44TH IAD CONFERENCE

FEBRUARY 6-9, 2023

KREMS, AUSTRIA

Tackling Present & Future Environmental Challenges of a European Riverscape

CONFERENCE BOOK

Austrian Committee Danube Research

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KARL LANDSTEINER PRIVATUNIVERSITÄT FÜR GESUNDHEITSWISSENSCHAFTEN

CONFERENCE MISSION

The 44th IAD conference* is held under the patronage of the Austrian committee of the IAD at the Karl Landsteiner University of Health Sciences in Krems, situated in the beautiful landscape of the Wachau, next to the Danube River. This young university (founded in 2013) has a strong research focus on water quality and health, being a key player in this research field in the Danube River Basin. Here, health is considered in a holistic, transdisciplinary way under the "One Health" concept of the WHO, combining human, animal and environmental health in an ecological context. Thus the conference shall bring together scientists and experts from different disciplines for discussing the present and future environmental challenges of our Danube riverscape.

*This conference was originally planned to be organized by our Ukrainian colleagues at the Institute of Hydrobiology of the National Academy of Sciences in Kyiv, but due to the Russian aggression this became unfortunately impossible. We wish our esteemed colleagues all the best for their future.

TOPICS

- Pollution and health under the "One Health" concept
- Climate change and land-use change impacts on aquatic ecosystems
- Integrated water management – from environmental monitoring to sustainable solutions
- Status and future trends of aquatic species and habitats
- Protected areas and biodiversity conservation
- Floodplain ecology and restoration – constraints and perspectives
- The Human Dimension – rivers as socio-ecological systems
- Riverine landscapes and wetlands
- The Danube River delta and coastal ecosystems

CONFERENCE BOARD

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Ion Toderas (Bulgarian Academy of Sciences)

