canalization, marshes and floodplain drainage, cutting off meanders, river bank reshaping and embanking, tributary deviations, etc.), and pollution.

Regression analysis showed significant statistical relations between the diversity of benthic macro-invertebrates and the following biotope parameters: slope, dissolved oxygen, biochemical oxygen demand, organic matter, total hardness, chloride and sulphate concentration, and degree of mineralization. Some examples are given below (in the equations r^2 signifies the determination coefficient, S.D. is the standard deviation and q the level of significance):

$ln(MA) = 2.523 – 0.053 \ ln(BOD_5) \ ln(DO) \ ln(COD\text{-}Mn)$;
$r^2=0.799$; S.D.±0.247; $q<0.001$

$ln(H) = 1.526 - 0.029 \ ln(BOD_5) \ ln(COD\text{-}Mn) \ ln(DO)$;
$r^2=0.897$; S.D.±0.09; $q<0.001$

$ln(SIM)=-2.712 + 0.056 \ ln(BOD_5) \ ln(COD\text{-}Mn) \ ln(DO)$;
$r^2=0.788$; S.D.±0.269; $q<0.001$

$ln(ME)=0.639 – 0.150 \ ln(TH) \ ln(RF)$;
$r^2=0.795$; S.D.±0.391; $q<0.005$

Conclusions

The predictive potential of regression analysis can be used by changing the independent variables (e.g., parameters of habitat quality) in various scenarios of river management. The output of such models is a prognostic variation in biodiversity (as a measure of homeostasis) of benthic macroinvertebrates with a known range of error. Hence, the model may deliver a set of modifications of some biotope parameters that can be used to establish a sound programme for sustainable river basin management. It must be stressed that such statistical and empirical models can hardly be transposed from one system to another and cannot be generalized without a sound calibration. These methods are time and resource-consuming, involving a highly skilled team of professionals.

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The use of models in flood risk management of the Lower Danube

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Introduction

Long-term strategic planning to achieve the objectives of the Water Framework Directive and the effective implementation of flood prevention, protection and mitigation need a sound scientific basis. The complexity of natural hydrological processes determines the principles, methods and analysis used for their study.

For example, establishing and reassessing the flood defence lines of settlements in the Lower Danube Plain and developing an integrated analysis of the hydromorphological, ecological, and economic conditions means to map, in a first step, the hydro-geomorphological units such as floodplains and agricultural polders.

Mapping has been neglected in the last 25 years. Therefore, a digital terrain model (DTM) was created which can design the defense strategy against flooding and base spatial planning (Kraus & Pfeifer 1998). With the DTM, floodplain dynamics and land use can be correlated, and indicators and indices of landscape can be characterized. Maps make the results clearly visible to the public, stakeholders and politicians.

Methods of mapping and modeling

Since the area of the Lower Danube Plain is crowded with channels and dams, the DTM needs at least nine topographical points to model a dam in three dimensions (2 pts for its base, 4 pts for the berm, 3 pts for its top). Hence, four points per square meter with a precision in altitude of ±5 cm are necessary when considering a dam with a base-width of 20 m. LIDAR (Light Detection and Ranging) is the only method that can ensure these requirements. The light detection is based on echo/laser pulse backscattering, i.e., measures the time used by the beam from leaving the sender in a round-trip plane to reaching the targeted scanned object, e.g., the land surface with hills, trees, houses, etc. We used a laser scanner with an accuracy of 5 cm (Riegl LMS-Q560) located on a plane (Partenavia P3) with two engines (Ly-

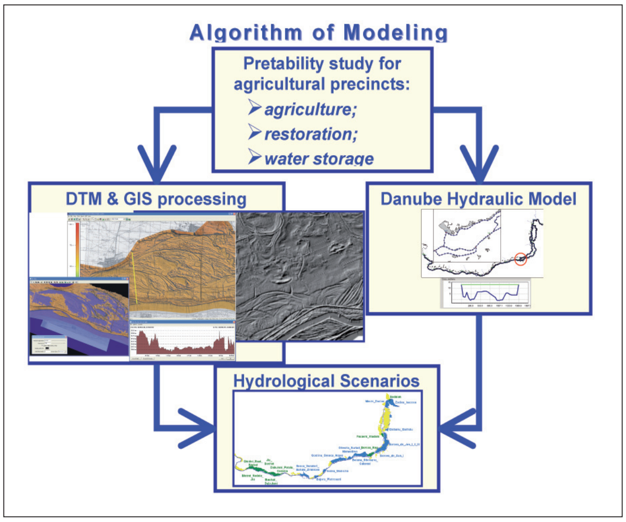

Figure 1. Scheme for using models in decision making. The first step of mapping the floodplains is followed by parallel DTM/GIS and hydraulic modeling that provides the basis for hydrological scenarios

