Leaching of C, N, P and S out of leaves of five characteristic floodplain forest tree species was studied by a litter bag method in the Rezáti-Holt-Danube parapotamon type side arm, along which the patterns of leaf litter transport depends on the hydrological regime. During leaching (48h) ash leaf litter lost 26 %, poplar 25 %, elm 24 %, willow 21 % and oak 3.5 % from their initial dry mass and an important amount of C (0.8–25.6 %), N (11.3–24.2 %), P (23.1–52.4 %) and S (34.4–76.7 %) were washed out. The decreasing order in the amount of nutrient released was: *Ulmus*>*Populus*>*Quercus*>*Salix*>*Fraxinus* for P and *Ulmus*>*Populus*>*Fraxinus*>*Salix* for N; while on the decomposing *Quercus* leaf litter N and S immobilization occurred.

The examined leaf litter species contributed in different degree to the allochthonous nutrient input of the side arm in their initial decomposition phase.

This work was supported by the DBU, AZ 24050 project and by the H.A.S.

Actual state and fish production of Sasyk Reservoir

LYASHENKO ARTEM, ZORINA-SAKHAROVA KATERYNA, MAKOVCKYI VADIM, SANZHAK YURYI, PROTSEPOVA VALENTYNA

Institute of Hydrobiology NAS of Ukraine, Ukraine, artemlyashenko@bigmir.net, zsk@bigmir.net, vmakovskiy@gmail.com, sanzhak_uriy@bigmir.net, ollivander@rambler.ru

The Sasyk Estuary before the 1970s was among the most productive water bodies of the Ukrainian Danube region. During 1979–1980 it was separated from the Black Sea by a dam and connected with the Danube River by the 14 km long channel Danube-Sasyk. The new reservoir with a fresh water volume of 50 km³ was mainly designated for irrigation including transport via Danube-Dniester canal systems to supply the dry South Ukrainian regions with fresh water.

After technical modification (1984–1990) the reservoir featured high primary, secondary and fish (about 50 kg/ha) production. Later, commercial over-fishing and minimum stocking led to a significant decline of valuable fish species (European carp, silver carp, crucian carp, pike perch, etc.) and fish catch. Further, evaporation, construction mistakes and changes in water management enhanced salt concentrations up to 4 mg/l. The reservoir became eutrophic and silted up, the landscape deteriorated. Hence, the ecological, economic and social situation in the region was negatively affected. Local people demand reconstruction of the salt marine liman.

The study presents results of complex hydro-biological investigations carried out during 2008–2009. The actual state of Sasyk Reservoir is reflected by structural indices and biomass of macro-invertebrate assemblages. The potential of fish yield is estimated.

Morphological evolution of riverbeds case study: inferior sector of CIBIN RIVER upstream of sibiu (Olt basin – Romania)

MARIOARA COSTEA

Sibiu “Lucian Blaga University”, Science Faculty, Ecology and Environment Protection Department,
Romania, marioara_costea@yahoo.com

The analysis of river evolution is based on the systemic and diachronic approach stating that riverbeds are the result of geomorphological and hydrological mechanisms. Natural processes and anthropogenic impacts interact dynamically forming the fluvial relief that is in permanent change.

Spatial and temporal river configurations documented in historical or actual cartographic maps can be characterized and classified according to dominant phenomena, either anthropogenic or natural. In addition, historical flow data are fundamental in the diachronic study of riverbeds. The modifications are continuous and accelerated in recent times. In the Cibin River case, the old maps from the beginning and the end of the 19th century provide an important data basis for the interpretation of the evolution of the floodplain landscape. These references are compared with the situation presented on recent maps (1970–1975) and actually found in the field. An interpretation of the changes to explain the dynamic evolution of the Cibin riverbed and its floodplain are given.

Water chemical characteristics and the spatio-temporal patterns of zooplankton assemblages in a side arm of the Danube (rkm 1437–1440, Hungary)

MÁRIA DINKA, KÁROLY SCHÖLL, EDIT ÁGOSTON-SZABÓ, ANITA KISS, ÁRPÁD BERCZIK

Hungarian Danube Research Station of the H.A.S., Hungary, dm@botanika.hu

The Project “*Development of the active floodplain at South Hungarian Danube River Stretch*” of the Hungarian Danube Research Station includes investigations of water bodies in the active floodplain with different hydrological character. The hydrobiological research in the plesiopotamal side arm Külső-Béda (4.2 km long) started in 2007; it contains detailed water chemical surveys as well as the faunistic and ecological analysis of zooplankton assemblages.

Notable differences were found between water chemical parameters of the main arm and the side arm and among the sampling sites of the side arm as well. These differences are dependent on the water level of the main arm which influences the hydrological connectivity between the Danube and the side arm.

During 2007–2008 24 Rotifer and 17 Crustacea taxa were found; these are the first zooplankton data of this side arm. The zooplankton density and diversity is higher in the side arm than in the Danube, the differences increase parallel with the distance from the mouth of the side arm. Negative correlation was found between zooplankton density and water level of the main arm. The zooplankton assemblages are influenced by the seasonal changes and the water regime of the main arm.

Experience from and challenges for development and implementation of a large scale floodplain restoration – the dyke relocation in Lödderitzer Forst, Elbe River, Germany

ASTRID EICHHORN, GEORG RAST

WWF Germany, Germany, astrid.eichhorn@wwf.de, rast@wwf.de

In the framework of a National Nature Conservation Programme a large scale floodplain restoration project in the forest of Lödderitz on the Middle Elbe River near Dessau was planned and is being implemented since 2003. The main component is a dyke relocation with construction of a new dyke of 7 km length and an enlargement of the Elbe floodplain over 600 ha. The affected new floodplain area is to 90 % covered by different forest habitats, with some oxbows and currently some arable land. The whole project area is designated as Natura2000 site within a biosphere reserve. The presentation will focus on the critical steps to manage the process of plan approval, the facilitation of public participation and the implementation of construction works which have to meet much higher technical standards after the recent big floods. Special emphasis is put on the necessary approach to EU environmental legislation and public participation to achieve a timely and transparent implementation process as well as to secure political and stakeholder support.

The status report on German floodplains

KLAUS FOLLNER, THOMAS EHLERT, BERND NEUKIRCHEN

Federal Agency for Nature Conservation (BfN), Germany, Klaus.Follner@BfN.de

Floodplains are hotspots of biodiversity and central elements of an ecological network. They are also flood protection areas, greenery of waterways, and areas of agricultural as well as urban use. The Federal Agency for Nature Conservation (BfN) funded a number of projects which aimed to raise an inventory of the remaining active floodplains of the larger rivers in Germany and their status. For about 10,000 kilometres of larger rivers and streams of Germany dimension, loss of flooding areas and status of the remaining active floodplains are presented in three maps. These maps and the status report on floodplains show that at large parts of rivers like Rhine, Elbe, Danube, and Odra only 10–20 % of the former floodplains can be inundated now. The floodplains' status is expressed in five classes of modification relative to a potentially natural status – from “nearly unmodified” to “very heavily modified”. Only 10 % of the German floodplains are nearly unmodified or slightly modified; however, 54 % are heavily or very heavily modified. These results show that there is an urgent need of floodplain restoration. The report and the maps shall be an useful information source for administrations, planners and nature conservation organisations.