PROGRAM DAY 1_ February, 6 Monday					
09:00	**10:00**	**Opening Session**			**Chair: Bernd Cyffka**
09:00	09:20	**Alexander Kirschner, Bernd Cyffka, Rudolf Mallinger**	Karl Landsteiner University of Health Sciences, Austria/KU Eichstätt-Ingolstadt, Germany	CONFERENCE OPENING	**oral**
09:20	10:00	**Slobodnik Jaroslav**	Environmental Institute, Slovakia	CHEMICAL POLLUTION STATUS OF THE DANUBE RIVER	**Keynote-oral**
10:00	**10:30**	**Coffee break**			
10:30	**12:20**	**Session 1 - Faecal Pollution**			**Chair: Farnleitner AH/Vierheilig J**
10:30	10:45	**Kirschner Alexander**	Karl Landsteiner University of Health Sciences, Austria	JOINT DANUBE SURVEY 1 TO 4: CONCEPTS, LESSONS LEARNED AND FUTURE VISIONS ON FAECAL POLLUTION AND ANTIMICROBIAL RESISTANCE	**oral**
10:45	11:00	**Steinbacher Sophia**	Karl Landsteiner University of Health Sciences, Austria	A NEW MONITORING DATA DRIVEN APPROACH TO EVALUATE THE IMPACT OF SHIPS ON THE FAECAL POLLUTION LEVEL OF THE DANUBE RIVER IN LOWER AUSTRIA	**oral**
11:00	11:15	**Kolarevic Stoimir**	University of Belgrade, Serbia	APPLICABILITY OF WASTEWATER BASED EPIDEMIOLOGY IN COUNTRIES WITH POOR WASTEWATER TREATMENT – COVID-19 CASE STUDY IN SERBIA	**oral**
11:15	11:30	**Oudega Thomas**	Technische Universität Wien, Austria	TRANSPORT AND REMOVAL OF BACILLUS SUBTILIS ENDOSPORES IN AN ALLUVIAL GRAVEL AQUIFER AT DIFFERENT FLOW RATES AND IMPLICATIONS FOR SETBACK DISTANCES	**oral**
11:30	11:45	**Reiter Michael**	Medical University of Vienna, Austria	WHAT IS THE EFFECT OF MUNICIPAL WASTEWATER TREATMENT REGARDING THE REDUCTION OF HYGIENICALLY RELEVANT MICROORGANISMS? – A META STUDY	**oral**
11:45	12:00	**Sommer Regina**	Medical University of Vienna, Austria	HEALTH-RELATED INACTIVATION REQUIREMENTS FOR UV-IRRADIATED WASTEWATER EFFLUENTS DISCHARGED INTO RECREATIONAL SURFACE WATER BODIES	**oral**
12:00	12:15	**Farnleitner Andreas**	Technische Universität Wien, Austria	GUIDING FUTURE DEMANDS ON MICROBIAL DRINKING WATER SAFETY MANAGEMENT ALONG A LARGE HUMAN WASTEWATER IMPACTED RIVER: A RISK-BASED MODELLING APPROACH	**oral**
12:15	**13:15**	**Lunch break**			
13:15	**15:00**	**Session 2 - Chemical Pollution & Climate change and land-use change impacts on aquatic ecosystems**			**Chair: Slobodnik J / Sommer R**
13:15	13:30	**Kittlaus Steffen**	Technische Universität Wien, Austria	A DANUBE BASIN WIDE INVENTORY OF HAZARDOUS SUBSTANCE CONCENTRATIONS IN SURFACE WATERS AND IN MAIN EMISSION PATHWAYS	**oral**
13:30	13:45	**Nagy Eszter**	Budapest University of Technology and Economics, Hungary	EUTROPHICATION POTENTIAL OF THE STREAM NETWORK OF THE DANUBE BASIN	**oral**
13:45	14:00	**Kračun-Kolarević Margareta**	University of Belgrade, Serbia	IN SITU GENOTOXICITY ASSESSMENT IN THE WEIGHT-OF-EVIDENCE APPROACH – THE JOINT DANUBE SURVEY 4 CASE STUDY	**oral**
14:00	14:15	**Niedrist Georg**	University of Innsbruck, Austria	ENHANCED WARMING AND LONG-TERM PHENOLOGICAL SHIFTS IN MOUNTAINOUS TRIBUTARIES OF THE DANUBE	**oral**
14:15	14:30	**Kaglyan A**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	THE ABSORBED DOSE RATE OF INTERNAL IRRADIATION OF FISH IN THE WATER BODIES OF THE CHORNOBYL EXCLUSION ZONE AT THE PRESENT STAGE	**oral**
14:30	14:45	**Stanković Jelena**	University of Belgrade, Serbia	ISOLATION OF MICROPLASTICS FROM FRESHWATER ASIAN CLAMS CORBICULA FLUMINEA (MÜLLER, 1774) IN THE DANUBE RIVER	**oral**
14:45	15:00	**Dyatlov S**	National Academy of Sciences, Institute of Marine Biology, Ukraine	PRELIMINARY ASSESSMENT OF CONTAMINANTS FROM KILIA BRANCH OF THE DANUBE TO THE BLACK SEA	**oral**
15:00	**15:30**	**Coffee break**			
15:30	**16:54**	**Session 3 - Antimicrobial Resistance & Short Oral Poster Presentations**			**Chair: A Kirschner/S Kolarevic**
