ISSN 2070-1292

danube news

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

donau aktuell

The Danube River landscape

Editorial

Dear Reader

Riverine landscapes are an integral part of a river basin. This has been scientifically proven by the concept of the „catchment approach“ and adopted by new strategies of water protection. In December 2009, the Danube River Basin Management Plan has been delivered by the ICPDR in the time frame of the EU WFD. This is a significant milestone of the Integrative Water Management (IWM) in the Danube River Basin.

IAD as an observer of the ICPDR contributed by reviewing the draft report to the promotion of specific environmental issues, such as elements of riverine landscapes including aquatic and terrestrial ecosystems. Stretching between basic and applied science, IAD is predestinated to transfer complex ecology to the public, managers and decision makers. Thereby, proper language and adequate simplification are crucial tools. We need to elucidate the links between plants and animals as key actors of biological processes (e.g. the food chain and production), the role of physical and chemical properties (e.g. temperature and pollution), and habitats as distinct elements that host the biota; and to explain the importance of an intact ecosystem to human health.

This issue of Danube News explains first the role of riverine landscapes in a historical perspective when the Danube was a “pristine” water course. Then, we present a detailed overview of the actual situation. The scientific part includes aspects of the water cycle, land cover and land use, the riparian zones and related ecotones of rivers, and ecosystem services of floodplains. Geographic and geological features of landscapes meet with precipitation and hydrology (runoff) as well as hydromorphological structures and groundwater areas. Forests may mitigate erosion while agriculture may provide significant diffuse sources of nutrients and pollutants. Urban areas clogging soils increase surface runoff and hence the discharge pattern of rivers. Human activities in a river basin significantly impact

Figure 1. The Mures River Basin features a still natural landscape and a rather natural river course, as demonstrated by the hydromorphological map of Ulrich Schwarz (2010). This basin, traditionally stressed by mining activities, is now threatened by multiple economic development such as gravel exploitation, freeway construction and industrial development. The picture shows the Târnava Mare and an outstanding example of how cities (Blaj) near rivers were built in earlier times: in safe distance and protected by floods, hence, providing the space that the river needs to run naturally

various water uses such as drinking water supply, irrigation and ecosystem services. On the other hand, uses by hydropower and navigation as well as flood protection deteriorate hydromorphological structures and aquatic ecosystems. All these human impacts need to be balanced in a cooperative process of public participation and applied in a truly sustainable way.

We also stress the emotional dimension of landscapes which is an essential though often neglected aspect of environmental protection. The political instrument to protect, conserve and restore precious landscapes in a public interest of society is the legal framework. The tools for this policy are wise spatial planning and the designation of nature reserves and nature parks under various labels, such as Natura 2000 or Ramsar sites. Such actions are crucial to withstand economic pressures and particular interests of various users. A major issue in this context is the valuing of landscapes and ecosystems, as many services (like the genetic pool and biodiversity) cannot be given in monetary equivalents.

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

Legacies from the past: The Danube's riverine landscapes as socio-natural sites

Martin Schmid, Verena Winiwarter: Center for Environmental History, IFF-Institute of Social Ecology, Klagenfurt University, Vienna, Austria, e-mails: martin.schmid@uni-klu.ac.at; verena.winiwarter@uni-klu.ac.at
Gertrud Haidvogl: Institute of Hydrobiology & Aquatic Ecosystem Management, Department of Water, Atmosphere & Environment, BOKU – University of Natural Resources & Applied Life Sciences, Vienna, Austria, e-mail: gertrud.haidvogl@boku.ac.at

The Danube River Basin (DRB) has been changed by mankind for millennia and hence must be studied in a long-term perspective. Its current situation cannot be understood if the common past of nature and humans is studied apart. Ongoing social, economic and political changes along the Danube give historically and ecologically informed management a certain urgency. No environmental history of the DRB has been attempted before. The fundamental transformation of rivers like the Danube from 1800 onwards was driven only by few societal functions: navigation, land reclamation, flood control and electricity generation. Therefore we are currently confronted with uniform, often monotonous riverscapes. As environmental historians we approach the riverine landscapes as the result of a co-evolutionary process of nature and society. In our perspective riverscapes are socio-natural sites, a notion emphasizing legacies in river history.

The Danube as seen from environmental history

The Danube is the only major European river running eastwards. It crossed the former Iron Curtain at the present border between Austria and Slovakia. This makes the Danube's 20th century history special. The Cold War affected the river's transformation for navigation, electricity generation and flood protection differently as compared with rivers which where either completely part of the western world like the Rhine, or part of the eastern block like the Odra. The modern history of the Danube shows cooperation (Danube Commission, ICPDR, IAD) but also a lot of tension and even military conflicts between the riparian states. The collapse of Yugoslavia in the 1990s had significant environmental and economic impact on the Danube (Carter & Turnock 2002). This event is but one example for the long history of the Danube as a seat of warfare.

A rich diversity of societies has developed on the Danube's banks, including major urban agglomerations like the four European Danube capitals Vienna *(Figure 1)*, Bratislava, Budapest and Belgrade. Their development cannot be understood without the Danube and goes back further than the foundation of military camps and cities along the Roman Limes in the first centuries AD.

As environmental historians we approach the river (including the surrounding land) as the result of a co-evolutionary process of nature and society. In our perspective riverscapes are socio-natural sites (Winiwarter & Schmid 2008; Schmid 2009). They result from the co-evolution of human practices with biophysical arrangements. The concept of socio-natural sites emphasizes legacies in river history. Human practices in the past changed material arrangements in the riverscapes and these changed arrangements became constraints for later practices. Arrangements are inherited; they offer options for some and make other practices impossible.

To study the history of riverine socio-natural sites we combine two sets of questions: (1) How did humans perceive and use the riverine landscape? We approach the river as a societal resource and as a cultural symbol; (2) What was the state of the riverine environment in the past and how did it change? To investigate the latter we cooperate with natural scientists, in particular experts in morphology, limnology and (aquatic) ecology.

Nature is dynamic, even mountain ranges change over time. But rivers are highly dynamic even at timescales within human experience, processes of sedimentation and erosion can transform the physical shape of the riverine landscape during only one flood event, a river's discharge can rise or fall within minutes. These and other natural features of rivers have challenged societies for millennia. Human societies have to organise themselves to deal with these dynamics, to protect human lives and socio-economic infrastructures from riverine threats and to use these dynamics for human purposes

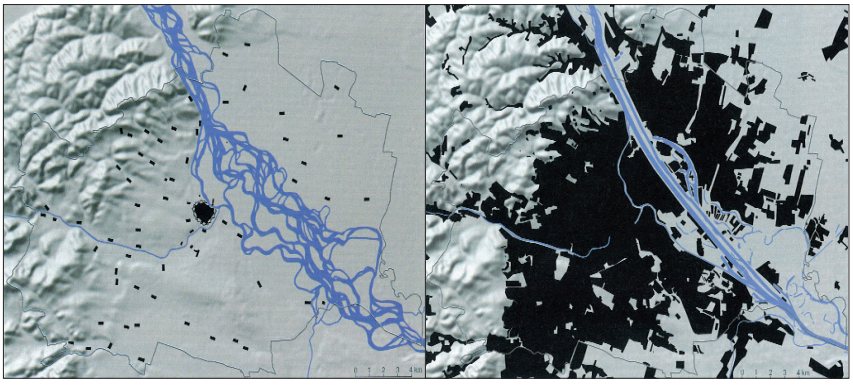

Figure 1. Vienna and the Danube as a socio-natural site, 1550 (left) compared to 2000 (right), (source: Brunner & Schneider 2005, 29–43). The rapid development of urban agglomerations like Vienna fundamentally transformed the riverine landscapes. For the next two years the Center for Environmental History in Vienna will study the Environmental History of the Viennese Danube with a grant by the Austrian Science Foundation (FWF P22265). This interdisciplinary research project integrates history, geomorphology, social ecology and other fields of expertise. The project aims to understand long-term dynamics, patterns and side-effects of the colonization of the river and its floodplains between 1500 and 1890

such as transportation. Concepts like social (urban) metabolism allow studying society-river-relations over time, thus integrating the biophysical world into human history (Schmid & Haidvogl 2008 with further references).

There is no doubt that changes in technology are a major force in the history of rivers. But in contrast to other approaches, we see technology not only as a sphere with a logic of its own ("technical progress") but also always as a reaction to changes in society, culture and nature. Nature, society and technology are transformative to each other: if one realm changes, the other two change as well.

Multifunctionality in pre-industrialised riverscapes in peace and war

For the case of the eastern Machland in Austria, a 10 km long stretch of the Danube in Upper and Lower Austria, landscape dynamics have been reconstructed in detail from the 1700s (Hohensinner 2008; Winiwarter & Schmid 2010). We see great changes in the riparian landscape over the course of 200 years, until regulation directs the natural course of events. Patterns of land use were well adapted to river dynamics up to the 19th century. Labour-intensive uses (fields, orchards, built infrastructure) can be found only in areas of low inundation and erosion risk (Haidvogl 2008). But land with high risk was also used, just extensively. We find a dense mix of different uses of water and semi-aquatic land. Archival material for river histories often originated from conflicts, as riverscapes were used for multiple purposes, and many of the functions of the riverine landscape were mutually exclusive. Ship mills could be obstacles for navigation, floating timber threatened fish populations; even the production of fibres was a source of conflict, as one can use the river either to condition flax or to catch fish, because decaying flax reduces the water's oxygen content.