Concept for monitoring zoocoenotic changes due to restoration of fluvial dynamics in Danube floodplain forests between Neuburg and Ingolstadt (Germany)

AXEL GRUPPE, MARKUS KILG, HANS UTSCHICK, ROLAND GERSTMEIER, REINHARD SCHOPF

Institute of Animal Ecology, Department for Ecology and Ecosystemmanagement, Technical University of Munich, Germany, gruppe@wzw.tum.de

To achieve a near natural state in the former floodplain forests along the River Danube, fluvial dynamics were restored in an area of 1200 ha between Neuburg and Ingolstadt (Germany) (see Stammel et al., this volume). In this project, a comprehensive study of the effects of flooding on the present zoocoenoses in the affected areas is performed. We compare the fauna before the first flooding (reference) to that in the two consecutive years and after more than five years (temporal scale). An experimental design, adjusted to the landscape model, with four treatments differing in the water regime after restoration, i.e. probability and duration of flooding, was used (qualitative scale). Moreover, faunistic studies are performed at three spatial scales: landscape, stand of trees and micro-habitat. Accordingly, birds are the target group at landscape level, birds and arboricolous insects at stand level and insects and slugs at micro-habitat level. All target groups are studied in three height levels of forest trees: on the forest floor, two to three meter above ground level and in tree crowns. The initial fauna was recorded between 2007 and 2009. Faunistic monitoring of the effects of restoration and flooding will start in spring 2010.

Plankton communities of the transboundary Ukrainian-Romanian section of the Tisa River

LIUDMYLA GULEIKOVA, OKSANA MANTUROVA

Institute of Hydrobiology, NAS of Ukraine, Ukraine, omanturova@ukr.net

The Tisa River is the main tributary of the Danube River. The headwaters are located in the Ukrainian Carpathians. Along 64 kilometers (from Dilove to Tiachiv) it serves as a state boundary between Ukraine and Romania. In 2009 phytoplankton and zooplankton was studied in the main channel of the Tisa River and in the mouth areas of its tributaries: right-bank Kisva, Shopurka, Apshytsia, Teresva and left-bank Iza, Vişeu and Săpânța. 65 algae species were found; Bacillariophyta represented the most diverse group (61 species). 47 taxa of zooplankton were collected, including 28 species of Rotatoria. The number of algae species in different sites of the main channel was fairly constant (21–22), while in the tributaries it varied between 15 and 36. The most abundant were periphytic forms of the genera *Gomphonema*, *Didymosphenia* and *Rhoicosphenia*. 26 and 34 zooplankton species were present in the main river channel and in the tributaries, respectively. Density and biomass of both phyto- and zooplankton in the main channel were significantly lower than in the mouth areas of the tributaries. Since all tributaries are subject to human activity, pollution in particular, they influence the development of plankton communities in the Tisa.

Changes of plant diversity in riparian grassland after extreme hydrologic events

PETER J. HORCHLER¹, FRANZISKA KONJUCHOW², JUDITH GLÄSER², CHRISTIANE ILG², EVA MOSNER¹, MATHIAS SCHOLZ²

¹German Federal Institute of Hydrology, Germany

²Helmholtz Centre for Environmental Research – UFZ, Germany

Riparian grasslands dominate the floodplains along the River Elbe. In a monitoring project, vegetation data of a riparian grassland site were collected in three different periods over 12 years. The effects of two extreme hydrologic events, the summer flood of 2002 and the extreme low water of 2003 on plant diversity, were analysed.

Between 1999 and 2003, species richness and Shannon diversity declined in all classes while Simpson's dominance increased. In the following years and in 2009, species richness increased and reached even higher levels than before the 2002 flood and 2003 drought in wet and moist grassland. In these classes Shannon diversity and Simpson dominance reached values similar to those of 1998 and 1999.

Diversity and dominance were most strongly affected in the vegetation of flooded depressions. Due to the higher disturbance regime, even after six years, species composition remained less balanced and more dominated by single species as compared to 1999. However, it remains uncertain if the flood event of 2002 or the drought of 2003 or both led to the observed changes in vegetation. A yearly monitoring (KLIWAS project) of these sites at least until 2013 may provide further understanding of the effect of extreme hydrologic events.

First records on effect of renewed flooding of three wetlands from Belene Island (Lower Danube, Bulgarian stretch)

ROUMEN KALCHEV¹, MICHAELA BESHKOVA¹, LUCHEZAR PEHLIVANOV²

¹Department of Hydrobiology, Institute of Zoology, Bulgarian Academy of Sciences, Bulgaria, rkalchev@zoology.bas.bg

²Central Laboratory for General Ecology, Bulgarian Academy of Sciences, Bulgaria

Three marshes situated on Belene Island, permanently separated from the Danube River for many years started to be frequently flooded by irregular opening of installations operated by man at times of high river water level during 2009 as part of a large wetland restoration project.

To investigate possible early effects and efficiency of the new hydrological regime on the marsh status we compared several sporadic samplings for water chemistry, phytoplankton and zooplankton from 1997, 1998, 2000 and 2004 with those of 2009. Main nutrients and oxygen showed similar concentrations and large scattering of measurements before and after the restoration start. A lack of oxygen seems to be responsible for the continuing poor fish presence and occasional fish kills. Similarly, phytoplankton and zooplankton composition and abundance did not show significant changes after renewed flooding. Since the flushed water could not remove the thick anoxic layer of mud and the intense coverage of macrophytes during summer, the applied flood regime seems to have a low restoration effect on the marshes. The artificial flood regime must be improved and additional measures such as dredging of mud and/or macrophyte control may be needed.

Diversity of beetle communities from ground level to canopy in the Danube floodplain forests between Neuburg and Ingolstadt (Germany)

MARKUS KILG, REINHARD SCHOPF, HANS UTSCHICK, ROLAND GERSTMEIER, AXEL GRUPPE

Department for Ecology and Ecosystem Management, Technical University of Munich, Germany,
Markus.Kilg@gmx.de

In Germany, most of the flood plain forests along the Danube River lost their typical character since the 19th century due to river regulations and embankment. A remaining forest area between Neuburg and Ingolstadt will be restored by a particular flooding management starting in 2010 (see Stammel et al.). In order to get faunistic baseline data prior to changes by the water regime beetle communities were studied since 2007. Beetles were collected in four habitat classes according to the relief: (1) close to a water-bearing ditch, (2) in areas which will be flooded irregularly (0–4 times per year) depending on the Danube water level, (3) in areas expected to be flooded only once in 100 years, and (4) in special sites which are dry stands due to gravel deposits. On each site beetles were sampled from the ground layer to the canopy using a variety of automatic traps. The main objectives of the study are (1) beetle diversity in relation to soil moisture, (2) beetle diversity in relation to their vertical distribution (ground level, lower part of the trunk, tree crown), and (3) horizontal and vertical distribution of feeding guilds. The presented results characterize beetle communities typical for different hardwood forest habitat classes.

Spatial differences of the zooplankton assemblages and chemical characteristics of water in a plesiopotamal side-arm of the active floodplain at the Danube (rkm 1442–1440)

ANITA KISS, K. SCHÖLL, M. DINKA, E. ÁGOSTON-SZABÓ, Á. BERCZIK

Hungarian Danube Research Station of the H.A.S., Hungary, e-mail: kissa@botanika.hu

The Gemenc floodplain and the Béda-Karapanca (Gemenc-Béda-Karapanca wetlands, Duna-Dráva National Park) represent an exceptional example of a larger old floodplain with big meanders, oxbow lakes, marshland and extended hardwood forests. Due to river regulation works in the 19th century this area has changed: the floodplain remained more or less isolated from the main channel and the length of the side-arms decreased. Detailed investigation was carried out in one of the plesiopotamal side-arms of the area to monitor phyto- and zooplankton assemblages and the chemical characteristics of the water. The Mocskos-Duna (rkm 1442–1440) is situated in the active floodplain of Karapanca area, approximately 3.4 km long, 60 m wide and shallow (average water depth 1.5 m), a side-arm with very dense macrophyte vegetation. An artificial channel connects the side-arm with the Danube. Diverse zooplankton assemblages (Cladocera, Copepoda, Rotifera) developed in the side-arm. The composition, density and taxon number of assemblages as well as the number of the macrophyte-associated species showed large variations in the different habitats. Our results demonstrate that these side-arms are important storage zones for zooplankton and play an important role in the river-floodplain system.