15:30	15:45	**Vierheilig Julia**	Technische Universität Wien, Austria	SURVEILLANCE OF ANTIBIOTIC RESISTANCE GENES IN AUSTRIAN WASTEWATER TREATMENT PLANTS WITHIN THE DANUBE RIVER BASIN	**oral**
15:45	16:00	**Zarfel Gernot**	Medical University Graz, Austria	THE DANUBE´S WATER AND BIOFILMS: ANTIMICROBIAL RESISTANCE IN THE ENTEROBACTERIACEAE POPULATIONS	**oral**
16:00	16:15	**Schachner-Gröhs Iris**	Medical University of Vienna, Austria	OCCURRENCE OF ANTIBIOTIC RESISTANCE GENES ALONG GRADIENTS OF FAECAL POLLUTION IN WATER AND BIOFILM SAMPLES FROM THE whole DANUBE RIVER	**oral**
16:15	16:18	**Galazka Sonja**	Austrian Agency for Health and Food Safety AGES, Austria	IMPACT OF FLOODING ON ANTIBIOTIC RESISTANCE GENE CONCENTRATIONS IN SOILS OF THE DONAU-AUEN NATIONAL PARK	**short oral/Poster P1-1**
16:18	16:21	**Dielacher Irina**	Technische Universität Wien, Austria	OCCURRENCE OF ANTIBIOTIC RESISTANT GENES IN TWO TRIBUTARIES OF THE DANUBE ALONG DIFFERENT ENVIRONMENTAL GRADIENTS	**short oral/Poster P1-2**
16:21	16:24	**Haaser Dominik /Kainrath Stefanie**	Karl Landsteiner University of Health Sciences/ IMC University of Applied Sciences, Austria	ANTIBIOTIC RESISTANCE OF ESCHERICHIA COLI ISOLATED FROM WATER AND BIOFILM SAMPLES OF THE KAMP RIVER	**short oral/Poster P1-3**
16:24	16:27	**Leopold Melanie**	Karl Landsteiner University of Health Sciences, Austria	HIGH LEVELS OF TOTAL SUSPENDED SOLIDS IN DANUBE FLOOD WATER SAMPLES AS A FACTOR FOR REDUCED DNA EXTRACTION EFFICIENCY AND POTENTIAL BIAS IN MOLECULAR DETECTION APPROACHES	**short oral/Poster P1-4**
16:27	16:30	**Teubner Katrin**	University of Vienna, Austria	WETLAND DYNAMICS OF LAKE NEUSIEDL AND SODA PANS MEASURED BY USING HIGH RESOLUTION PROBES	**short oral/Poster P1-5**
16:30	16:33	**Jovičić Katarina**	University of Belgrade, Serbia	IMPACT OF WASTEWATER DISCHARGES ON FATTY ACID PROFILE OF ROACH (RUTILUS RUTILUS) FROM DANUBE RIVER, BELGRADE	**short oral/Poster P1-6**
16:33	16:36	**Kurant V**	Ternopil Volodymyr Hnatiuk National Pedagogical University, Ukraine	COMPREHENSIVE ESTIMATION OF HEAVY METALS CONTAMINATION OF ECOSYSTEMS OF SMALL RIVERS FROM WESTERN PODILLYA (DNIESTER RIVER BASIN, UKRAINE)	**short oral/Poster P1-7**
16:36	16:39	**Subotić Srđan**	University of Belgrade, Serbia	DIFFERENCE IN ELEMENT ACCUMULATION AND HISTOPATHOLOGY OF PONTIC SHAD (*ALOSA IMMACULATA*) MIGRANTS CAUGHT IN THE DANUBE RIVER IN INTERVAL OF ONE DECADE	**short oral/Poster P1-8**
16:39	16:42	**Oudega Thomas**	Technische Universität Wien, Austria	UPSCALING THE FATE AND TRANSPORT OF BACILLUS SUBTILIS ENDOSPORES AND COLIPHAGE PHIX174 IN HETEROGENEOUS POROUS MEDIA FROM THE COLUMN TO THE FIELD SCALE	**short oral/Poster P1-9**
16:42	16:45	**Niedrist Georg**	University of Innsbruck, Austria	DISPROPORTIONAL VULNERABILITY AND DIFFERENTIAL RESPONSE WITHIN AQUATIC INVERTEBRATE COMMUNITIES IN MOUNTAINOUS HEADWATERS OF THE DANUBE	**short oral/Poster P1-10**
16:45	16:48	**Pavel Ana Bianca**	National Institute of Marine Geology and Geo-Ecology, Romania	BIOACCUMULATION OF HEAVY METALS IN COMMON REED (PHRAGMITES AUSTRALIS) IN GORGOVA-UZLINA DEPRESSION, DANUBE DELTA	**short oral/Poster P1-11**
16:48	16:51	**Zhezherya V**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	METALS IN THE WATER OF THE KILIYA DANUBE DELTA IN MODERN CONDITIONS: CONCENTRATION, SPECIATION, LABILITY AND BIOAVAILABLE	**short oral/Poster P1-12**
16:51	16:54	**Zhezherya V**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	BIOGENIC SUBSTANCES IN THE WATER OF THE KILIYA DANUBE DELTA IN MODERN CONDITIONS	**short oral/Poster P1-13**
16:54	**17:45**	**Poster Session Day 1**			
18:00	**19:30**	**IAD General Assembly**			