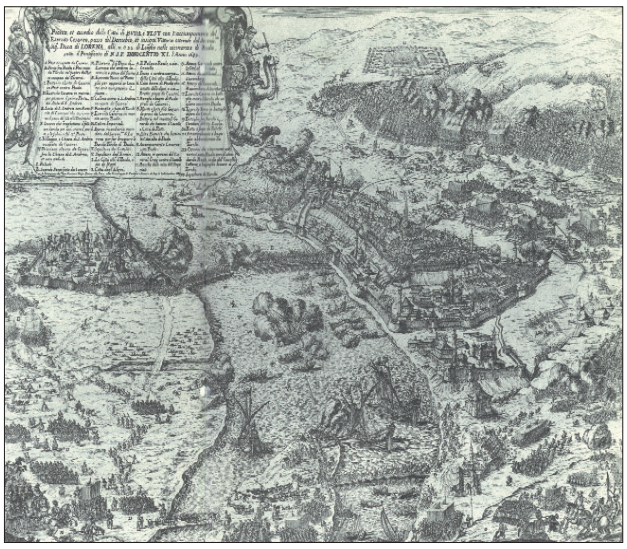

Figure 2. The riverine landscape as a seat of war: the siege of Buda in 1684 (etching by Giovanni Giacomo de Rossi). The role of rivers in warfare can hardly be overestimated, this is in particular true for early modern times. Rivers were means of transportation not only of provisions but also means of communication, and they were prime battlegrounds of intense fighting. Warfare is environmentally destructive. Especially islands in the Danube were contested sites, strategically important possessions enabling easier access to both sides of the river

Peacetime and wartime uses of the river stand in sharp contrast. The Danube was the seat of warfare for centuries *(Figure 2).* During the early modern era Danube landscapes were theatres of military operation almost continuously: among others between Russians and Ottomans, between the latter and the Habsburg empire, between the empire and Hungarian "rebels" (labelled from an Austrian perspective), between Habsburg and Bavarians and French. Winiwarter has analyzed references to the Danube in English newspapers from the late 1600s until the end of the 18th century (Winiwarter, unpublished). A major part of the news is connected to war in and close to the Danube. Two phenomena stand out. Strategic considerations could lead to a wasteful handling of resources, this resulted in intense pressure on natural resources (e.g. sturgeons as food for troops) and a heavy toll on local agro-ecosystems. By the end of the 18th century wrecked ships, dismantled parts of bridges, abandoned ship-bridges, and deliberately sunken cannons dotted the battle sites on the Danube. Obstacles to the flow of the river, such as new islands hampering navigation could form at wrecks. Deforested banks and new sandbars and islands were among the legacies of war.

Modern driving forces making riverscapes uniform

This short sketch of the Danube's environmental history in early modern times leaves no doubt: There was no pristine, 'natural' river in Europe before 1800. We therefore aim at a long-term perspective on the Danube, emphasizing the legacies of human uses of the river in peace and war in the more distant past. The current state of the river cannot be explained without identifying historical legacies of human interventions into riverscapes before their major transformation.

But from the early 1800s we observe a new quality of reshaping and reinventing rivers in Europe and worldwide with drastic and often irreversible human interventions. A main reason is the gradual change in metabolic regimes (Fischer-Kowalski & Haberl 2007) during the process commonly termed industrialisation. Large-scale rectifications of rivers would have been impossible without the relative abundance of (fossil) energy and technologies depending on that energy.

What were the societal drivers behind the large-scale, systematic regulation of rivers? For the Danube the findings are clear. In sharp contrast to the multifunctionality of pre- or early modern riverscapes only a handful of human purposes drove the industrialisation of rivers: (1) Steam navigation on the Danube started in the 1830s. Due to the strong current in the alpine sections of the river, the first steamboat upstream of Vienna had to be drawn by oxen through the gorge of the "Strudengau". But eventually, the entire river would be redesigned for heavy transport. (2) Land reclamation was a major issue in particular in the middle DRB. Count Széchenyi is known as promoter of

the regulation of rivers in the Hungarian plains and became an impersonation of Hungarian modernization; (3) Nowadays, flood protection is a major concern at the Danube. In the 19th century, flood protection measures were confined to major urban agglomerations; the case of Vienna shows that flood protection coincides with the colonisation of floodplains for industry and working class quarters in the second half of the 19th century. (4) Electricity generation became a major factor in the 20th century; the hydropower plant became the key symbol of the Danube's transformation not only in the upper, alpine part of the basin.

High modernism and its enemies

The interest in far-reaching, high-modernism-type interventions can be observed in the DRB after WW II across ideologically opposed political systems, with interesting precedents in the early 20th century. We suggest to study the recent environmental history of the Danube as a 'cold war history' in which the two opponents in this conflict were connected by the river course.

Within only a few decades the German and Austrian upper DRB has been heavily modified by dams and weirs. Today only about 50 km of the 321 km of the Austrian stretch is free flowing from an ecological perspective. The Iron Gate power plant, situated today in the border zone of Serbia and Romania, was put into operation in 1972 as a common project of the Socialist Republics of Yugoslavia and Romania. This power plant interrupts the longitudinal continuum at an ecologically sensible site of the river (at least from the perspective of anadromous fish migrating upstream for spawning). "High Modernism", the dream of total control over nature, has been identified as the cultural program behind this and other large scale transformations of rivers all over the world (McNeill 2000; Zeissler-Vralsted 2008). What makes the Danube a particularly fascinating case to deepen our understanding of high modern attitudes towards nature is that here, within one river basin, this attitude and its environmental consequences can be studied across ideologically opposed political systems.

High modernism produced not only dams, but also its contemporary critics. The debates about hydropower are one of the major keys to understand changes in the recent history of rivers. The Gabcikovo dam (nowadays Slovakia) was finished in 1996, its Hungarian counterpart Nagymaros was impeded in 1984 by the "Danube circle" (Duna Kör), a civil society movement which today is seen not only as a cradle of environmentalism in Hungary but also as one of the country's broadly based anti-communist movements in the 1980s. In the same year 1984 plans to build a dam in the Danube floodplains downstream of Vienna were withdrawn by the Austrian government. Hainburg, the site of the powerplant-to-be became a myth of nature conservation, environmentalism and successful civil resistance in Austria (Schmid & Veichtlbauer 2007).

Nuclear power plants (NPP) should gain more attention in riverine environmental history. NPPs draw water from the river for cooling and emit heated water back into the river; via nuclear power plants rivers become part of technical arrangements with immediate and long lasting ecological effects. That makes NPPs perfect examples for what Richard White (1995) called an "organic machine". Zwentendorf at the Austrian Danube was completely built but never put into operation after a plebiscite in 1978. Elsewhere along the river we find early examples like Gundremmingen (1966) in Germany and current conflicts like the one about Belene in Bulgaria.

Conclusions and outlook: What can environmental history contribute?

What we try to manage today in riverine landscapes is neither "nature" nor "society" as such: the landscape is a socio-natural site, the result of a process in which biophysical (partly technology-driven) arrangements and human practices co-evolved over a long time. The pre-industrial riverscape, roughly spoken the riverscape before 1800, offered manifold, although mutually exclusive, societal functions. Warfare had a significant impact on the riverine environment, but we are just beginning to assess the impact of war on riverscapes in the past.

The fundamental transformation of rivers like the Danube from 1800 onwards was driven only by few societal functions: navigation, land reclamation, flood control and electricity generation. Industrialisation of rivers can be described as a reduction from many different to only a small set of human uses of the riverine landscape. Due to that we are currently confronted with uniform, often monotonous riverscapes.

In 2008 the Danube Environmental History Initiative (DEHI) was founded and is coordinated by the Centre for Environmental History in Vienna. It aims at building a multi-national scientific network involving a broad range of scholars from history, archaeology, paleo-sciences and sciences. A database of currently about 100 researchers interested in an interdisciplinary, long-term historical perspective on the DRB was established and can be accessed online (http://umweltgeschichte.uni-klu.ac.at/dehi). DEHI aims at influencing European and national research agencies to build up research infrastructures designed for interdisciplinary research in countries throughout the DRB.

Rivers are highly dynamic compared to other elements of landscapes. Their natural features provoke conflicts of use and create the need for human decisions. Sustainable development is about human decisions for a desirable future. As natural dynamics of rivers create the need for human decisions, rivers can become ideal laboratories for sustainable development. Learning to deal with historical legacies is an important feature of sustainable development in river basins today, and will remain so in the future.