Influence of environmental factors on riparian forests and scenarios of changes in the vegetation after restoration in the Danube floodplain between Neuburg and Ingolstadt, Bavaria

PETRA LANG, JÖRG EWALD

Hochschule Weihenstephan-Triesdorf, Germany, petra.lang@hswt.de, joerg.ewald@hswt.de

The main focus of this work is the observation of the effects of the restoration project (see abstract by Stammel et al.), especially of the ecological flooding, on alluvial forest vegetation using a system of stratified and randomly selected permanent plots. In plot selection, the following parameters were combined in a GIS:

- 1) position between the two subsequent barrages Bergheim and Ingolstadt (6 sections)
- 2) situation in the zone of projected ecological flooding (yes or no)
- 3) relative elevation above the depth contour of the projected water course ($</>1.25\text{m}$)
- 4) horizontal distance to the projected water course ($</>25\text{m}$)

Within each stratum (unique combination of parameters 1–4), three plots were placed randomly in the GIS, located in the field and sampled in 200 m² plots (in total 117 plots). The baseline survey of vegetation took place in 2008/2009 prior to the onset of restoration. Besides the study of vegetation types, we analysed relationships between site factors (soil moisture, nutrients, water storage capacity and flooding events as well as groundwater depth and flooding regime as modelled in GIS) and vegetation gradients. The resulting environment-vegetation model will serve as basis to project expected vegetation dynamics as induced by restoration measures.

1D hydrological model as a predictive tool for the assessment of aquatic habitat changes in floodplain rivers

I. POTYÓ, G. GUTI

Hungarian Danube Research Station of the H.A.S., Hungary, guti.g@t-online.hu

Predictions of future changes of floodplain habitats are essential for planners and decision-makers of river restoration programmes. In the Szigetköz section of the Danube, several alternative scenarios were proposed to improve the ecological status of the river-floodplain system impacted by the operation of the Gabčíkovo hydropower station. The rehabilitation scenarios were ranked by a preliminary quantitative benchmark system considering the areal extent and proportion of aquatic habitats, with the reference of historical habitat distribution. The typology of the aquatic habitats followed the 'functional sets' concept with minor modifications. The recent distribution of the aquatic habitats was analyzed using areal photographs and direct field observations. The future changes in structure and areal extent were predicted using results of 1D hydrological models produced by the MIKE 11 software. Discharge, flow velocity and water depth data were used for habitat typology. The results were presented on GIS habitat maps according to the rehabilitation scenarios of the river-floodplain ecosystem.

The herbaceous vegetation of the terrestrial-aquatic zones of Danube River oxbows

UDO SCHMIDT-MUMM

University of Vienna, Department of Freshwater Ecology-Hydrobotany, Austria, uschmidt@tele2.at

Both plant zonation and plant interaction are initiated by environmental gradients in floodplains. The important first step in understanding the relationship between environmental factors and zonation is to gain knowledge at the community level about species composition along gradients of riverine areas. In Austria the zonation pattern of herbaceous plants in riverine areas are rarely investigated. The present study focuses on the vegetation zonation and species composition along former side channels of the River Danube, the “Mühlwasser-Großenzendorfer Arm” oxbows, influenced by the surrounding urban environment and different leisure activities, and water bodies with negligible urban influences which belong to the “Lobau Donau-Auen” national park. For each site the floristic, quantitative and life form structure of the herbaceous vegetation along the terrestrial-aquatic zones were analyzed by transects. The community structure on each transect studied is characterised by ordination and classification methods. Resulting communities are then compared to determine differences in the vegetation structure for sites with urban influence and those with negligible urban influence. The final results and conclusions contribute to the basic knowledge needed for the specific management of the terrestrial-aquatic transitional zones within the oxbow system.

Floodplain restoration by dike relocation along the Elbe River and the need to monitor the effects

MATHIAS SCHOLZ¹, CHRISTIANE ILG¹, FRANZISKA KONJUCHOW¹, PETER HORCHLER², MICHAEL GERISCH¹, HOLGER RUPP¹

¹Helmholtz Centre for Environmental Research - UFZ, Germany

²German Federal Institute of Hydrology, Germany

In the last centuries, the Elbe lost 80 % of its retention areas due to dyke constructions for flood prevention. This led to severe damage or destruction of many essential wetland habitats. Furthermore, dike raisings have proved to be insufficient to ensure protection in case of extreme flood events. The creation of new retention areas by dike relocation is a major task in European river basin management. Also in the Middle Elbe stakeholders have attended to this challenge and fifteen dike relocation projects (2,600 ha of retention surfaces) are planned. To give more room for the river by opening former floodplains is a chance to combine flood risk management with biodiversity functioning.

The restoration of the hydrological connectivity is expected to improve the dynamics and functions of these floodplain ecosystems and restore their biodiversity. Thus, a long-term monitoring of the effects is a prerequisite for successful restoration.

In the poster we will present the sampling design and the first results of the interdisciplinary monitoring of dike relocation and floodplain restoration project carried out at Rosslau (Saxony-Anhalt). This dike relocation project offers the unique opportunity to follow the first implemented floodplain restoration project in the biosphere reserve Riverine Landscape Elbe.

Pre-restoration analysis of soil seed bank patterns in the backwater system of the Danube floodplain between Neuburg and Ingolstadt

A. SCHWAB^{1,2}, K. KIEHL¹

¹University of Applied Sciences Osnabrück, Vegetation Ecology and Botany, Germany, k.kiehl@fh-osnabrueck.de

²Floodplain Institute Neuburg, Germany, a.schwab@fh-osnabrueck.de, andre.schwab@aueninstitut-neuburg.de

In spring 2010 a new watercourse will flow through old oxbows of the Danube between Neuburg and Ingolstadt (Bavaria) to enhance fluvial dynamics in the floodplain forest (see abstract of Stammel et al.). Vegetation monitoring has already started to get exact baseline data. The aim of this study is to investigate the potential of the seed bank to contribute to the restoration of stream vegetation along the new watercourse in different parts of the Danube backwater system. These parts differ in the actual water regime (before restoration) from totally dry, over temporarily flooded to deep oxbow lakes. Approximately 350 soil samples were taken in autumn / winter 2009 and in spring 2010. Sampling plots were distributed along 22 transects across the backwater system, with transect sections stratified by geomorphology and plant communities. Seed bank samples will be concentrated (according to the Ter Heerdt method, 1996), stratified and brought to the greenhouse to germinate. The results on seed numbers and species composition will be discussed. To compare the soil seed bank with the input of hydrochoreous seeds transported by the inflowing Danube water seed traps will be installed in 2010 as soon as the water runs.

Topic 4

**Waterway- and river management,
sediments, transport dynamics,
ecological functions, fish migration,
TEN-T (Trans European Networks)
Rhine, Meuse-Main-Danube with special
regard to the ecology of the rivers**

Ship-induced waves alter the macrozoobenthos community composition of the river Havel

F. GABEL, X.-F. GARCIA, M. PUSCH

Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Germany, gabel@igb-berlin.de

Ship-induced waves impact littoral invertebrates, e.g. by displacing individuals. However, the long-term effects of ship-induced waves on the littoral macrozoobenthos community composition have rarely been quantified.

Macrozoobenthos was sampled at a stretch of the river Havel between Potsdam and Brandenburg, comparing sites highly exposed to ship-induced waves with sites which are intermediately exposed and reference sites without wave disturbance. A gradient of wave exposure was verified by monitoring wave heights from April to October 2008.

At the highly exposed sites species richness and individual abundances were reduced in comparison to not exposed reference sites. However, invasive species such as *Dikerogammarus villosus* occurred in higher densities at highly exposed sites. Hence, ship-induced waves impact the community composition of littoral macrozoobenthos.

Can we find parallels between a temperate large river and a tropical small stream?