PROGRAM DAY 2, February, 7 Tuesday					
09:00	**10:00**	**Opening Session Biodiversity and Ecology**			**Chair: Cyffka B**
09:00	09:20	**Afanasyev Sergyi**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	FROM DONETS TO DANUBE: HYDROECOLOGICAL PROBLEMS AT THE BACKGROUND OF HOSTILITIES	**Keynote-oral**
09:20	10:00	**Weigelhofer Gabriele**	University of Natural Resources and Life Sciences, Vienna & WasserCluster Lunz, Austria	CASCADING DROUGHT EFFECTS ON STREAM ECOSYSTEMS' FUNCTIONS AND COMMUNITIES	**Keynote-oral**
10:00	**10:30**	**Coffee break**			
10:30	**12:30**	**Session 1 - The Danube River delta and coastal ecosystems**			**Chair: Teubner K**
10:30	10:45	**Becker Isabell**	Karlsruhe Institute of Technology (KIT), Germany	ABOVEGROUND BIOMASS AND CARBON STOCK OF FLOODPLAIN FORESTS AND REED BEDS IN THE DANUBE DELTA, ROMANIA	**oral**
10:45	11:00	**Minicheva Galyna**	National Academy of Sciences, Institute of Marine Biology, Ukraine	MORPHOFUNCTIONAL ASSESSMENT OF MACROALGAE FOR MONITORING OF THE ECOLOGICAL STATUS OF THE UKRAINIAN DANUBE AVANDELTA	**oral**
11:00	11:15	**Kulakova Irina**	National Academy of Sciences, Institute of Marine Biology, Ukraine	ECOLOGICAL STATUS OF THE DANUBE DELTA COASTAL AREA (UKRAINIAN PART) BASED ON THE ANALYSIS OF THE MEIOBENTHOS AND NEMATODE COMMUNITIES	**oral**
11:15	11:30	**Goncharov Oleksandr**	National Academy of Sciences, Scientific Hydrophysical Center, Ukraine	VARIABILITY OF THE DANUBE RIVER FLOW AFFECTS THE DISTRIBUTION OF CHLOROPHYLL IN THE NORTH-WESTERN BLACK SEA	**oral**
11:30	11:45	**Vyshnevskyi Viktor**	National Aviation University, Ukraine	THERMAL REGIME OF THE LOWER COURSE OF THE DANUBE RIVER	**oral**
11:45	12:00	**Ivanova Natalia**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	CHANGES IN THE HYDROLOGICAL REGIME OF THE WETLANDS OF THE DANUBE DELTA (ON THE EXAMPLE OF STENSOVSKO-ZHEBRIANSKY PLAVNI)	**oral**
12:00	**12:15**	**Session 2 - Riverine landscapes and wetlands & Protected areas and biodiversity conservation**			**Chair: Teubner K**
12:00	12:15	**Scrieciu Albert**	National Institute of Marine Geology and Geo-Ecology, Romania	NATURAL ASSURANCE SCHEME DEVELOPMENT IN THE LOWER DANUBE: FROM NBS DESIGN PROCESSES TO CO-BENEFITS CAPITALIZATION	**oral**
12:15	**13:30**	**Lunch break**			
12:00	**12:15**	**Session 2 continued- Riverine landscapes and wetlands & Protected areas and biodiversity conservation**			**Chair: Hein T**
13:30	13:45	**Cyffka Bernd**	Catholic University of Eichstätt-Ingolstadt, Germany	MEDIUM- AND LONG-TERM MONITORING OF HYDROLOGY AND FLUVIAL MORPHODYNAMICS OF A NEAR-NATURAL BYPASS STREAM ALONG THE UPPER DANUBE BETWEEN NEUBURG AND INGOLSTADT (BAVARIA/GERMANY)	**oral**
13:45	14:00	**Subotić Srđan**	University of Belgrade, Serbia	GROWTH AND LENGTH-WEIGHT RELATIONSHIP OF THE PIKEPERCH (SANDER LUCIOPERCA) FROM COMMERCIAL CATCHES IN THE RIVER DANUBE NEAR BELGRADE (1162–1163 RKM)	**oral**
14:00	14:15	**Pařil Petr**	Masaryk University, Czech Republic	INTERMITTENT STREAMS – NEWLY RISING AND SIGNIFICANT PHENOMENA IN THE DANUBE BASIN	**oral**
14:30	14:45	**Schneider Erika**	Karlsruhe Institute of Technology (KIT), Germany	BLACK ALDER (ALNUS GLUTINOSA) FOREST STANDS ON THE LOWER STRETCH OF THE SFÂNTU GHEORGHE BRANCH OF THE DANUBE DELTA	**oral**
14:45	15:00	**Sokolov Yevhen**	National Academy of Sciences, Institute of Marine Biology, Ukraine	LANDSCAPE ASSESSMENT OF THE UKRAINIAN DANUBE REGION	**oral**
15:00	15:15	**Bilous Olena**	University of Natural Resources and Life Sciences, Vienna, Austria	DISTRIBUTION PATTERNS OF ALGAE IN RIVERINE LANDSCAPES	**oral**
15:15	15:30	**Trichkova Teodora**	Academy of Sciences, Institute of Biodiversity and Ecosystem Research, Bulgaria	COLLECTING DATA ON INVASIVE ALIEN SPECIES THROUGH BIOBLITZ SURVEYS IN THE DANUBE AND BLACK SEA BASINS IN BULGARIA	**oral**