References

Brunner K, Schneider P (2005): Umwelt Stadt. Geschichte des Natur- und Lebensraumes Wien. Wien. Böhlau

Carter FW, Turnock D (2002): Environmental Problems of East Central Europe: Second Edition, London: Routledge

Fischer-Kowalski M, Haberl H (2007): Socioecological Transitions and Global Change. Trajectories of Social Metabolism and Land Use. Cheltenham, UK: E.Elgar

Haidvogl G (2008): Von der Flusslandschaft zum Fließgewässer: Die Entwicklung ausgewählter österreichischer Flüsse im 19. und 20. Jahrhundert mit besonderer Berücksichtigung der Kolonisierung des Überflutungsraums, Wien: Dissertation an der Universität Wien

Hohensinner S (2008): Rekonstruktion ursprünglicher Lebensraumverhältnisse der Fluss-Auen-Biozönose der Donau im Machland auf Basis der morphologischen Entwicklung von 1715–1991, Wien: Dissertation an der Universität für Bodenkultur

McNeill J R (2000): Something new under the sun. An environmental history of the twentieth-century world, London: Allen Lane

Schmid M (2009): Die Donau als sozionaturaler Schauplatz: Ein konzeptueller Entwurf für frühneuzeitliche Umweltgeschichte. In: Ruppel S, Steinbrecher A (eds), "Die Natur ist überall bey uns", Mensch und Natur in der Frühen Neuzeit, Basel, 59–79

Schmid M, Haidvogl G (2008): Coupling the long-term dynamics of natural and social systems: Towards an environmental history of the Danube. In: Szábo P, Hédl R (eds), Human Nature, Studies in Historical Ecology and Environmental History, Brno:Institute of Botany of the ASCR, 64–73

Schmid M, Veichtlbauer O (2007): Vom Naturschutz zur Ökologiebewegung. Umweltgeschichte Österreichs in der Zweiten Republik. Innbruck, Wien, Bozen: Studienverlag

White R (1995): The Organic Machine. The Remaking of the Columbia River, New York: Hill and Wang

Winiwarter V, Schmid M (2008): Umweltgeschichte als Untersuchung sozionaturaler Schauplätze? Ein Versuch, Johannes Colers „Oeconomia" umwelthistorisch zu interpretieren. In: Knopf Th (ed), Umweltverhalten in Geschichte und Gegenwart, Vergleichende Ansätze, Göttingen: Attempto, 158–173

Winiwarter V, Schmid M (2010): Umwelt Donau: Eine andere Geschichte. Katalog zur Ausstellung des Niederösterreichischen Landesarchivs im ehemaligen Pfarrhof in Ardagger Markt, St. Pölten: NÖ Institut für Landeskunde

Zeissler-Vralstedt D (2008): The Cultural and Hydrological Development of the Mississippi and Volga Rivers. In: Mauch C, Zeller Th (eds), Rivers in History: Perspectives on Waterways in Europe and North America, Pittsburgh: University of Pittsburgh Press, 63–77

Beyond the river channel: Floodplains as strategic resources of global importance

Klement Tockner: IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Müggelseedamm 310, D-12587 Berlin, Germany, e-mail: tockner@igb-berlin.de

Floodplains: Pivotal ecosystems along river corridors

River floodplains are low-relief Earth surfaces positioned adjacent to rivers and subject to flooding. Similarly, riparian zones are semi-terrestrial areas that extend from the edge of permanent water bodies to the edge of uplands and are influenced by freshwater (Junk et al. 1989, Tockner & Stanford 2002, Naiman et al. 2005, Tockner et al. 2008). As expanding and contracting ecosystems floodplains and riparian zones are among the most complex, dynamic, and diverse ecosystems globally. At the same time, floodplains offer a remarkable diversity of ecosystem services including flood retention, recharge of groundwater, biomass production, nutrient removal, as well as aesthetic and cultural values (see article of C. Sandu). Worldwide, floodplains cover about 2 % of the land surface but provide about 25 % of all continental ecosystem services, more than any other ecosystem type. These multiple services favoured the development of modern civilizations along large rivers. However, about 70 % of the human population in Europe, as well as in Japan, live on (former) floodplains. At the same time more than 90 % of the former continental floodplains are functionally extinct or have been converted into cropland and urban areas (Tockner & Stanford 2002, Nakamura et al. 2006, Tockner et al. 2008). Habitat degradation, species invasion, pollution, and climate change are among the most important pressures threatening floodplain ecosystems and their rich biodiversity. Presently, floodplains are among the most threatened ecosystems globally.

Vegetated islands: critical instream riparian zones

Vegetated islands form pivotal instream riparian zones. They were once highly abundant along large rivers such as the Danube. Today, islands are an endangered landform throughout Europe because they are among the first features that disappear as a consequence of flow regulation and channelization. While more than 95 % of the former islands disappeared along the Upper Danube, many intact islands still remain along the Middle and Lower Danube, as well as along major tributaries such as the Sava and Drava Rivers (Tockner et al. 2009, Sommerwerk et al. 2010). Today, along the entire Danube corridor, a total of 349 islands have been mapped, and they are still abundant in the Bulgarian/Romanian section and in the middle reach in Hungary *(Figure 1;* Tockner et al. 2009). The total area of these islands combined is 134,000 ha. These remaining islands are less impacted by humans than the adjacent riparian floodplains. Therefore, islands may serve as critical nuclei for establishing conservation and restoration strategies because they provide aquatic and terrestrial habitats as well as refugia for many endangered and threatened species. Observations along the Tagliamento River, NE Italy, demonstrated the important role of islands and how they contribute to the high physical and biological complexity of a river corridor (Gurnell et al. 2005). However, the formation of vegetated islands requires (1) a natural flood regime, (2) an unconstrained river corridor, (3) a sediment source, and (4) a source of large woody debris, a combination of conditions not present in highly managed river systems. It is now understood that restoring vegetated islands means to restore the underlying hydrogeomorphic processes that are responsible for their formation and change.

Figure 1. Large wood accumulation close to Petronell, Alluvial Zone National Park, Austria (Photo: C. Baumgartner, Alluvial Zone National Park, Austria) Floating organic matter, large wood accumulations and vegetated islands are pivotal for linking aquatic with terrestrial habitats, and for forming pioneer habitats. Not removing floating organic matter would be one of the most effective (and cheapest) restoration measurements along large rivers. Large wood deposits facilitate the formation of vegetated islands, and floating organic matter serves as a vector for the mass dispersal of riparian organisms along river corridors thereby enabling the genetic exchange along rivers

Novel ecosystems – novel communities

Today most rivers and their fringing floodplains are altered by human activities. Human impacts facilitated the formation of novel ecosystems, as well as of novel communities that are composed of a mixture of native and non-native assemblages with no common evolutionary history. Particularly the Danube has served as a major source and dispersal corridor for non-native species (the so-called SE European invasion corridor). Today, in the Middle and Upper Danube, the benthic communities are numerically dominated by exotic species (Sommerwerk et al. 2010). Furthermore, we expect that the temporal (and spatial) turnover of species assemblages will remain high because of the climate change induced migration of species as well as through ongoing accidental introductions of non-native species. In any case, we must be cautious in considering non-native species as "negative" per se because we have very limited understanding about the ecological and evolutionary consequences of these novel communities. In addition, actual conservation strategies may not be sufficient because they do not take into account the presence of these novel communities.

Among the most threatened species along large rivers are organisms with complex life cycles. Amphibians, aquatic insects, or long-distance migrating fish require various habitat types for completing their life cycle. Restoration projects must encompass both the aquatic and terrestrial habitat conditions; as well as the functional linkages among the various habitat types.

Large rivers under pressure

Recently, an EU-funded large integrative project, BioFresh, started to provide a comprehensive overview of the freshwater biodiversity at global, continental and catchment scales (www.freshwaterbiodiversity.eu). The key goals of this project are to establish an open source data platform for freshwater biodiversity, to use these data for predicting freshwater biodiversity change under global impact scenarios, and to raise awareness about the critical status of freshwater biodiversity. In particular large rivers, such as the Danube, are among the most threatened freshwater systems; at the same time they have only recently been considered by the EU Water Framework Directive (WFD). I propose to use shoreline communities and processes to assess the ecological integrity of linked river-floodplain ecosystems. Shorelines are highly sensitive areas against human impacts; at the same time they easily can be sampled along large complex river systems as well as along smaller streams and lakes. Overall, conserving the remaining intact floodplains as strategic global resources and restoring degraded floodplains have highest priority for future ecosystem management. However, floodplains designated for restoration and conservation must be large enough to support its native plant and animal assemblages and to perform key ecosystem functions. The present activities along the Danube, i.e. within the Alluvial Zone National Park east of Vienna, are important and brave steps into this direction *(Figure 1*¸ http://www.donau.bmvit.gv.at). The removal of bank protections along 50 % of the main shipping channel would not have been possible 10–15 years ago. This largest restoration project along the Danube is carefully monitored through an ambitious scientific research program that will provide the knowledge for further restoration projects along the Danube as well as along the large rivers globally. However, the success of these restoration projects not only depends on the improvement of local environmental conditions but primarily on the regional landscape context the projects are placed in. Present plans to establish a network of the large-scale conservation areas within the Danube River Basin (www.danubeparks.org) may therefore be crucial for the success of future restoration plans.

References

Gurnell AM, Tockner K, Edwards PJ, Petts G (2005): Effects of deposited wood on biocomplexity of river corridors. *Frontiers in Ecology and Environment* 3, 377–382

Junk WJ, Bayley PB, Sparks RE (1989): The flood pulse concept in river-floodplain systems. *Canadian Special Publication of Fisheries and Aquatic Sciences* 106, 110–127

Naiman RJ, Decamps H, McClain ME (2005): *Riparia.* Elsevier/Academic Press. San Diego, USA

Nakamura K, Tockner K, Amano K (2006): River and wetland restoration: Lessons from Japan. *BioScience* 56, 419–429

Sommerwerk N, Bloesch J, Paunović M, Baumgartner C, Venohr M, Schneider-Jacoby M, Hein T, Tockner K (2010): Managing the world's most international river basin: the Danube. Marine and Freshwater Research. In Print.