MARIA LEICHTFRIED¹, WASANTHA S. WELIANGE², LEOPOLD FÜREDER³, GERNOT BRETSCHKO[†]

¹Institute for Limnology, Austrian Academy of Sciences, Austria, maria.leichtfried@oeaw.ac.at

²University of Kelaniya, Department of Zoology, Sri Lanka

³University of Innsbruck, Institute of Ecology, Austria

In the framework of different projects in Austria on the end of the last century, the Austrian part of River Danube ecosystem was investigated with its structural and functional units of this ecosystem to recognize and understand its ecological functioning.

Within the framework of the cooperative project IRESA (Initiative of **R**iver **E**cology in Sri Lanka: from **S**cience to **A**pplication), two tropical low order streams in different climatic zones in Sri Lanka Island (wet and dry) were investigated, for the first time with an ecological approach. This project was a cooperation between Austria and Sri Lanka, mainly financed by Austrian Agency for Development Studies and Austrian Agency for Academic Exchange, supported by Universities in Kelaniya and Innsbruck, as well as by the Institute for Limnology Mondsee of the Austrian Academy of Sciences.

We try to present in this poster the comparison of important results, and the comparison of ecological factors influencing these ecosystems, searching for parallels and differences in temperate and tropical climatic zones, or in large and small running water ecosystems.

Comparative assessment of the ecological state of sediments in the Ukrainian part of the Danube Delta, Dnipro and Boh Estuary

VICTOR ROMANENKO¹, ARTEM LYASHENKO¹, SERGEY AFANASYEV¹, IGOR KONOVS¹, KATERINA ZORINA-SAKHAROVA¹, LIUDMILA KIPNIS¹, ROBERT M. BURGESS², KAY T. HO², ANNA TERLETSKAYA³, MICHAIL MILYUKIN³

¹Institute of Hydrobiology NAS of Ukraine, Ukraine, artemlyashenko@bigmir.net

²U.S. Environmental Protection Agency, Atlantic Ecology Division USA, U.S.A., Burgess.Robert@epamail.epa.gov

³Institute of Colloid Chemistry and Water Chemistry NAS of Ukraine, Ukraine, annaterlet@ukr.net

This study focuses on identifying impaired and unimpaired areas within the Ukrainian part of the Danube Delta, Dnipro and Boh Estuary using recently developed environmental diagnostic approaches and tools. To characterize the state of these areas, a triad approach was used including (1) chemical analysis of priority contaminants in sediments (e.g., heavy metals, PCBs, DDTs, PAHs), (2) toxicity tests on whole sediments and water-sediment elutriates, and (3) assessment of zoo- and phytobenthos community characteristics. Sediment samples were collected in September/October 2006–2008 at the same stations across the delta and estuary (31 stations with three replicates at each station).

Moderate sediment contamination reflected adverse biological effects of toxicity tests. As expected, increased contamination and toxicity were often related to urban development while undeveloped areas were less impacted. However, a direct relationship between contamination, toxicity and benthic community structure was not always identified. The large spatial and temporal scale data set provided a comprehensive comparative assessment of the ecological state of sediments in two important Ukrainian water bodies. The study will be extended for several years.

The study was carried-out by several dedicated Ukrainian scientists with financial and technical support from the United States Department of State and Environment Protection Agency.

Benthic organic matter dynamics along a stream–middle size river–large river continuum

BENCE TÓTH, ERIKA BÓDIS, JÁNOS NOSEK, NÁNDOR OERTEL

Hungarian Danube Research Station of H.A.S., Hungary, tbenc@botanika.hu

After investigations performed at lower spatial scale (i.e. riverbank section, river section) we determined the organic matter content of the sediment along a stream, middle size river, large river continuum. Samplings were carried out in a second and third order stream (Hosszúvölgyi, Börzsöny), in a medium size river (River Ipoly) and in a large river (River Danube) 7 times during 2007–2008 (altogether 12 sampling sites). Bed sediment samples were collected by core sampler (4 cm in diameter) to the depth of 5 cm. Samples were washed through a series of sieves to separate fractions as follows: coarse (2360–710 μm), fine (710–250 μm), very fine (250–63 μm) and ultra fine (63–0.45 μm). Benthic organic matter was analysed in each fraction by loss on ignition (550 Co, 4 hrs).

During the investigation period average organic matter content was 1973 ± 651 (streams), 2087 ± 700 (River Ipoly), 1480 ± 1082 (River Danube) g AFDWm⁻².

Similarly to results of our earlier studies, lowest organic matter content occurred at high current velocity sites of the river, highest organic matter content was recorded at deposition zones characterized by low current velocity, where silt and clay dominated in the sediment.

Topic 5

**Water quality, new emerging pollutants,
biomonitoring, ecotoxicology**

The dragonfly *Gomphus flavipes* and mayfly *Palingenia longicauda* as indicators of the Danube River basin

EVA BULÁNKOVÁ, P. BERACKO, T. DERKA

Faculty of Natural Sciences, Comenius University, Slovakia

Till now, altogether 50 species of dragonflies were found in the Danube River and its arms in Slovakia. One of the most important indicator species is *Gomphus flavipes*, its occurrence in Slovakia was confirmed in the past and present. Today, large populations of *Gomphus flavipes* are found in the Malý Dunaj River called Danube's "inland delta". In 2007–2008 sampling of dragonflies in the Danube Delta (Romania) demonstrated another large population of this species.

The Gabčíkovo power plant (in operation since 1992) represents a significant impact on the functioning of the Danube ecosystem. Since 1994, we perform a long-term monitoring of dragonflies aiming at evaluating the influence of the dam on biota. During this monitoring we found only one larva of *Gomphus flavipes* at the site downstream of the dam.

In 2009 we observed emergence of giant mayfly *Palingenia longicauda* in the Danube Delta in Romania. This species disappeared totally in the 1930s from many European rivers.

In suitable conditions indicator species are more resistant to disturbances as well as to climatic changes. This study was carried out within the project 2/0059/09.

The influence of pH and temperature on the enzymatic activity of acidophilic heterotrophic microorganisms of the genus *Acidiphilium*

CARMEN MADALINA CISMASIU

Institute of Biology, Romanian Academy, Romania, madalinabio@yahoo.com, carmen.cismasiu@ibiol.ro

Acidophilic heterotrophic bacteria are one important component of the biodiversity in extreme environmental conditions and have a high biotechnological potential: they contribute to the biogeochemical cycling of elements, preventing the accumulation of environmental contaminants and, thus, creating the potential for the restoration of affected sites (former mining areas, decontamination of galvanic wastes or animal farms wastewater, etc.). Although they are adapted to grow in acidic conditions, their enzymatic activity is highly dependent on environmental parameters.

This study presents the influence of pH and temperature on starch hydrolysis of mesophilic and acidophilic *Acidiphilium* strains isolated from mining effluents of Ilba area (Maramureş, Romania).

Growth experiments were carried out at different temperatures (15°C, 28°C, 37°C, 42°C) and pH values (1.5, 2.0, 2.5, 3.0, 3.5), at different starch concentrations. The optimum substrate concentration was 0.1 %; at higher concentrations growth was inhibited. The highest metabolic activity was found at 28°C and pH 2.5, meaning that these would be the best conditions in the natural environment for maximum decomposing activity of the bacteria. In comparison with the regular laboratory cultures, the isolated strains proved to be more active due to their adaptation to the acidic conditions of the mine.