15:30	15:45	**Ozimec Siniša**	Josip Juraj Strossmayer University of Osijek, Croatia	NEW RECORDS ON DISTRIBUTION OF NATURA 2000 HABITAT TYPE 3130 ISOËTO-NANOJUNCETEA IN THE CROATIAN DANUBE REGION	**oral**
15:45	**16:05**	**Coffee break**			
16:05	**17:32**	**Session 3 - Status and future trends of aquatic species and habitats & Short Oral Poster presentations**			**Chair: Trichkova T**
16:05	16:20	**Dokulil Martin**	University of Innsbruck, Austria	PHYTOPLANKTON PRIMARY PRODUCTION IN RIVERS AND STREAMS – A REVIEW	**oral**
16:20	16:35	**Germ Mateja**	University of Ljubljana, Slovenia	THE DISTRIBUTION OF MACROPHYTES IN ALPINE LAKE BOHINJ (SLOVENIA) AND CONTENT OF SELECTED ELEMENTS IN SEDIMENT, WATER, AND MACROPHYTES	**oral**
16:35	16:50	**Mihaljević Melita**	Josip Juraj Strossmayer University of Osijek, Croatia	HALF A CENTURY OF PHYTOPLANKTON RESEARCH IN THE KOPAČKI RIT FLOODPLAIN –CONTRIBUTION TO NATURE PROTECTION AND INTERNATIONAL RECOGNITION THROUGH THE IAD	**oral**
16:50	16:53	**Ergović Viktorija**	Josip Juraj Strossmayer University of Osijek, Croatia	LIMNOMYSIS BENEDENI (CRUSTACEA: MYSIDAE) IN THE NATURE PARK KOPAČKI RIT: THE FIRST COMPREHENSIVE STUDY ON DISTRIBUTION	**short oral/Poster P2-1**
16:53	16:56	**Hupalo Olena**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	FISH SPECIES DIVERSITY OF THE UPPER TYSA RIVER (UKRAINE) – THREATS AND WAY OF SOLVING	**short oral/Poster P2-2**
16:56	16:59	**Novaković Boris**	Ministry of Environmental Protection of the Republic of Serbia	FIRST RECENT RECORD OF PRICKLY WATERLILY (EURYALE FEROX) SALISB. (NYMPHAEACEAE) IN FRESHWATERS OF EUROPE	**short oral/Poster P2-3**
16:59	17:02	**Costea Gabriela**	Leibniz-Institute für Freshwater Ecology and Inland Fisheries (IGB), Germany	INTERGENERATIONAL LEARNING AS A TOOL FOR TRAINING NATURE GUIDES IN THE LOWER DANUBE	**short oral/Poster P2-4**
17:02	17:05	**Deže Denis**	Josip Juraj Strossmayer University of Osijek, Croatia	MICROALGAL CULTIVATION ON DIFFERENT DIGESTATE CONCENTRATIONS FOR BIOGAS PRODUCTION	**short oral/Poster P2-5**
17:05	17:08	**Đuknić Jelena**	University of Belgrade, Serbia	MACROINVERTEBRATE FAUNA ALONG THE SERBIAN STRETCH OF THE DANUBE RIVER	**short oral/Poster P2-6**
17:08	17:11	**Subotić Srđan**	University of Belgrade, Serbia	COMPARATIVE EVALUATION OF LIVER ENZYMES ACTIVITIES IN VIMBA BREAM AND COMMON NASE LIVING UNDER THE SAME ECOTOXICOLOGICAL CONDITIONS	**short oral/Poster P2-7**
17:11	17:14	**Manturova Oksana**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	CASES OF MASS VEGETATION OF DIDYMOSPHENIA GEMINATA IN UKRAINIAN PART OF THE TYSA RIVER BASIN	**short oral/Poster P2-8**
17:14	17:17	**Trichkova Teodora**	Academy of Sciences, Institute of Biodiversity and Ecosystem Research, Bulgaria	FIRST REPORT ON NATURAL REPRODUCTION OF RAINBOW TROUT ONCORHYNCHUS MYKISS IN BULGARIA BASED ON DNA ANALYSIS OF REDD MATERIAL FROM THE OGOSTA RIVER	**short oral/Poster P2-9**
17:17	17:20	**Vidinova Yanka**	Academy of Sciences, Institute of Biodiversity and Ecosystem Research, Bulgaria	ASSESSMENT OF THE MACROINVERTEBRATE INVASION IN WATER BODIES OF THE DANUBE RIVER BASIN, BULGARIA	**short oral/Poster P2-10**
17:20	17:23	**Nikolić Dušan**	University of Belgrade, Serbia	LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF THE WHITE BREAM (Blicca bjoerkna) IN THE DANUBE RIVER NEAR BELGRADE (1168-1170 RKM)	**short oral/Poster P2-11**
17:23	17:26	**Subotić Srđan**	University of Belgrade, Serbia	A PRELIMIARY STUDY ON SEASONAL CHANGES OF FISH DIVERSITY IN COMMERCIAL CATCHES IN THE RIVER DANUBE NEAR BELGRADE (1162–1163 RKM)	**short oral/Poster P2-12**
17:29	17:32	**Marinets A**	National Academy of Sciences, Institute of Marine Biology, Ukraine	MORPHOFUNCTIONAL INDICATORS OF PHYTOFOULING OF NAVIGATION CONSTRUCTION IN THE UKRAINIAN PART OF THE DANUBE DELTA	**short oral/Poster P2-13**
17:32	**18:15**	**Poster Session Day 2**			
19:30	**23:00**	**Conference Dinner**			