Tockner K, Stanford JA (2002): Riverine floodplains: present state and future trends. *Environmental Conservation* 29, 308–330

Tockner K, Bunn SE, Quinn G, Naiman R, Stanford JA, Gordon C (2008): Floodplains: Critically threatened ecosystems. In: Polunin NC (ed), *Aquatic Ecosystems.* Cambridge University Press. pp. 45–61

Tockner K, Uehlinger U, Robsinson CT (eds) (2009): Rivers of Europe. Academic Press. 700 pp

Human alteration of ecosystem services provided by riverine landscapes

Cristina Sandu: Institute of Biology, Romanian Academy, Bucharest, Romania, e-mail: sanducri@yahoo.com

Humans have settled since ancient times along the river banks, influencing their ecology. Evidence dates back to the Mesopotamian and Egyptian time: even the name of Mesopotamia (in Greek: "the land between the rivers") acknowledged its location between Tigris and Euphrates Rivers, while the Egyptian civilization focused on the Nile River. The decisive factor enabling mankind to settle in permanent communities was agriculture - once people could control food supply, their nomadic lives changed and they could occupy fertile river valleys (Guisepi 2007).

Although the ancient cilizations were not aware of sustainability, their influence was not so harmful as it turned to be after the industrial development, and especially in the past 60 years, as a consequence of the demographic evolution: the rapidly growing population had increasing demands of food, water, constructions, energy, transportation, etc, which resulted in a substantial loss of biodiversity on Earth (MEA 2005). Through their structure and functionality, natural ecosystems provide worldwide a series of goods and services that are vital for human society and that we took for granted; unfortunately, as our ability to alter these ecosystems was much higher than their resilience, today, the scientific evidence shows a dramatic decline of the provided services which, consequently, impairs our well-being (MEA 2005).

What are the ecosystem services and how are they linked to human well-being?

Between 2001-2005, over 2000 experts contributed worldwide to realize the Millenium Ecosystem Assessment, aiming to offer a comprehensive evaluation of the consequences of ecosystem change for human well-being and to identify actions needed to enhance their sustainable use (MEA 2005).

Ecosystem services are the benefits people obtain from ecosystems, comprising (De Groot et al. 2002; MEA 2005):

(1) Provisioning services – refer to products obtained from ecosystems such as food (plants, vegetables, fish, game), raw materials (wood, oil, fossil fuel, organic matter, natural fertilizers), medicinal and ornamental resources (pharmaceuticals, drugs, ivory, aquarium fish, etc.); (2) Regulating services – include benefits obtained from the regulation of global processes such as atmospheric composition and climate, essential in e.g. maintaining air quality; water regulation is important for flood/drought mitigation as floodplains serve as buffer areas during extreme hydrological events; biological regulation is important for providing pests and diseases control through food-web relationships, etc; (3) Supporting services – are essential in the production of all the other ecosystem services – they include e.g. oxygen and biomass production, waste purification, nutrient cycling, soil retention and formation, pollination and seed dispersal, provision of habitat for human, natural and commercially harvested species, etc.; (4) Cultural services – include the non-material benefits people obtain from ecosystems such as aesthetic, recreational, cultural, spiritual, historic, scientific, educational, eco-touristic, etc.

Human well-being is multidimensional, dynamic and context-specific, but in general includes: material aspects (money income, assets, food, etc.); health (feeling well, capacity to work, healthy environment); social networking (social cohesion, joy); security (personal safety, tranquility) and freedom of choice and action (dependent also on education) (MEA 2005).

People are an integral part of the ecosystems; considering the dynamic interactions between biocenoses and their habitat, the human impact on the environmental quality is turning back in a boomerang effect, diminishing our well-being.

What caused the decline of ecosystem services provided by riverine landscapes?

In a healthy state, the riverine systems provide human society with most of the services presented above; however, the pressure of the demographic evolution and the subsequent economic development led worldwide to an un-sustainable exploitation of their potential: the industrial and agricultural development accelerated the negative impact on landscapes and ecosystem services *(Figure 1).*

The lowland rivers were highly impacted due to their historical exploitation and specific geographic position. As a consequence of the increasing industrial and agricultural emissions, the air, water and soil were polluted with increasing amounts of chemical compounds, having a negative impact on biological communities. Technical development led to significant hydromorphological alterations (dams, embankments, channelization for navigation). Through land use changes, e.g. deforestation, natural ecosystems were replaced by anthropogenic (man-made) ecosystems such as agricultural fields, rural and urban areas, reservoirs, etc. Excessive production led to the overexploitation of natural resources (water, wood, fish). The fragmentation of natural habitats and disruption of connectivity led to the loss of migration corridors and shelters, feeding, spawning habitats, affecting the whole food-web. The accidental or intentional introduction of alien invasive species led to an increased competition for the existing resources (food and habitat) and usually to the decline of native species. The ongoing climate change does not only rise air and water temperatures, melts

glaciers, shifts precipitation regimes, increases the frequency of extreme weather events (floods/droughts), but also affects riverine ecosystems.

Is it possible to revert the declining trend?

The ecosystem services are vital for the human society; we are intimately bond to the ecosystems quality and functionality, as without their support, life on Earth will cease to exist. Therefore, it is essential to stop the decline of environmental health and look for sustainable measures to secure our and future generations wellfare. A major conceptual shift should occur in the local, regional, national and trans-national management, from the development of different sectoral policies towards an integrative approach, aiming to balance the human needs with the environmental protection.

Possible solutions might be:

– mitigate the anthropogenic impact – since the trend was determined by the increasing pressure of human society, measures should be directed towards fighting the causes, i.e. diminish the drivers pressure *(Figure 1)* and promote environmental friendly ("green") solutions;

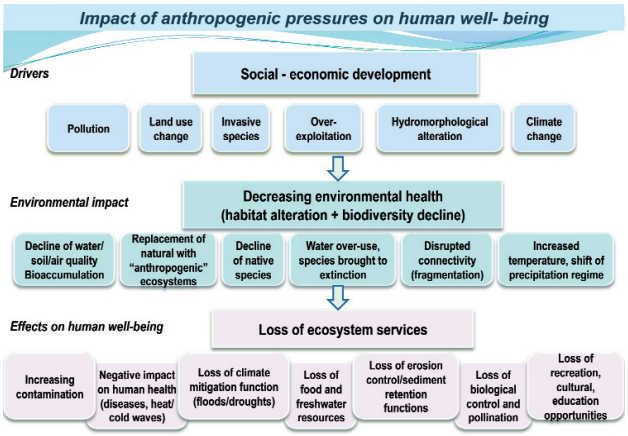

Figure 1. Impact of anthropogenic pressures on human well-being

– as the ecological equilibrium of many ecosystems was disturbed and their functionality highly impacted, there is a strong need to preserve the remaining natural ecosystems and to restore at least part of the affected ones; for the future socio-economic projects, the sequence of priority should be: (1) prevention, (2) mitigation, and (3) compensation;
– enhance ecological education as part of the teaching system so people can understand the environmental values and improve their attitude towards nature;
– support scientific research for innovation in science, technology and social sciences in order to find ways to fit the increasing population with the limited natural resources and curb the consumption trends;
– raise stakeholders awareness regarding the benefits of ecosystems goods and services as this may increase their willingness and their involvement to support the environmental health management;
– as freshwater scarcity is among the highest threats (especially in Southern Europe), a holistic management of the water resources is highly needed in order to establish a balance between the freshwater ecosystem needs and use; recent approaches recommend the introduction of payment for watershed services.

What is the situation in the Danube River Basin?

A former assessment of WWF has shown that in the Danube River Basin (DRB) about 80% of the floodplains are lost or functionally extinct. Wetlands and river floodplains are important factors for regulating DRB water balance and therefore, in light of the expected climatic changes and water scarcity, they should receive a higher attention. As the knowledge about the services they provide for human society is raising, hopefully their protection will increase: for instance, their ecosystem services were estimated to at least 500 €/ha/year, only water purification being valued at 368 million €/year (WWF 2010).

The Water Framework Directive (WFD) provides the legal basis to improve waterbodies protection, wetlands and river floodplains included. The DRB Management Plan (ICPDR 2009), aiming for the implementation of WFD, offers the frame to adjust the water policies across the basin by considering the synergistic action of the current drivers on water quality and quantity; its Joint Program of Measures represents the first step towards the "integrated water resources management" recommended by the World Water Council.

The Danube Strategy, currently developed by the Danube countries under the guidance of the European Commission, will have the mission to balance economic and social development with environmental aspects in order to ensure sustainability in the DRB. Supporting environmental health means also securing economy as ultimately *"business cannot function if ecosystems and the services they deliver – like water, biodiversity, fiber, food, and climate – are degraded or out of balance."* (World Business Council for Sustainable Development, MEA 2005).