coming 180CV) providing a flight altitude between 450 and 500 m. The scanned width is a land strip of 520 m, with 20% overlap between the parallel strips, and the flying speed is 45 m/s. LIDAR points were calculated by the software GraphNav, with simultaneous observations using GPS reference stations at ground, and calculations to collate the range of GPS and IMU (inertial measurement unit) by the laser sequential INERTIAL EXPLORER program (Hofmann-Wellenhof et al. 1992). This procedure allows coordinates with the required accuracy to show a good quality 3D picture. The method combined with a flight photogrammetry for viewing both normal color and infrared ranges supports mathematical models with applications in ecology and decision analysis.

DTM modeling is suited to simulate complex hydromorphological dynamics. It provides information on the restoration potential as well as natural and anthropogenic changes. DTM supports the adopted hydraulic model by designing various flood scenarios respecting water level and flow and by determining various stages of a flood alarm system.

The hydraulic model (software Sobek_Rural produced by the Institute of Hydraulics Delft, Netherlands in collaboration with the Institute for Water Management and Treatment of Interiors Waste, Riza Netherlands, SOBEK 2000) is one-dimensional and encompasses five distinct modules for modeling natural processes. These include permanent and temporary flow, sediment transport, river morphology, water quality, hydraulic scenarios for water management, hydro-engineering (dredging, dams, canals), controlled flooding and navigation. Model input parameters are cross sections over the total length of the Lower Danube, data series (daily values of levels and flows) from hydrometric stations, and channel roughness (Manning and Chezy formulas, Arcement & Schneider 2004).

Model application

Dykes along almost the entire Lower Danube Plain have affected the hydro-geomorphological function of the river, the socio-economic and natural capital, and the local and regional climate (Romania 2006). Global climate change further accentuates the problem. Hence, reassessment of economic activities in the polders of the Lower Danube Plain with a scientific, coherent foundation of sustainable development will provide alternative technical solutions. To restore the socio-ecologic balance in the Lower Danube Plain complex measures within the damaged and abandoned agricultural enclosures are necessary. These are identified by a multi-criteria model of socio-economic analysis. The following three aspects are important for spatial planning issues:

(1) Systems should be considered as a whole identity (according to the concept of River Basin Management). Otherwise, a water manager intervening directly only in a part of the system will not consider the consequences in other parts of the system.
(2) Human and natural systems are dynamic and, hence, constantly evolving, but never in balance. Therefore, small interventions of water managers involved in changing the system may trigger, at a certain critical point, consequences of great importance.
(3) River systems need space due to the natural flow pulse. Hence, the consequences of planning policy depend on the spatial design.

The applied method supplements the physical analysis through an evaluation of the socio-ecologic quality and ecosystem functions: productivity, habitat for species of plants and animals, regulation and control of biodiversity and links and exchange between two or more ecosystems. The purpose of this analysis is to elucidate the dynamics of functional and structural variables and to

- determine the indicators that define the structure, composition and operational components of the Natural Capital and Socio-Economic System
- perform an impact assessment (EIA) and environmental risk assessment (ERA)
- identify the tendency of structural and functional changes
- evaluate the causes of occurred changes.

Three flood scenarios were calculated with the hydraulic model to reduce maximum water levels by

- flooding not dammed agricultural enclosures as natural retention areas
- using water tanks for water storage in agricultural enclosures
- applying a mixed solution through water storage in some enclosures and flooding in others (restoration).

A combination of the three models described *(Figure 1:* multi criteria model of socio-economic analysis; digital terrain model (DTM); hydraulic model) helps to implement a strategic program for sustainable development and reassessment of the flood defense lines of settlements. The priorities are to develop the concept for flood defense of settlements by determining the capping level of new defending lines, to manage flooding of agricultural enclosures by storing water during periods of maximum Danube water levels, and to eval-