Preliminary PROGRAM DAY 4, February, 9 Thursday					
09:00	**10:20**	**Opening Session Management and Restoration**			**Chair: Haidvogl G**
09:00	09:40	**Edith Hödl**	ICPDR, Vienna, Austria	THE DANUBE RIVER BASIN MANAGEMENT PLAN: MANAGING PRESENT AND FUTURE ENVIRONMENTAL CHALLENGES TOWARDS ECOSYSTEM RESTORATION IN THE DANUBERIVER BASIN	**Keynote-oral**
09:40	10:00	**Hein Thomas**	University of Natural Resources and Life Sciences, Vienna, Austria	HOW CAN THE META-ECOSYSTEM APPROACH IMPROVE THE MANAGEMENT OF LARGE RIVER NETWORKS?	**oral**
10:00	10:20	**Bloesch Jürg**	EAWAG, Switzerland	INTEGRATED WATER MANAGEMENT: LINKING THE DANUBE RIVER WITH THE BLACK SEA	**oral**
10:20	**10:45**	**Coffee break**			
10:45	**12:00**	**Session 1 - The Human Dimension – rivers as socio-ecological systems**			**Chair: Natho S**
10:45	11:00	**Kutzenberger Harald**	TBK Office for Ecology and Landscape Planing, Austria	DANUBE LANDSCAPES – HISTORY, DIVERSITY, CONFLICTS, IDENTITY, BUT NO LOBBY!	**oral**
11:00	11:15	**Mousazadeh Hossein**	Eötvös Loránd University, Department of Regional Science, Budapest, Hungary	RIVER AND WELL-BEING: A PERMA CONCEPTUALIZATION ON URBAN DWELLERS PERSPECTIVE	**oral**
11:15	11:30	**Stammel Barbara**	Catholic University of Eichstätt-Ingolstadt, Germany	INTEGRATIVE FLOODPLAIN MANAGEMENT BASED ON ECOSYSTEM SERVICES AND ITS POTENTIAL TO IMPROVE WATER QUALITY - THE IDES PROJECT	**oral**
11:30	11:45	**Rotaru Sabin**	National Institute of Marine Geology and Geo-Ecology, Romania	ANNUAL RIVERBED CHANGES IN THE LOWER DANUBE: HUMAN IMPACT VERSUS MORPHODYNAMIC FEEDBACKS	**oral**
11:45	12:00	**Tschikof Martin**	University of Natural Resources and Life Sciences, Vienna, Austria	LARGE-SCALE MULTIFUNCTIONALITY ASSESSMENTS IN DANUBE FLOODPLAINS USING ECOSYSTEM SERVICES	**oral**
12:00	**13:15**	**Lunch break**			
13:15	**15:15**	**Session 2 - Floodplain ecology and restoration – constraints and perspectives**			**Chair: Nichersu J**
13:15	13:30	**Teubner Katrin**	University Vienna, Austria	MACROPHYTE HABITAT ARCHITECTURE AND LAKE RESTORATION: PHOTIC DEMAND FOR SUSTAINED MACROPHYTE DEVELOPMENT	**oral**
13:30	13:45	**Martyniuk M**	National Academy of Sciences, Institute of Marine Biology, Ukraine	IDENTIFICATION OF AREAS WITH POTENTIAL SIGNIFICANT FLOOD RISK IN THE RENI AREA IN THE LOWER REACHES OF THE DANUBE RIVER	**oral**
13:45	14:00	**Mihaljević Melita**	Josip Juraj Strossmayer University of Osijek, Croatia	HALF A CENTURY OF PHYTOPLANKTON RESEARCH IN THE KOPAČKI RIT FLOODPLAIN –CONTRIBUTION TO NATURE PROTECTION AND INTERNATIONAL RECOGNITION THROUGH THE IAD	**oral**
14:00	14:15	**Seliger Carina**	University of Natural Resources and Life Sciences Vienna, Austria	RIPARIAN ZONES - A KEY FACTOR IN PURSUING JOINT CONSERVATION EFFORTS FOR TERRESTRIAL AND FRESHWATER ECOSYSTEMS	**oral**