References

De Groot RS, Wilson MA, Boumans RMJ (2002): A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41, 393–408

Guisepi R (2007): The origins of cilizations. International World History Project http://history-world.org/egypt_and_mesopotamia_compared.htm (accessed 15 February 2010)

ICPDR (International Commission for Protection of Danube River) (2009): Danube River Basin Management Plan. www.icpdr.org

MEA (Millennium Ecosystem Assessment) (2005): Ecosystems and Human Well-being. Synthesis reports. http://www.millenniumassessment.org/en/Synthesis.aspx (accessed 15 February 2010)

WWF (2010) : New life for Danube http://www.panda.org/what_we_do/where_we_work/black_sea_basin/danube_carpathian/?188201/New-life-for-the-Danube

The catchment approach: The influence of land use on river and stream biodiversity

J.H.Janse, M.H.J.L. Jeuken: Netherlands Environmental Assessment Agency, Bilthoven, The Netherlands, e-mails: jan.janse@pbl.nl; michel.jeuken@pbl.nl
M.J. Weijters: B-ware, Nijmegen, The Netherlands, e-mail: m.weijters@b-ware.eu
J.T.A. Verhoeven, Department of Biology, Utrecht University, Utrecht, The Netherlands, e-mail: j.t.a.verhoeven@uu.nl

A recent review shows how the intactness of aquatic biodiversity in rivers and streams is related to the land use in the catchment. These results may be useful for global and regional environmental studies as well as for integrated river basin management.

Changing land use

Starting from the beginning of human history, humans have been altering the landscapes by land reclamation, habitation and agricultural activities. Over the past 100 years, the pace of reclaiming natural areas for agricultural purposes has increased dramatically. In addition, agricultural practices have intensified. Already more than half of the world's territory that is physically suitable is being used by man.

Land use and the health of aquatic ecosystems are related via the river basins (catchments). The alterations mentioned have had strong negative effects on biodiversity in terrestrial, freshwater and marine ecosystems. Global biodiversity is currently declining fast, in response to human-induced changes in the global environment (e.g. MEA 2005). Freshwater ecosystems are especially vulnerable, as people have settled preferentially near lakes and rivers. Besides land use changes and eutrophication, other major factors causing this rapid decline in freshwater species are: physical alteration or loss of habitat, change of water flow, pollution, overexploitation and the introduction of non-native species (MEA 2005; Revenga et al. 2005). These factors also apply to the Danube Basin (ICPDR 2005).

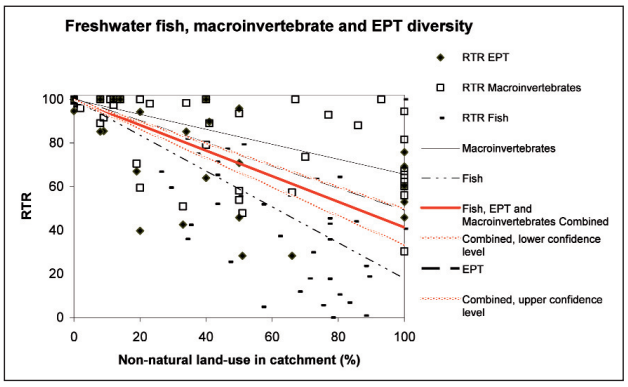

Figure 1. Linear regression between the percentage of non-natural land use in the catchment and relative taxon diversity of EPT (Ephemeroptera-Plecoptera-Trichoptera), macroinvertebrates and fish in rivers and streams. When combining all data points, a significant linear regression is found (r^2 = 0.26, slope = -0.59, p<0.001). Upper and Lower Confidence Levels (95%) are depicted in red. Note that the EPT line overlays the Upper Confidence Level of the combined regression line. Data are based on 12 studies (From Weijters et al. 2009)

The alteration of river catchments has mostly implied deforestation, increased drainage of wet areas, soil amelioration and the planting of crops or the introduction of domestic grazers. These developments can lead to erosion, nutrient increase, and increased runoff of pollutants (e.g. Verhoeven et al. 2006; Seitzinger et al. 2009) or may result in overall changes in the functioning of the river ecosystem itself (Smith et al. 1999; Nijboer & Verdonschot 2004). In addition to land conversion, the increase of nutrient loading to rivers has been caused by increasing use of fertilizers, disposal of human waste water, erosion (increased by deforestation) and atmospheric nutrient deposition. The average nutrient export from (parts of) agriculturally used catchments averages 1–5 kg P ha^{-1} y^{-1} and 100–400 kg N ha^{-1} y^{-1}, whereas the export from forested areas is about an order of magnitude lower (e.g. Harper 1992). These changes are reflected in the correlations between land use and nutrient concentrations in streams and rivers that have been found in many studies (e.g. Johnes & Heathwaite 1996; Soranno et al. 1996; Gergel et al. 2002).

For the case of the total Danube Basin (800,000 km^2), the share of the land use is: arable land 47.4%, grassland and pasture 6.2%, forest 33.5 %, urban areas 3.9%, surface water area 0.9% and other areas including open land, wetlands and glaciers 8.0% (ICPDR 2005). The fraction cultivated land is thus nearly 60% (assuming forests can be regarded as near-natural).

Effects on biodiversity

In a recent review, we compared the biodiversity in rivers and streams with the land use in the (upstream part of) their catchments (Weijters et al. 2009). The aim of this study was to explore the relationships between altered catchment land use and increasing nutrient concentrations on the one hand, and global river and stream biodiversity on the other. We selected scientific publications meeting the following criteria: (a) The studies compared data found at impacted sites with a pristine reference situation (either in time or space); (b) The studies clearly defined the land use cover in the catchment and/or water nutrient concentrations; (c) The studies clearly defined biodiversity, either by giving number of native fish or macroinvertebrate species, by presenting species lists or by using an IBI (Index of Biotic Integrity) approach. In order to combine data on highly different ecosystems and taxonomic groups, biodiversity was expressed as a relative measure: the number and abundance of native taxa, relative to their abundance in a pristine situation, ranging between 0 and 1.

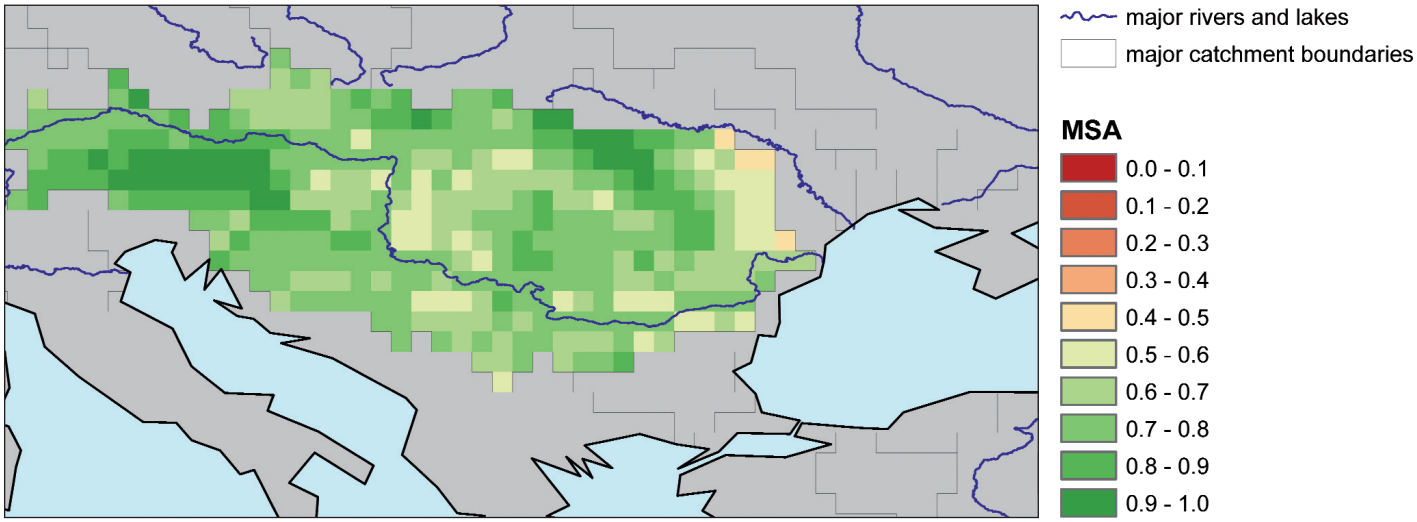

Figure 2. Biodiversity intactness (MSA) in rivers related to the land use in the upstream catchment, calculated by the GLOBIO model on a 0.5 degree lat/long; Danube Basin selected from the map. MSA (also called RTR) may range between 1.0 (pristine situation) and 0.0 (no native species left). Pressures other than land use change are not included. (From Janse et al. 2009)

This relative taxon richness (RTR, also called MSA = 'mean species abundance of original species', Alkemade et al. 2009), is thus a measure of the naturalness or intactness of an ecosystem. The index is comparable to the Biodiversity Intactness Index (BII, Scholes & Biggs 2005) and related to the widely used Index of Biotic Integrity (IBI) score (Karr & Chu 2000), although the relation is not straightforward. The literature survey revealed some 240 publications, mostly on macroinvertebrate and fish species. Within the macroinvertebrates, special attention was paid to the group of Ephemeroptera, Plecoptera and Trichoptera (EPT). The literature covered streams of different orders. Unfortunately, only about 10 % of the publications contained sufficient information to allow quantitative analysis for our purpose. Out of 15 studies, 6 showed a significant, negative relation between the RTR (or IBI) and the percentage agricultural land, 2 a positive relation and 7 were not significant (n.s.). 4 out of 7 showed a negative relation with urban land use (1 was positive, 2 n.s.), while 6 out of 18 studies demonstrated a positive relation with forest cover (5 were negative and 7 n.s.). Concerning nutrients there were fewer data, but in 4 cases out of 6 the RTR or IBI was negatively related to the phosphorus concentration in the river (1 positive, 1 n.s.), while 3 out of 5 showed a negative relation with nitrogen (with 1 positive and 1 n.s.). Combining all studies, the relative biodiversity for all animal groups significantly ($P<0.001$) decreased with the percentage of non-natural land use. The slopes of the linear regression lines were -0.34 for macroinvertebrates in general, -0.51 for the EPT and -0.82 for fish; the average slope was -0.59 *(Figure 1).* This means that on average, every 10% land use change leads to 6% loss of aquatic biodiversity. Fish thus appear to be the most sensitive organisms to land use changes, while the group of EPT is more sensitive than the macroinvertebrates in general. The relative biodiversity of macroinvertebrates and EPT also correlated negatively with the P concentration in the water; the relation with N was less clear. The variation in all data was considerable, however, especially for the macroinvertebrates. Part of the variation in the data may be due to the fact that no information was available on the intensity of the human land use. Although the causal relationships cannot be detected from this analysis, the effects were definitely related to catchment land use and not to large alterations in the rivers themselves as these had not taken place in the streams described in the literature used.