Monitoring the ichthyofauna in Nature Park Kopački rit (Croatia) in 2008

DINKO JELKIĆ, ANĐELKO OPAČAK, SINIŠA OZIMEC, TIHOMIR FLORIJAČIĆ, ZLATKO PUŠKADIJA, IVICA BOŠKOVIĆ

Department of Wildlife, Fishery and Beekeeping, Faculty of Agriculture, Josip Juraj Strossmayer University of Osijek, Croatia, djelkic@pfos.hr

Nature Park Kopački rit is one of the largest natural areas for spawning and breeding of freshwater fishes in Europe. The ichthyofauna was monitored at 8 sites in June and October 2008 by using fishing nets and electro-fishing gear. The total catch of fish was 371 individuals, classified in 6 families and 12 species. Total biomass was 468 kg. The most diverse family was Cyprinidae with 7 species. Prussian carp dominated in abundance and biomass with 47 %, followed by Common carp (30 %), and predatory fishes, such as Pike and Catfish (16 % each). Beside fish, 3 individuals of crayfish *Astacus astacus* were recorded. The American crayfish (*Orconectes limosus*) was not found, although its occurrence in Kopački rit was confirmed. Absence of fishes in size up to 20 cm and weight up to 300 g was noticeable in the catch, caused by direct impact of the predating Great Cormorant's colonies. A comparison between abundance and biomass indicated that fish communities in Kopački rit are under moderate stress.

β -HCH sediment eco-toxicity for crustacean *Gammarus fossarum* – chemical analyses and risk assessment in the Elbe River

KATEŘINA KOLAŘIKOVÁ¹, WOLF VON TÜMPLING²

¹Institute for Environmental Studies, Charles University, Czech Republic, kolarikova.katerina@seznam.cz

²Helmholtz Centre for Environmental Research – UFZ, Germany, wolf.vontuempling@ufz.de

β -HCH as a waste isomer of the Lindane production is a pollutant in the Elbe River catchment for a long time. Presently, this pollutant still remains a concern, although the insecticide production was stopped more than two decades ago. In a laboratory experiment crustacean *Gammarus fossarum* was exposed to natural sediment spiked with different β -HCH concentrations (0, 1, 10, 100, 1000 $\mu\text{g}\cdot\text{kg}^{-1}$) for two weeks. *Gammaridean* amphipods are common epibenthic invertebrates in European inland waters and are known to be sensitive to a wide range of pollutants. This research addresses linkages between laboratory findings and results found in Elbe River and tributaries in our previous study. Results should lead to significant improvements in understanding the possible environmental stress factor on the lower trophic level and potentially for the fish community. At the endpoint of sub-chronic exposition the mortality of males and females are discussed. Selected chemical biomarkers of organochlorine pesticides will be established: glutathione-S-transferase (GST) activity and (EROD).

Monitoring of algal blooms and eutrophication processes in the River Danube

WILLI KOPF, WERNER PÖHLMANN

Bavarian Environment Agency – Office Munich, Germany, willi.kopf@lfu.bayern.de

In Bavaria two monitoring stations control the water quality of the River Danube. One of the near-continuous automated stations is located near Regensburg at Bad Abbach (rkm 2400). Raw river water is analysed and subsamples are treated immediately by continuous filtration (mesh size 30 µm and 20 nm) to remove suspended matter for further analysis. The online monitoring emphasizes 9 chemical and physical sensors including chlorophyll and nutrients. Online-biomonitors detect the presence of toxic substances.

Biomass of phytoplankton is quantified by measurement of chlorophyll-a using delayed fluorescence. Algal blooms are indicated by a maximum of chlorophyll-a concentration of about 100 µg/L as well as by high amplitudes of chlorophyll due to the light dependent diurnal rhythm of algal growth affecting the balance of, e.g., oxygen, pH-value, nutrients and suspended solids. In the German stretch of the Danube phytoplankton growth is often limited by the availability of phosphorus, a crucial nutrient for water plants. In general algal blooms in the Upper Danube are controlled by (1) phosphorus, (2) an abrupt decrease of light intensity as a consequence of adverse weather, (3) rising discharge caused by torrential rain, or (4) water temperatures above 20 °C with respect to the diatoms.

Monitoring of selected drugs in surface waters of the Vltava River Basin

PAVLA BABKOVÁ, MILAN KOŽELUH, LUMÍR KULE

Povodí Vltavy, státní podnik, VHL Plzeň, Czech Republic, kozeluh@pvl.cz

For the first time contamination of active ingredients of OTC medicines such as NSAIDs (ibuprofen, diclofenac), anticonvulsants (carbamazepine), antibiotics (erythromycin, sulfamethoxazole) and contrast agents (iopromide and iopamidol) was investigated in the Vltava River Basin. Sources of these chemicals are municipal waste water treatment plants (WWTP). Selected drugs were included to the monitoring in January 2009. Samples were collected at monthly intervals at 28 sites of the Vltava River Basin and analyzed by LC-MS/MS with direct injection of large volume water sample. Data were statistically processed (average, minimum and maximum concentration) and compiled in a map of pollution. Most of the measured concentrations were below analytical detection limits; however, in some cases, concentrations greater than 1000 ng/l were found. This situation can occur when waste water from municipal WWTP in big cities discharges into small rivers with insufficient dilution of pollutants (for example Rakovník city – Rakovník stream, Kladno city – Zakolany stream, Píbram city – Píbram stream etc.). At present, maximal limits of drugs in surface water are not yet established in the Czech Republic. Increased concentrations of these substances are the reason for continued monitoring focusing on sites with permanent pollution especially in highly populated regions or in regions with specific industrial production.

Riverine Transport and Sources of Polyfluoroalkyl Compounds (PFCs) along the Rivers Elbe and Rhine

AXEL MÖLLER*, LUTZ AHRENS, RENATE STURM, RALF EBINGHAUS

*GKSS Research Centre Geesthacht, Institute for Coastal Research, Geesthacht, Germany, axel.moeller@gkss.de

Polyfluoroalkyl compounds (PFCs) are currently one of the most elucidated emerging pollutants due to their extreme persistence in the environment, high bioaccumulation potential and several adverse effects on humans and animals. They have been detected in various environmental compartments including air, water, sediment and biota. Sources of PFCs in surface waters are, e.g., industrial effluents, release of treated wastewater and diffuse sources like precipitation.

The purpose of this study is to understand the riverine transport behaviour of PFCs and to identify sources discharging PFCs into the Elbe and Rhine river basins. Surface water samples were taken along the River Elbe and from the German Bight in 2007. A comparative sampling campaign took place along the River Rhine and the Dutch Coast in 2008.

The total PFC concentration ranged from <1 ng/L in the open North Sea up to a few hundred ng/L in river sections with high industrial density. The Rivers Elbe and Rhine showed a different composition profile pointing to the influence of diverse sources located in the river basins. The results show that both rivers are important sources discharging PFCs into the North Sea where they are transported along the coastline via the ocean currents.

New methods in estimating biodiversity: a case study on aquatic and semi-aquatic heteroptera in the Arieş river basin (Romania)

HOREA OLOSUTEAN, DANIELA MINODORA ILIE

Lucian Blaga University of Sibiu, Faculty of Sciences, Department of Ecology and Environmental Protection, Romania

This paper is part of a study to assess the quality of water resources in the Arieş River Basin. The aim was to establish an inventory of habitats (number and quality) of aquatic and semi-aquatic Heteroptera considering the human intervention in the area. Further, biodiversity was investigated by using two different methods (the classical, index-based one, and a new emerging method: Jost's number equivalent) that estimate both α -, β - and γ -biodiversity. Samples were taken from 16 sampling stations along the hydrographic basin. We found at least 17 species, most of them eurivalent; however, some species were rare sightings in the Romanian fauna, such as *Gerris gibbifer* Schummel 1832, *Hebrus pusillus* (Fallén, 1807) or *Hesperocorixa sahlbergi* Fieber 1848. The α -biodiversity was low but counterbalanced by higher β -biodiversity for most of the hydrographic basin (the gradient chosen was altitude). Both methods used for diversity estimation show more or less similar results; however, Jost's method is easier to use and the results are comparable with any other area.