14:15	14:30	**Čerba Dubravka**	Josip Juraj Strossmayer University of Osijek, Croatia	SHALLOW WATER BODIES IN A DANUBE FLOODPLAIN, AN IMPORTANT HABITAT FOR CHIRONOMIDAE (DIPTERA) AND OTHER AQUATIC MACROINVERTEBRATES	**oral**
14:30	14:45	**Cvijanović Dušanka**	University of Novi Sad, Serbia	CONSERVATION ASSESSMENT OF AQUATIC HABITATS IN THE TEMPERATE WETLAND MOSAICS USING UAV PHOTOGRAMMETRY (MIDDLE DANUBE)	**oral**
14:45	**15:15**	**Coffee break**			
15:15	**16:48**	**Session 3 - Integrated water management – from environmental monitoring to sustainable solutions & Short Oral Poster presentations**			**Chair: Seliger C**
15:15	15:30	**Nichersu Iulian**	Danube Delta National Institute for Research and Development, Romania	ECOLOGICAL RESIZING THROUGH URBAN AND RURAL ACTIONS & DIALOGUES FOR GHG MITIGATION IN THE LOWER DANUBE FLOODPLAIN & DANUBE DELTA - EDAPHIC-BLOOM DANUBE	**oral**
15:30	15:45	**Pöppl Ronald**	University of Vienna, Austria	MANAGING WATER AND SEDIMENT (DIS)CONNECTIVITY IN FLUVIAL SYSTEMS: SOME PRINCIPLES AND APPLICATIONS	**oral**
15:45	16:00	**Ullmann Veronika**	Catholic University of Eichstätt-Ingolstadt, Germany	LONG-TERM MONITORING OF AQUATIC AND RIPARIAN VEGETATION ALONG A BYPASS WATERCOURSE IN A FLOODPLAIN FOREST BETWEEN NEUBURG AND INGOLSTADT (BAVARIA/GERMANY)	**oral**
16:00	16:15	**Neuburg Jakob**	University of Natural Resources and Life Sciences Vienna, Austria	ESTIMATIONS OF STERLET POPULATIONS BASED ON MONITORING DATA IN THE AUSTRIAN DANUBE	**oral**
16:15	16:30	**Kowal Johannes**	University of Natural Resources and Life Sciences, Vienna, Austria	EFFECTS OF CHANGES IN LONGITUDINAL CONNECTIVITY ON POTAMODROMOUS FISH IN THE UPPER DANUBE CATCHMENT	**oral**
16:30	16:33	**Natho Stephanie**	University of Potsdam, Germany	MODELLING NUTRIENT RETENTION UNDER CONSIDERATION OF CURRENT DISCHARGE AND INUNDATION IN THE GERMAN DANUBE	**short oral/Poster P4-1**
16:33	16:36	**Novaković Boris**	Ministry of Environmental Protection of the Republic of Serbia	EFFECTS OF PESTICIDES TO BENTHIC INVERTEBRATE COMMUNITY IN THE SERBIAN DANUBE STRETCH USING THE SPEAR INDEX	**short oral/Poster P4-2**
16:36	16:39	**Nezbrytska Inna**	National Academy of Sciences, Institute of Hydrobiology, Ukraine	ALTERATIONS IN THE ALGAL DIVERSITY TO BE USED AS AN INDICATOR OF THE FORTY-YEAR TRANSFORMATION OF THE HYDROLOGICAL REGIME OF THE SASYK ESTUARY TO THE RESERVOIR (THE DANUBE RIVER BASIN)	**short oral/Poster P4-3**
16:39	16:42	**Novković Maja**	University of Novi Sad, Serbia	FLY, FLY BIRDIE: TOWARDS A UAV ASSISTED MONITORING OF AQUATIC MACROPHYTES WITHIN LARGE RIVERS	**short oral/Poster P4-4**
16:42	**17:15**	**Poster Session Day 4**			
17:15	**17:45**	**Closing Session**			