Application potential

Relations like these may be combined with (GIS-based) global or regional land use and catchment models. An example is the IMAGE – GLOBIO model chain (Bouwman et al. 2006; Alkemade et al. 2009; Janse et al. 2009). This model describes, among others, global land use changes, currently on a 0.5 degree (lat/long) grid (approx. 30 x 50 km at this latitude). In the aquatic module this is combined with a water flow network and a river map, all at the same scale. This allows calculation of the percentages of different land use classes in the upstream part of the catchment of every river cell. Combining this information with the relations found in our review study, an estimate can be made of the remaining biodiversity in different parts of the river system. *Figure 2* gives an example of a global application for the year 2000, using the average regression line from *Figure 1*, and zooming in on the Danube Basin. It can be seen that in a great part of the basin the aquatic biodiversity is at great risk as a result of land use changes in the catchment, except in the upstream and mountainous areas. For the whole basin, the model calculates an average index of 0.67. It should be noted that the picture is an excerpt from a global model, with input data averaged over large areas. Furthermore, only the effect of catchment land use is depicted in this example; the effects of other stress factors, like dams and water withdrawal, to which the Danube is highly subjected, will further decrease the biodiversity intactness. Nevertheless, the approach is also applicable to

finer scale models and may well complement or be combined with other ecological assessment methods at the landscape scale (see e.g. Verdonschot 2000; Gergel et al. 2002). It would be interesting to perform such an application and to compare the results with observational data and other biotic assessments of streams in the Danube Basin.

References

Alkemade R, Van Oorschot M, Miles L, Nellemann C, Bakkenes M, Ten Brink B (2009): GLOBIO3, a framework to investigate options for reducing global terrestrial biodiversity loss. Ecosystems 12, 349–359

Bouwman AF, Kram T, Klein Goldewijk K, eds. (2006): Integrated modelling of global environmental change; an overview of IMAGE 2.4. Neth. Environm. Assessment Agency, Bilthoven, The Netherlands (www.pbl.nl)

Gergel SE, Turner MG, Miller JR, Melack JM, Stanley EH (2002): Landscape indicators of human impacts to riverine systems. Aquatic Sciences 64, 118–128

Harper D (1992): Eutrophication of freshwaters. Chapman & Hall

ICPDR (2005): The Danube river basin district, part A: Basin-wide overview. (www.icpdr.org)

Janse JH et al. (2009): GLOBIO-aquatic, a global model for the assessment of aquatic biodiversity. Pres. at Diversitas Open Science Conf., Cape Town, Oct. 2009 (www.globio.info)

Johnes PJ & Heathwaite AL (1996): Modeling the impact of land use change on water quality in agricultural catchments. Hydrological Processes, 11 (3), 269–286

Karr JR & Chu EW (2000): Sustaining living rivers. Hydrobiologia, 422/423, 1–14

MEA (2005): Millennium Ecosystem Assessment. Ecosystems and human well-being: Current state and trends, Ch. 20, Inland water systems, and Wetlands and water synthesis. World Resources Institute, Washington, DC

Nijboer RC, Verdonschot PFM (2004): Variable selection for modelling effects of eutrophication on stream and river ecosystems. Ecological Modelling 177, 17–39

Revenga C, Campbell I, Abell R, de Villiers P, Bryer M (2005): Prospects for monitoring freshwater ecosystems towards the 2010 targets. Philosophical transactions of the Royal Society B: Biological Sciences, 360 (1454), 397–413

Scholes RJ, Biggs R (2005): A biodiversity intactness index. Nature 434, 45–49

Seitzinger SP, Mayorga E, Bouwman AF, Kroeze C, Beusen AHW, Billen G, Van Drecht G, Dumont E, Fekete BM, Garnier J, Harrison JA (2009): Global river nutrient export: A scenario analysis of past and future trends. Glob. Biogeochem. Cycles

Smith VH, Tilman GD, Nekola JC (1999): Eutrophication: impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems. Environmental pollution, 100, 179–196

Soranno PA, Hubler SL, Carpenter SR, Lathrop RC (1996): Phosphorus loads to surface waters: a simple model to account for spatial pattern of land use. Ecological Applications, 6, 865–878

Verdonschot PFM (2000): Integrated ecological assessment methods as a basis for sustainable catchment management. Hydrobiologia 422/423, 389–412

Verhoeven JTA, Arheimer B, Yin C, Hefting MM (2006): Regional and global concern over wetlands and water quality. TREE 21: 96–103

Weijters MJ, Janse JH, Alkemade R, Verhoeven JTA (2009): Quantifying the effect of catchment land-use and water nutrient concentrations on freshwater river and stream biodiversity. Aquat. Cons.: Mar. Freshw. Ecosyst. 19, 104–112

Landscape planning in the Danube River Basin

Meinhard Breiling: *Technology Tourism Landscape (TTL) TU Wien Interfaculty Competence Centre, Vienna, Austria, e-mail: breiling@breiling.org*

Understanding landscape planning

Landscape planning became necessary as there was a paradigm shift from traditional to modern life style with dramatic changes for individuals. How can we conserve the ecological and cultural qualities from the past and combine them with the possibilities and increased choices of the present and future? The altered resource access brings a lot of improvements along with negative aspects that usually are considered only later on. For many non professionals landscape planning is often understood as a kind of repair planning at the local scale, while practicing professionals would rather like to see it as a vision for every aspect of planning at any spatial scale. The reality is somewhere in between.

With regard to the Danube River Basin (DRB), landscape planning started in the rich Upper Danube countries Germany, Switzerland and Austria in the 1960s and was promoted during the 1970s and 1980s. In the former communist countries of the DRB often state institutions were dealing with landscape planning but rational development planning in five years plans was favored over landscape planning. In the 1990s and the first decade of this century all DRB countries are in theory concerned with landscape planning; however, the level and awareness to landscape planning can vary significantly from place to place.

Tasks in landscape planning can widely vary from nature protection zoning to developing urban green infrastructure. Landscape is perceived as an arena where all natural and human processes are taking place. Planning is any action directed to the future. There are known limitations: we do not anticipate surprises and it is hard to define an “end point” of planning. Landscape planning is open ended and has to be adjusted regularly.

Sometimes people differentiate between landscape planning and spatial planning. They refer to the same regions and areas but often to different groups of interests. Landscape planning is often related to ecological and nature conservation interests, while spatial planning is more connected to economic interests. Another distinction is undertaken between urban planning and landscape planning. Urban areas, usually the densely populated cities and towns of the DRB, are perceived as a separate field of planning, and landscape planning is considered to take care of non urban landscapes with low population densities.

Planning instruments were lacking back in time. The regulations of today refer to necessities of the past. We tend to neglect many processes to ease the management of required actions. Today s necessities will be incorporated in the future planning instruments. A prominent example is climate change. So far, we do not have any binding instrument to consider this change, but climate change adaptation plans are on the way to be incorporated into future landscape planning. Without landscape planning the number of unwanted change is higher.