Assessment of Water Quality in the Upper Course of Siret river (N-E Romania)

GABRIELA SASU¹, CRISTINA BLANARU¹, OANA ONOFREI¹, ROXANA NECHIFOR²

¹National Administration Romanian Waters, Siret Water Branch, Suceava Water System Management, Romania, sasu_gabriela@yahoo.com, bla_cristina@yahoo.com, oana.onofrei@sgasv.das.rowater.ro

²National Administration Romanian Waters, Siret Water Branch, Romania, roxana.nechifor@das.rowater.ro

With a length of 599 km, Siret River is the third longest tributary of the Danube and drains a catchment area of 46289 km² (90 % belonging to Romania and 10 % to Ukraine). It encompasses different landscapes, including Eastern Carpathians, the Sub-Carpathian hilly region, the Moldavian Plateau, the Siret Meadow and Plain; all its major tributaries originate from the Eastern Carpathian Mountains.

The paper presents a water quality assessment in three sections of the Upper Siret River (upstream Siret city, Hutani, Lespezi), based on physico-chemical and biological parameters, during 2005–2009. Samples were taken monthly for physico-chemical parameters, three times a year for biological quality elements (phytoplankton, macroinvertebrates) and once every three years for fish populations.

Ammonium (0.053–0.108 mg N-NH₄/L) and total phosphorus concentrations (0.040–0.047 mg P/L) reflected category I of water quality by Romanian standard. However, nitrites showed higher concentrations equivalent to quality class II (0.017–0.024 mg N-NO₂/L).

Phytoplankton showed an average abundance between 627777 and 724722 individuals/L, and the respective Saprobic index ranged between 2.04 and 2.22. Macroinvertebrates showed low densities: 122 individuals/m² (upstream Siret), 138 individuals /m² (Hutani), 139 individuals /m² (Lespezi). The corresponding Saprobic indices were: 2.03, 2.06 and 2.16. In 2006, 77 fish specimens of 8 species were collected.

Wastewater disinfection at River Ilz to improve bacteriological water quality: effects and constraints

MARGIT SCHADE¹, W. KOPF¹, G.H. REISCHER², A.H. FARNLEITNER²

¹Bavarian Environment Agency, Germany, Margit.Schade@lfu.bayern.de

²Institute for Chemical Engineering, Vienna University of Technology, Austria

Contamination with fecal bacteria often hampers the use of surface waters for bathing purposes. Different sources may deteriorate water quality including wastewater, agricultural runoff, or wildlife. If fecal input mainly results from wastewater treatment plants (WWTPs) disinfection of secondary effluents is supposed to noticeably improve hygienic water quality.

Along the River Ilz, a tributary of the Danube from the Bavarian Forest, five WWTPs between Hutthurm and Passau have recently been equipped with UV irradiation (3 WWTPs), membrane filtration (1 WWTP), and ultrasound/ozone-treatment (1 WWTP) for wastewater disinfection. Fecal indicator organisms (*E. coli*, Enterococci) were determined by cultivation-based methods to evaluate the disinfection efficiencies and monitor the effects on the microbiological quality of the Ilz. The disinfection systems mostly revealed satisfying reduction rates of the fecal indicators. Thus secondary effluents no longer account for a considerable fecal pollution in this stretch. Intense rain events, however, led to a significant impairment of bacteriological water quality possibly caused by sewer overflows or agricultural runoff. For tracing back the origin of these contaminations a quantitative MST-(microbial source tracking) method will be applied identifying genetic *Bacteroidetes* markers from the 16S rRNA gene of populations specific to human or ruminant hosts.

Bioindication and biotesting of water and bottom sediments of water bodies of the Danube Biosphere Reserve

VOLODYMYR LYASHENKO¹, MARIA GONCHAROVA²

¹Taras Shevchenko National University Of Kyiv, Ukraine, volodimirl@bigmir.net

²Institute Of Hydrobiology Nas Of Ukraine, Ukraine, mariyagoncharova@mail.ru

The transboundary Ukrainian-Romanian UNESCO Danube Delta Biosphere Reserve encompasses one of the largest wetland complexes in the world. Continuous ecological monitoring of the aquatic ecosystem includes the assessment of water and sediment toxicity.

The aim of the study was to characterize the benthic community as bioindicators of water and sediments pollution and to perform toxicity tests in water and sediments. The results allowed a comparative assessment of the state of water bodies in three main arms of the Ukrainian part of the Danube Delta. The conventional bioindication and biotesting techniques have been used. Bioindices provided information on the degree of pollution and contamination.

The obtained data are indicative of moderate state of benthic communities of the Danube biosphere reserve. There was a gradient of toxicity from Ochakivskyi arm (“poor”) to Bystryi arm (“moderate”) and Vostochnyi arm (“good”). These differences will be discussed. We hypothesize that sources of pollution are located mostly upstream and not in the Delta area.

Distribution of organic UV-filters in surface water of the River Elbe

HENDRIK WOLSCHKE^{1,2}, ZHIYONG XIE¹, RENATE STURM¹, RALF EBINGHAUS¹

¹GKSS Research Centre, Institute for Coastal Research, Germany, hendrik.wolschke@gkss.de

²Leuphana University of Lüneburg, Germany

Organic UV-filters are commonly employed in sunscreens to protect the user skin against solar radiation. They are further applied as UV-stabilizer in several personal care products and in formulations of textiles, varnishes and plastics. The major input pathway of UV-filters into the aquatic environment is assumed to be the washing off from skin and clothes after superficial application in households or during swimming in lakes, rivers and the Sea. Other sources of contamination are, e.g., leaching from plastics, varnishes etc.

In this study, the most commonly used UV-filters are investigated in the surface water along the River Elbe. The analytical method was validated for the determination of UV-filter using gas chromatography and mass spectrometry (GC-MS). The extraction methods liquid-liquid-extraction with dichloromethane and solid phase extraction using PAD2-cartridges were validated. This study shows the concentration and distribution of the dissolved and particulate phase of UV-filters in the surface water along the River Elbe.

Topic 6

**Trophic relations (nutrients-bacteria-
algae-benthos-fish-birds-humans)**

Spatio-temporal changes of benthic organic matter and macroinvertebrate communities in the Danube Bend (Hungary)

N. OERTEL, E. BÓDIS, J. NOSEK, B. TÓTH

Hungarian Danube Research Station, IEB of the Hungarian Academy of Sciences, Hungary, oer63@ella.hu

Spatio-temporal changes in benthic organic matter, composition and abundance of benthic macroinvertebrate communities and functional feeding groups were investigated on depositional and erosive riparian zones of the River Danube between river kilometres 1688 and 1668 in 2005. Depositional zones were characterised by the dominance of ultra fine and very fine sediment, while erosive zones showed a significant amount of coarse bed material. The average organic matter content was 6.3 %. The macroinvertebrate fauna was represented by 30 species within 10 higher taxonomic groups (species number in bracket): Gastropoda (8), Lamellibranchiata (15), Polychaeta (1), Oligochaeta, Isopoda (1), Amphipoda (3), Trichoptera (1), Diptera, Chironomidae, Nematomorpha (1). Bed sediment and organic matter fractions and total benthic organic matter are strongly determined by the flow velocity and grain size distribution, while species composition, taxon and functional feeding group distribution significantly differ according the depositional or erosive character of the riparian zone. The results confirm our knowledge about the discontinuity in large rivers and the phenomena of structural simultaneousness (coexistence of different spatial patterns).

Topic 7
**General limnological themes following
the IAD traditions, flora and fauna**

The actual state of relict Pontic-Caspian invertebrate fauna of the Lower Danube within the area of Ukraine

LYASHENKO ARTEM, ZORINA-SAKHAROVA KATERYNA, MAKOVCKYI VADIM, SANZHAK YURYI

Institute Of Hydrobiology Nas Of Ukraine, Ukraine, artemlyashenko@bigmir.net, zsk@bigmir.net, vmakovskiy@gmail.com, sanzhak_uriy@bigmir.net

Long-term investigations on relict Pontic-Caspian invertebrate fauna for more than a century have been reflected in the Ukrainian Danube research. Especially the Lower Danube and its tributaries serve as complex habitat for this peculiar species community, being inhabited since the tertiary period. The Pontic-Caspian Basin restricted the area of these species for a long time, but in the last decades many representatives of this group became active invaders occupying new habitats far away from their home waters.