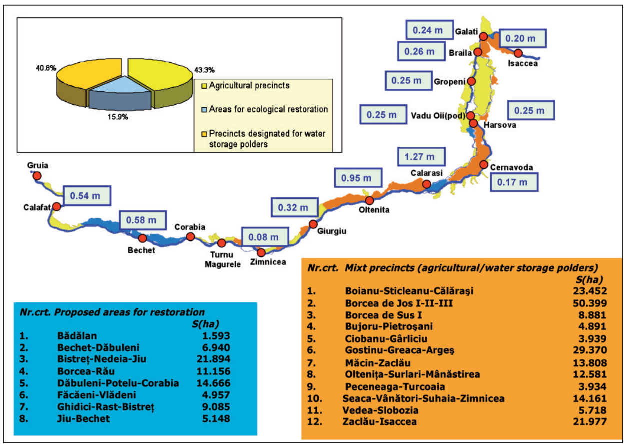

Figure 2. *Example of a mixed scenario (restoration, blue areas, and water storage, brown areas) to decrease high water levels of the Danube River. The meter values indicate the difference between actual reference water levels and predicted water levels*

uate agricultural enclosures for their reintegration into the natural water cycle and the creation of natural wetlands.

Based on available data and hydraulic scenarios, the landuse in the Lower Danube Plain encompassing in total 445,000 ha of presently impounded agricultural land could be quantified. 43% are suitable for agriculture; 41% are retention areas and can be used for mixed activities; 16% are suitable for restoration to create wetlands. This ensures a socio-economic sustainable development in the Lower Danube Plain *(Figure 2).* Wetland restoration is sustainable and conserves the integrity of ecosystems (van Breen 2002).

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In brief Information – New books

Kriska G, Tittizer Th.: ***Wirbellose Tiere in den Binnengewässern Zentraleuropas – Ein Bestimmungsbuch.*** *(Review by Jürg Bloesch: Stauffacherstrasse 159, CH-8004 Zürich, Switzerland, e-mail: bloesch@eawag.ch)*

A new identification key for aquatic invertebrates in freshwaters of Central Europe has been published. In the preface, the second author poses the critical question if such a new key is necessary, provided that numerous professional taxonomy books and popular illustrated identification books already exist. He himself provides the answer and stresses the positive sides of this book: it combines the two identification concepts and focuses on six eco-regions covering also the Danube River (Western and Central Mountains, Central and Hungarian Plains, Dinaric Western Balkans and Carpathians); it comprises 21 selected main groups of aquatic invertebrates with a general and a specific part; it provides simplified dichotomous identification keys supported by excellent colored photos and computerized drawings. Lists of photos, popular and scientific names of species, and expert expressions round off the book.

The book addresses to teachers and students of Universities and High Schools as well as interested people. The users will appreciate the attached CD containing demonstrations and exercises for further studies on aquatic organisms. For those willing to deepen their knowledge specific hints to group specific identification keys and literature would have been of advantage. (Weissdorn-Verlag Jena, 2009, 377 Seiten, 235 Abbildungen, 515 Farbfotos, Übungs-CD. ISBN-No. 978-3-936055-58-0. Price 34.90 Euros); an Hungarian version is also published, an English translation of the book is planned. The book (in German) can be ordered directly at Weissdorn-Verlag Jena, Wöllnitzer Str.53, D-07749 Jena, Germany (e-mail: weissdorn-verlag@t-online.de).

Rivers of Europe. *Edited by Klement Tockner, Christopher T. Robinson & Urs Uehlinger (Review by Georg Janauer: University of Vienna, Department of Freshwater Ecology, Althanstrasse 14, Vienna, Austria, e-mail: georg.janauer@univie.ac.at)*

I am most enthusiastic about this book and highly appreciate the enormous effort the editors, and the authors of the different chapters, have put into this most comprehensive piece of scientific literature. The extensive, yet detailed coverage of such a wide geographic area, from Iceland and the British Isles to the rivers in Russia, the Kaukasus and in Turkey, and from the Mediterranean countries to the rivers in Europe's "Northern Slope" is unsurpassed at present. Excellent haptic appearance competes positively with the very clearly structured contents, including highly informative overview maps, a table on river characteristics, and instructive diagrams and pictures of habitats and river sections. I especially enjoyed sub-chapters for all rivers and tributaries on biodiversity and human impact as well as on conservation and management, which rate this book as up-to-date with respect to urgent environmental problems of our time. Regarding the Danube River, my own prime research topic, I was quite delighted to see this subject most carefully worked out, including many interesting details and presenting a remarkable overview on that large river; Klement Tockner did certainly not forget about his personal study object a few years in the past. This book is a must regarding further reading for my students. (Academic Press as an imprint of Elsevier, London. First Edition 2009, 700 pp. ISBN-13: 978-0-12-369449-2. Price 146.– Euros).