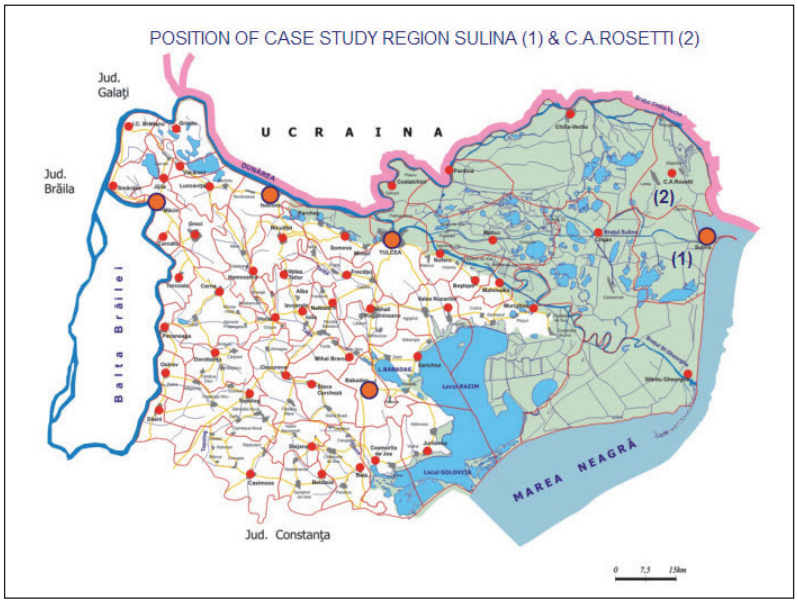

Figure 1. Map from Tulcea county, modified after http://www.cjtulcea.ro/judet/harta.htm

Legal frameworks are part of the planning procedure and a support to ensure that planning and its instruments remain operational and measures are controllable. Currently dozens of frameworks seem to be relevant for landscape planning, some of them legally binding others on a voluntary basis. A prominent example is the EU directives, in general also applied by non EU countries. Since 2000 the Water Framework Directive (EU 2000) is a very influential instrument, the Habitats Directive (EU 1992) incorporates the dedicated Natura 2000 areas of the Ramsar Convention, or the Renewable Energy Systems Directive (EU 2009) postulates that 20% of the EU energy demand has to be covered by renewable energy sources by 2020.

Landscape architects criticized that the current set of comprehensive instruments does not properly reflect the cultural aspects of landscape planning. Historical, archeological and other heritage aspects are not included in ecological oriented landscape planning. A major initiative was set by the Council of Europe with an European Landscape Convention (ELC) in 2000 (EC 2000). Any cultural and ecological treasures within the municipality should be identified and respected by future planning. The convention, however, is not signed by some states after ten years. A practical reason behind the non adaptation is lacking financial resources to implement this inventory; however, the principle to combine ecological and cultural aspects in landscape planning has never been questioned and is valid throughout Europe and the DRB.

According to the ELC, the smallest administrative unit (i.e., the municipality) is seen as the most appropriate for landscape planning. The area of municipalities in the Danube River Basin varies from 10 to 100s of square kilometers. At the smallest administrative scale the entity of natural and cultural elements does still exist and a holistic management as compared to sector management is only feasible here. Another reason why the smaller scale of landscape planning is needed is that only major problems and projects can be administered via an instrument like the WFD. The WFD dealing with the DRB as a single entity has as smallest unit areas of 4000 km² which is approximately 10 to 100 times larger than what the ELC considers as appropriate. However, the ELC and local landscape planning can support the WFD.

Currently there is discussion to merge several rural municipalities with scattered population to a larger political entity. The economic power of rural land is decreasing and indigenous development decisions became very limited. Young people migrate to urban centers and few people remain to continue the long-established occupation in agriculture, forestry and social life. The task of landscape planning is to find new initiatives and uses suitable for the remaining inhabitants to cope with changed socio-economic parameters or if this is not possible to come up with alternatives where nature functions are restored and very limited effort from the human side is needed.

Case study: Landscape planning in the Eastern Danube Delta

A case study from the most Eastern region in the DRB may exemplify landscape planning *(Figure 1):* The town of Sulina with surroundings (area: 312 km², incl. 14 km² urban land) and the rural municipality C.A. Rosetti (area: 266 km²), places I have visited several times during the last ten years, with a combined area of 600 km² and some 6000 inhabitants, two thirds of them living in the city of Sulina. Both municipalities are part of the Danube Delta selected as the "Landscape of the Year" in 2007–2009 by "Naturfreunde International". It is the last original delta in Europe and a major RAMSAR site, providing shelter to many endangered species. The inhabitants have different religions, languages and cultural background and this high diversity prevented significant mixing over centuries. Main activities are fishing, hunting and reed cutting.

The Danube Delta is one of the few Romanian regions where a development plan does exist (DDNI & IVL 2006). This plan respects the new conditions provided by the EU to new member states. In addition Sulina has made a municipal development plan targeted towards 2013 combining economic growth and sustainable eco-system management. The number of recreational homes, pensions and motorboats multiplied in the last decade. Municipalities are just beginning with waste disposal provisions as uncontrolled waste dumps are a frequent phenomenon. Visiting the area with students in 2009, we could collect hundreds of pet bottles in minutes. The Danube Delta Biosphere Reserve Administration (DDBRA) introduced a small fee for every visitor entering the delta to undertake cleaning measures.

The two neighboring municipalities Sulina and C.A. Rosetti provide an interesting contrast in the region. Sulina is the entry to the Rhine-Main-Danube Canal and has seen more important times in the past. From 1856 to 1939 it was the seat of the Danube Commission and as a free port considerably larger than today with 4600 inhabitants. During the 1990s there was a major decline in ship traffic and general activities in Sulina as a consequence of the war in former Yugoslavia. After 2000 the situation improved, in particular during the last five years, when EU regulations were predominant for the management of the Danube Delta. Projects for revitalization co-financed by EU funding programs are going on. The Russian, Greek and Romanian Orthodox, Catholic, Jewish, Muslim cemeteries give testimony of the diverse cultural life and are protected by the town. More than 8,000 tourists in summer triple the population to up to 15,000 and tourism became the most important income in the city that had a reported unemployment rate of 40% in 2004. The aim is an ecological sustainable tourism mixed with the unique position of Sulina and its extraordinary cultural history. Landscape planning is an important issue and should ensure that invested money has the wanted output. The coastal region, the most Eastern in Romania will be developed to a touristic beach in the coming years. A better integration of ecological and economic purposes is more feasible here than elsewhere in Romania.

Fewer tourists will make it to C.A. Rosetti. Its centre is about 15 km north of Sulina. This municipality is best known for Letea forest, a strictly protected region, which is one of the oldest natural reserves in Romania established in 1938 and covers an area of 30 km². The main village C.A. Rosetti hosts a monastery as the main attraction. Sfistofca alike Periprava further North at the Kylia branch are the most important Russian (Lipovan) villages in the Delta *(Figure 2).* Cardon in the South is the fifth location in the municipality. All together less than 1200 people live in the municipality of 266 km². A special task of landscape planning is to balance the conflicts of strict nature protection of Letea forest, wildlife and domestic animals. There are more than 3000 feral horses in the municipality, released into “freedom” after the collapse of socialist agricultural cooperatives. Today they challenge the protection of rare species of Letea forest. Harsh winters like the one of 2009/10 contribute to natural balance and killed in particular the young foals; hundreds of cadavers are now spread over the landscape and a considerable health risk. This problem is not only restricted to feral horses, but also to cattle. When the food reserves are eaten up, hungry cows are sent to the wilderness to care for themselves, sometimes with yellow marks, signs that they are registered under the EU agricultural support scheme. Many animals die this way, e.g. if they enter thin ice, fall into the water and drown or freeze to death if they reach land. After a major bird flu epidemic in 2006, in March 2010 a new case of bird flu virus alarmed the authorities. All domestic birds from Letea were killed to avoid the spreading of the virus to wild birds. The combined understanding of the natural and cultural processes is most important here to set the appropriate measures.

Figure 2. Church of Sfistofca, C.A. Rosetti Municipality, February 16, 2010 (Photo: M Breiling)

Concluding Remarks

Several thousands of independent municipal regions in the DRB already could profit from professional landscape planning on the local scale. It remains open, if funds will be available for future projects. It is advisable to combine development plans and protective landscape planning. There are many good examples within the DRB on how to do this. In Germany the concept of so called “Ausgleichsflächen” compensates scenic land used for new infrastructure (e.g. roads) by restoration of former agricultural or industrial areas. Another idea is compensation by money: For each large-scale infrastructure project a certain percentage has to be used for spin-off projects, such as promoting green corridors, greenways or bicycle-tracks. In Vienna many farmers would have given up cultivating wine yards, fruit trees and other agricultural land if they would not get compensation payments from the city, so called contract habitat protection, which is considerably higher than other EU support. Landscape planning with many measures on local scales will help that nature protection and cultural heritage get the adequate awareness that is not yet everywhere in the DRB, but has perhaps never been so high.

References

DDNI (Danube Delta National Institute), IVL (Swedish Environmental Research Institute) (2006): Master Plan – support for sustainable development in the DDBR Tulcea county/Tulcea county, LFA, Editors Stiuca R, Nichersu, I

EC (2000): Council of Europe, European Landscape Convention

EU (1992): EU Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

EU (2000): Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy"

EU (2009): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009

The emotional dimension of landscapes – a philosophical approach

Jürg Bloesch: Stauffacherstrasse 159, Zürich, Switzerland, e-mail: bloesch@eawag.ch

Everybody knows the sound of waterfalls, the beauty of sunsets, the cry of the loon, and the smell of blossoms, all emotions in nature. How do these feelings relate to intellectual power, human behavior and scientific evidence? The Cartesian view of our planet and humans is still prevalent. The soul is separated from the body, which is a machine that in the case of illness can be repaired by medical technology. At the ecosystem scale, environmental problems seemingly are solved with high-tech approaches. However, emotions still play a crucial role in our lives. Health has two components: the body and the soul. Intact natural landscapes provide refuge for stressed people, which contrasts with the continuous actions of construction, infrastructure and urban development. How can society survive in the long term if the fundamental components of health continue to be degraded?