The specified list of Pontic-Caspian macroinvertebrate fauna for the Ukrainian part of the Lower Danube is represented; ecological characteristics of some species are considered; comparative analysis with retrospective materials in relation to distribution of relict Pontic-Caspian fauna in a region is carried out.

Spatial patchiness and similarity of macrophyte assemblages along a cut-off channel of the River Danube in Linz (Austria)

VERONIKA BARTA, GEORG A. JANAUER, KATRIN TEUBNER

Department of Limnology, Research Group Hydrobotany, University of Vienna, Austria

Distribution of aquatic plant assemblages along a cut-off channel of the River Danube in Linz was surveyed four times a year during the vegetation periods 2001 and 2002. To illustrate spatial changes in macrophyte communities, Bray-Curtis Similarity and species turnover rates were calculated between each pair of 17 successive stream stretches. Results of both species change measures showed a significant inverse relationship. Floristic heterogeneity was highest at the stream source, resulting in lowest Bray-Curtis similarity value (6.85 %) and highest species turnover rate (0.65). With increasing stream length, uniformity of macrophyte communities also increased resulting in the trend of raising similarity values. The similarity index, however, did not exceed values of 80 % illustrating that at least 20 % floristic change was occurring between consecutive survey units. Similarity values were associated with trends of abiotic parameters. 'Survey unit length' and 'water temperature' were positively related with similarity while 'substrate type' and 'flow velocity' showed inverse negative relationships. These trends, however, were statistically not significant and could not explain sufficiently the spatial patchiness of plant communities. Our study indicates that the establishment of macrophyte assemblages in streams could also be influenced by ecological processes such as transport of propagules to downstream sections.

Phytoplankton composition and abundance in Srebarna Lake and adjacent temporary wetlands (Bulgarian floodplain of the Lower Danube River)

M.B. BESHKOVA¹, R.K. KALCHEV¹, L.Z. PEHLIVANOV², V.P. VASSILEV²

¹Institute of Zoology, BAS, Bulgaria, mbeshkova@zoology.bas.bg

²Central Laboratory of General Ecology, Bulgaria

Species composition, numerical and biomass abundance of phytoplankton were determined from 15 wetland sites in the Bulgarian part of the Lower Danube floodplain. Five sampling sites were located in the aquatic area of Srebarna Lake and several other water bodies in its vicinity, representing small ponds of rather temporary than permanent character. The sampling campaign during 2004–2006 encompassed 12 visits in the vegetation period (March–October). The sampling sites were additionally characterized by their min, max and average depths, water temperature, transparency, degree of surface coverage by macrophytes, sediment type, distance from the middle of the lake, etc.

Cluster and multidimensional analyses yielded different wetland site groups based on algal species, division and functional group composition. These algal groups were related to the environmental parameters mentioned above. In particular, periods of high and low lake levels depending mainly on the Danube level variations but also on man's regulation of inflow influence algal communities. The effects of interactions between main lake aquatic area and surrounding small water bodies on algal biodiversity and lake trophic status are discussed.

Recent drastic changes in the amphipod and mysid fauna (Crustacea: Malacostraca: Amphipoda, Mysida) of the Hungarian Danube stretch

PÉTER BORZA^{1,2}, NÁNDOR OERTEL²

¹Eötvös Loránd University, Institute of Biology, Department of Systematic Zoology and Ecology, Hungary, borzap@gmail.com

²Hungarian Academy of Sciences, Institute of Ecology and Botany, Hungarian Danube Research Station, Hungary

Amphipod and mysid crustaceans are among the most prominent groups of aquatic invaders. In the main arm of the River Danube in Hungary all species currently occurring are Ponto-Caspian immigrants. The rate of colonisation has undergone a drastic increase in the last two decades, which – along with the more intensive research – resulted in the doubling of the number of species in this section of the river in these groups (from six to twelve). Of the six new species five are recent invaders and one has been “rediscovered”. Within the gammaroid amphipods two species have been added to the four already present (*Dikerogammarus bispinosus*, *D. haemobaphes*, *D. villosus*, *Echinogammarus ischnus*); *Obesogammarus obesus* appeared in the early 1990s, while *Echinogammarus trichiatus* was found in 2009. Within corophioid amphipods the presence of *Chelicorophium sowinskyi* (formerly regarded as uncertain) has been proven, and *C. robustum* also appeared recently (2009), which have increased the number of species to three (with *C. curvispinum*). Similar changes have taken place within the mysids; the formerly solitary *Limnomysis benedeni* has been accompanied by two further species, *Hemimysis anomala* and *Katamysis warpachowskyi*. Colonisation patterns, current distributions, and ecological characteristics of the species are discussed.

Importance of the Danube River in spreading the infection of red deer with *Fascioloides magna* in eastern Croatia

TIHOMIR FLORIJAČIĆ¹, ANĐELKO OPAČAK¹, IVICA BOŠKOVIĆ¹, SINIŠA OZIMEC¹, DINKO JELKIĆ¹, ALBERT MARINCULIĆ², ZDRAVKO JANICKI²

¹Department of Wildlife, Fishery and Beekeeping, Faculty of Agriculture, Josip Juraj Strossmayer University of Osijek, Croatia, flory@pfos.hr

²Faculty of Veterinary Medicine, University of Zagreb, Croatia

American giant liver fluke (*Fascioloides magna*) is an important trematode, which mainly occurs in the liver of various wild and domestic ruminants. It was recorded for the first time in eastern Croatia in January 2000, during liver examination of shot red deer from the Danube region. Introduction of the parasite severely damaged the health status of cervids. The survey was carried out during 2001–2004 by qualitative and quantitative faecal examinations of deer living in epizootic areas of the Danube region and in other hunting grounds in eastern Croatia that manage deer game. The highest number of affected deer with a prevalence of 35–60 % was recorded in forested floodplains near the Danube. Mild infections were detected in hunting grounds along the Drava River and in its flooded middle part. Considering the migration paths of red deer along the Danube and epizootic indicators, the spreading of this parasitic disease is expected on left side of the Danube in Serbia, as well as in hunting grounds on the right side of the Drava River in Croatia.

Molecular studies on the phylogeny of immigrated *Theodoxus fluviatilis*, an alien species in the Upper Danube

WILLI KOPF, CORNELIA MORAWETZ

Bavarian Environment Agency – Office Munich, Germany, willi.kopf@lfu.bayern.de

Nowadays biodiversity in surface waters of central Europe is affected by the immigration of alien species. Molecular studies contribute to track the sources of the invaders and give a better understanding of the pathway of colonization.

Theodoxus danubialis (Pfeiffer, 1828) is a small aquatic gastropod mollusc of the family Neritidae. This endemic species is part of the present fauna in the Danube River Basin (DRB). In contrast, the river nerite *Theodoxus fluviatilis* (Linnaeus, 1758) is a fresh- and brackish water snail occurring in the former area of the Mesozoic Tethys Ocean. This river nerite is spread in the Rhine River Basin (RRB) but it was absent in the Upper Danube until first findings of *Th. fluviatilis* were reported in 2001 in Austria and in 2004–2005 in Bavaria (Passau, Regensburg). Immigrations into the Bavarian stretch of the Danube may originate from downstream (DRB) or from upstream (RRB) via Rhine-Main-Danube-Channel.

Molecular studies of the mitochondrial gene of cytochromoxidase are used to identify the affinity between individuals of *Th. fluviatilis* from different sites and sources. Using statistical methods a phylogenetic tree of the individuals can be generated.