Nature – Land use – People

Land use is a global phenomenon since man existed. Extensive local and regional hunting by nomadic tribes gradually developed into mobile, technocratic and globalized modern human societies concentrated mostly in large cities and agglomerations that spread into rural landscapes. For years, one square meter of Swiss land has been covered by buildings and construction every second. The driving force is economic development and quantitative as well as qualitative growth. The human population is still "exploding", and societal demands seem to ever expand. Although already in 1972, Meadows et al. (2004) showed that natural resources and growth are limited. In developing as well as developed countries, an increasing tension between urbanized and forest or pasture areas exists. International companies destroy rainforests and exploit landscapes for mining and agricultural industries. On the other hand, many people that live in cities move into "green" landscapes for recreation. When these people build new houses and related infrastructure for traffic in near-natural areas, these will turn into landscapes of pollution and noise.

Being aware of the numerous terrestrial and aquatic ecosystem services (Wiens 2002; Allan 2004) and their loss by human impact has lead to the development of valuation methods for landscapes (De Groot et al. 2002). A crucial point of discussion is whether all natural qualities can be given a monetary price. This is impossible in my opinion as, for example, the genetic pool has substantial value but no price. Similarly, the beauty, aesthetic and emotional effects of landscapes cannot be priced because there is no clear market. One of the valuing criteria is willingness to pay, but this is a doubtful approach since it is an individual and speculative declaration depending on the well-fare of people.

Capra (1982) in his outstanding "turning point" described the similarities between the human body (medicine) and nature (science). Philosophy is a way to perceive natural principles documented by scientists. For example, the laws of thermodynamics and the theory of relativity (Einstein) state all can be deduced to waves, recycling (growth and decay) and duality. The duality between ratio and emotions has activated numerous philosophers over centuries. While medical doctors and philosophers argue first on the individual psyche of people, environmental scientists tend to elucidate functions of systems as the upper hierarchy of individuals.

Balance and equilibrium

The scientific discussion about chemical and physical equilibrium has a long tradition. Are ecosystems in equilibrium or not? In fact, they constantly try to achieve it, e.g., by energy or chemical flux from high to low concentration. Weather is another example at a higher level, as high pressure systems equilibrate with low pressure systems. This dynamic refers to the fundamental principle of waves (Einstein's theory), and each natural state is an oscillation between two extremes of which both are harmful. Our emotions feature the same behaviour: shifting between good and bad moods, optimism vs pessimism, etc. But it is never black and white – we also find gray scales of various intensity. It is probably the greatest achievement of one's life to reach a full balance between soul, spirit and body (as shown by the Yin-Yang principle). However, stochastic natural disturbance prevents nature to ever reach full equilibrium. Focusing on river ecosystems, this is shown by catastrophic flood events and the subsequent recovery by biota (Ward & Stanford 1995).

In agreement with the concepts of Capra (1982) and Gaia theory (www.gaiatheory.org), Braun (2009) has shown how the balance at the individual level can be compared with, and is linked to, the collective level. He visualized this with several analogous examples like human depression and flood events. Such examples may help to understand the present situation of ecosystems and our environment more clearly. Complementary medicine is equivalent to complementary environmental protection, i.e., fighting the cause and not the effect, remediation for the whole body/system not a repair of individual organs/parts. An interesting question following Gaia theory that the earth is an organism at a higher level: Does earth have a soul? Do landscapes have a soul? Or alternatively, if feelings, in a rather reductionist point of view, are only a product of our brain function: Is the human soul simply mirrored by the environment and landscape? One thing is for sure: as much as humans need active and resting phases (usually working by day and sleeping during night), ecosystems at a higher hierarchical level require the same. With overexploitation, ecosystems react by malfunctioning or breakdown, and then will need remediation and a recovery period. Here, the duality between body and soul finds reflection in natural landscapes.

The rationale behind nature (landscape) protection

Nature is not only the romantic beauty as described, for example, by Rousseau. Dualism is demonstrated by earth quakes, hurricanes, floods and volcanic eruptions. Ultimately, we have to accept this and the Cartesian view turns out to be in error. In former times, landscape and nature protection aimed at conserving the actual state of the area. This concept is wrong, as nature is always changing *(panta rhei, Heraklit dixit).* Therefore, the modern approach is to let ecosystems (protected nature parks) change naturally. Modern park management strategies follow this new philosophy. Habitats are sub-units of ecosystems and landscapes at various scales; if protected, species protection is normally included.

The year 2010 has been declared as the year for biodiversity. Biodiversity is a major ecosystem service that is threatened by man. An important element in habitat and biodiversity protection is farmers. Farmers were once our "landscape gardeners", but under economic pressure and agricultural politics aimed at maximum production, they actually became a major impact to ecosystems. Misconceived agricultural politics and inadequate subsidies are now gradually being replaced by green farming and eco-products. Yet in Switzerland, for example, the use of eco-areas is still poorly optimized for ecological function of riverine and terrestrial landscapes; in particular, individual small areas are not properly connected and migration corridors are disfunctional.

This issue is not only an economic but also an emotional affair. Farmers must survive on their products and land, but they can do it in an intensive way (fertilizers, monocultures, large machines, animal farms) or in an extensive sustainable way. Society's general demands and living standards are the economic and social drivers. If the soil is overexploited, crops will diminish or develop diseases, soil erosion will increase, and landscapes will suffer from uniformity as do rivers (Sieber & Bloesch 2003). It remains open to what extent ecosystem resilience and recovery are affected. However, landscapes are perceived by our senses and emotions and, hence, become a substantial part of integrated human health.

The emotional binding of people to landscapes is not just fantasy or theory. Real examples in the 1960s were the Surlej (Engadine, Inn River) and Lavaux (Lake Geneva) cases where the dedicated Swiss environmentalist Franz Weber (www.ffw.ch) launched initiatives for landscape protection that were approved by vote. Today, after decades of intensive infrastructure development, the Swiss are still proud to show these areas to tourists, as they were not impacted by large construction and provide a resort for well-being. A similar situation exists still in the Danube Green Corridor and the Danube Delta. People and politicians in these regions will ultimately decide how this outstanding riverine landscape will look in 30 years.

Putting landscapes into a global framework

Landscapes are part of the globe. The debate between religious creationists and scientists represented by the big-bang theory and biological evolution has been accentuated in 2009 by the celebration of Darwin's 200th anniversary. Once again, rational thinking meets emotional beliefs. Whatever attitude you have, the universal mechanisms of the planetary system, including the planet earth, will continue. Global changes will occur with or without human contributions. However, humans do have the potential power to accelerate and guide such changes in certain directions. Ultimately, human society is part of nature and cannot suppress nature *sensu* Descartes. The major problem is to bring such views into the awareness of people, political leaders and decision makers.

Presently, politicians are guided mostly by economy. The approach to sustainability, giving equal weight to ecology, social aspects and economy, is subject to nice statements but rarely implemented as shown in December 2009 at the Copenhagen Climate Conference. Climate shapes entire landscapes and scenarios show that droughts may enhance desertification, even in Europe. Plant cover and animal distributions follow changes in temperature and precipitation. What ultimately is needed is a paradigm change as proposed by Meadows and Capra, but never considered thus far by politics. Much of our common future will depend therefore on individual behaviour.

Outlook: New paradigm urgently needed

If we want to keep beautiful landscapes and their inherent biodiversity for future generations, the globalized society must significantly change its behaviour and politics: (1) growth of the human population must be stabilized; (2) societal demands must be modest; (3) economic theory and practice must be changed so that growth is not the ultimate driver; (4) technology must be driven in an ethical direction and to lessen energy consumption; (5) implementation is the ultimate political demand, as only actions count (the best theories and laws have no power if they are not realized); the trite "sustainability" must be clearly substantiated; (6) soul and spirit must be better balanced; and (7) education must be strengthened to balance real nature with virtual electronic media.

References

Allan JD (2004): Landscapes and riverscapes: The influence of land use on stream ecosystems. Annu. Rev. Ecol. Evol. Syst. 35, 257–284

Bloesch J, Sieber U (2003): The morphological destruction and subsequent restoration programmes of large rivers in Europe. Arch. Hydrobiol. Suppl. 147/3-4, Large Rivers 14/3-4, 363–385

Braun M (2009): Aus dem Gleichgewicht. Verlag Simon Nomis, Studen BE, 63 pp

Capra F (1982): The turning point: Science, society, and the rising culture. Simon and Schuster, Bantam paperback (1983 ISBN 0-553-34572-9); Wendezeit. Scherz Verlag Bern & München (4. Auflage 1995)

De Groot RS, Wilson MA, Boumans RMJ (2002): A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41, 393–408

Meadows D, Meadows DL, Randers J (2004): Limits to Growth: The 30-Year Update. Chelsea Green, ISBN 1-931498-58-X

Ward JV, Stanford JA (1995): The serial discontinuity concept: extending the model to floodplain rivers. Regulated rivers 10, 159–168

Wiens, JA (2002): Riverine landscapes: taking landscape ecology into the water. Freshwater Biology 47, 501–515

ISSN 2070-1292

danube news

donau aktuell

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

International Association for Danube Research (IAD)

Presidium

President	General Secretary
Dr. Ivana TEODOROVIC	Dr. Harald KUTZENBERGER

Member Country Representatives

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

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

Expert Groups

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

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

Hydrological catchment of the River Danube

Address / General Secretary:

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

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

Editor:

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

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

Printing:
FUTURA – Petrovaradin, Serbia