Inventory of Macrophytes and Habitats along the River Danube in Croatia

SINIŠA OZIMEC¹, JASENKA TOPIĆ², GEORG JANAUER³

¹Department of Wildlife, Fishery and Beekeeping, Faculty of Agriculture, Josip Juraj Strossmayer University of Osijek, Croatia, sinisa.ozimec@pfos.hr

²Sisačka cesta, Croatia

³Department of Limnology and Hydrobotany, University of Vienna, Austria

The stretch of the River Danube through Croatia is 137 km long. The Danube is a bordering river between Croatia and Serbia, and right side belongs to the Croatian territory. During 2003–2004, the inventarisation of aquatic macrophytes and assessment of habitat parameters were carried out along the right riverside of the main channel, in survey units of one river km length. In total 34 plant species were recorded, of which 11 were exclusively found in the Danube main channel. This number indicates a low macrophyte diversity similar to that in the adjacent reaches of the Danube course in Hungary and Serbia. Information on the conservation value of macrophytes is given. In the bank structure, fine inorganic material prevails (63 %), followed by stone blocks used for river regulation (30 %), and concrete embankments (5 %). Among the river sediment types, fine inorganic material is dominant (64 %); sand is present with 29 %, and gravel with 5 %. Average water transparency is 60–70 cm, and medium flow velocity is the most frequent flow class. Broad-leaved forests dominate along the riverside (86 %), agricultural area covers 3 %, and industrial and urban areas were recorded by 4 % each.

Advantage of a Hungarian Rotifer Database System from the aspect of the Danube research

ADRIENN TÓTH¹, TAMÁS LÓRINCZ², ATTILA SZÜCS³

¹Hungarian Academy of Sciences, Institute of Ecology and Botany, Hungarian Danube Research Station, Hungary, toth.adrienne@gmail.com

²Ministry of Environment and Water, Nature Conservation Monitoring Department, Hungary

³Central Services Directorate, Hungary

Our 2008–2009 results showed that rotifers contribute the highest proportion of zooplankton in the River Danube (70–95 % of the abundance and biomass). During this research period we found 92 taxa from the main arm and 83 taxa from the side arm near Göd (rkm 1669). Nowadays the collection of information in well organized databases means an effective tool for easy data access and utility. We constructed a new database system for collecting rotifers data on a country scale, which provides correct information for different water systems (lakes, ponds, canals). There are many taxon lists on the internet, which can provide current, accurate and reliable information about the species. Our database collects recordings of rotifer species in the Hungarian fauna based on scientific papers. Numerous tables facilitate easy access to actual information on valid taxon name, synonym taxon name, paper quotation (name of author(s) and journal, year of publication), date and place of sampling with GPS coordinate or by cities, habitat type, photo of the animal and a habitat map based on recent data. The database operating system functions like Google and Yahoo. The Rotifer database is flexible, expandable and the uploading is continuous.

Can reservoirs compensate oxbow disappearance? The amphibian fauna of the Rétközi reservoir and the Várközi oxbow lake

MIHÁLY TÓTH¹, MIKLÓS PUKY²

¹Department of Hidrobiology, University of Debrecen, Hungary, archangel.of.justice@gmail.com

²Hungarian Danube Research Station, Institute of Ecology and Botany, HAS, Hungary

The decline of amphibians is a global problem. In Europe it is mainly caused by the disappearance and alteration of habitats. Therefore, it is necessary to counterbalance this negative process with the protection of already existing and the creation of new amphibian habitats. Several large-scale interventions will be realised in the framework of the New Vásárhelyi Plan, a river-regulation oriented programme along the Hungarian stretch of the River Tisza including the construction of new reservoirs. Rétközi reservoir (48°16'30" N, 22°01'50" E) was built in 1990 providing a good locality to study the mid-term impacts of such constructions. Várközi oxbow lake is a nearby semi-natural habitat. Our survey started in March, 2008. Two sampling methods, visual encounter survey and sound monitoring according to the MONITOR2000 protocol were applied. *Bombina bombina*, *Bufo bufo*, *Epidale viridis*, *Hyla arborea*, *Pelophylax ridibundus*, *Pelophylax lessonae*, *Pelophylax kl. esculentus* were detected using sound monitoring. In addition, *Rana arvalis* and *Pelobates fuscus* were found during visual encounter surveys. The occurrence of species is different at the two sites. From green frogs *P. lessonae* was only detected at the oxbow, where *H. arborea* and *E. viridis* were also more abundant, while *B. bufo* was heard only at the reservoir.

Diversity of Benthic Macroinvertebrates in Relation to Environmental Parameters in Reservoirs, Danube Basin, North-West Bulgaria

TEODORA TRICHKOVA¹, VIOLETA TYUFEKCHIEVA¹, LUBOMIR KENDEROV¹, ZDRAVKO HUBENOV¹, IVAN BOTEV¹, DIMITAR KOZUHAROV², YANKA PRESOLSKA¹, YORDAN UZUNOV³, STEFAN STOICHEV¹, SVETOSLAV CHESHMEDJIEV⁴

¹Institute of Zoology, Bulgarian Academy of Sciences, Bulgaria, trichkova@zoology.bas.bg

²Biological Faculty, Sofia University, Bulgaria

³Laboratory of General Ecology, Bulgarian Academy of Sciences, Bulgaria

⁴NGO EcoForum for the Nature

Twelve reservoirs in the Danube Basin in North-West Bulgaria were sampled in September – October 2009 to study species composition and distribution of benthic macroinvertebrates in relation to selected environmental parameters. The reservoirs, located at altitudes of 110–445 m a.s.l. and with surface areas of 10–360 ha are used for irrigation, drinking water supply, electricity production, aquaculture and recreational fishing.

The benthos fauna consisted of 40 % Oligochaeta, 3 % Gastropoda, 30 % Bivalvia (mostly *Dreissena polymorpha* and *D. bugensis*), 0.1 % Hydracarina, 0.5 % Odonata, 0.5 % Ephemeroptera, 1 % Trichoptera, and 25 % Diptera (16 % Chaoboridae, 7 % Chironomidae, 2 % Ceratopogonidae). Hirudinea, Mysidacea, Decapoda, Heteroptera and Coleoptera were found as well. Highest species diversity was recorded in reservoirs close to the Danube River and in the largest reservoir.

Physico-chemical parameters were analyzed by Principal Component Analysis (PCA). Most of the variance was explained by conductivity, Ca concentration and nutrients. Reservoirs with high values of these parameters were separated from those with low values but high transparency. The diversity of macroinvertebrates is dependent on the environmental parameters and can be used to assess the ecological status. In particular, the role of invasive *D. polymorpha* and *D. bugensis* is discussed.

The study was supported by the Bulgarian Science Fund, Project DO02-283/2008.

Long-term changes of fish fauna in the Hungarian section of the Ipel River

A. WEIPERTH, T. GAEBELE, I. POTYÓ, G. GUTI

Hungarian Danube Research Station of the H.A.S., Hungary, guti.g@t-online.hu

Setting environmental objectives for rehabilitation of large rivers is hindered by a lack of knowledge of the pre-regulation or reference conditions. Our study was aimed to assess the deviation of the recent fish fauna from its reference state in the regulated lowland section of the Ipel River. Historical habitat analysis and literature study gives a chance for judgement of former fish fauna. Acceptable reports from the fishes of the Ipel River are available mainly from the 19th century and the beginning of the 20th century. The number of observed species increased over time and the occurrence of 57 fish species was reported up to now. The description of recent species composition was based on the results of fish surveys by electrofishing. The comparison of data sets yielded the disappearance of sterlet (*Acipenser ruthenus*) and bullhead (*Cottus gobio*) and increasing abundance of bream (*Abramis brama*), Prussian carp (*Carassius gibelio*) and Ponto-Caspian gobies.

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