- PROGRAM DAY 1 -

POLLUTION, GLOBAL CHANGE AND HEALTH

Keynote lecture:

CHEMICAL POLLUTION STATUS OF THE DANUBE RIVER

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According to the WFD, priority substances causing failure to achieve good chemical status and River Basin Specific Pollutants (RBSPs) adversely impacting ecological status of water bodies should be monitored and eventually phased-out from the environment. This presentation provides an overview on outcomes of four Joint Danube Surveys (JDS), which have been carried out by the International Commission for the Protection of the Danube (ICPDR) in six years intervals since 2001 to improve the knowledge on chemical pollution in the Danube River Basin (DRB).

Compared to, at that time, the state-of-the-art screening of ca. 100 chemical pollutants in the JDS1 (2001), an extensive screening of JDS4 (2019) surface water, sediment, biota, waste water and ground water samples has been performed with target analytical techniques, focused on the determination of legacy pollutants, and novel wide-scope target (>2,600 substances) and suspect (>65,000 substances) screening methodologies. The results have shown that only a handful of legacy substances were posing a threat to Danube fauna and flora. Hundreds of chemicals detected in the samples were prioritised and several tens of candidate Danube RBSPs were proposed. This list had been used as a valuable contribution for update of Watch List substances at the EU level. Suspect screening demonstrated its feasibility to reveal the presence of toxic substances and their transformation products, which would otherwise stay unnoticed. The raw data with mass spectra ('chemical fingerprints') of all detected pollutants stay stored for future retrospective screening, without the need for additional investments in sampling and analysis campaigns.

Screening of waste water effluent samples indicated that inefficient treatment in WWTPs across the basin is among the main sources of DRB chemical pollution. Effect-based monitoring tools have been used for measurements of toxicity effects of mixtures of chemicals and effectiveness of their use was demonstrated for wastewater and more polluted surface water samples. The screening methodology, as proposed by the NORMAN Association and Water Europe, was tested with the JDS4 data and used as an important input for the revision of the Urban Waste Water Treatment Directive (UWWTD; COM(2022) 541 final, recast). Passive sampling results have shown that the spatial variability of investigated hydrophobic priority substances in surface water of the Danube is low. Similarly, pollutants in ground water bodies, connected to the surface water via bank filtration, did not exceed regulatory toxicity threshold values.

The novel monitoring techniques are vastly superior compared to traditional target monitoring of a few legacy substances and provide both 'early-warning' and 'safety net' signals needed for a holistic chemicals management in support to the EU 'zero-pollution policy'. The traditional monitoring applied in compliance with the current environmental legislation does not sufficiently protect the Danube ecosystem. Fully harmonised screening methodologies have been used for monitoring of the Black Sea impacted by the Danube river discharge and the first list of Black Sea Specific Contaminants has been proposed.

JOINT DANUBE SURVEY 1 TO 4: CONCEPTS, LESSONS LEARNED AND FUTURE VISIONS ON FAECAL POLLUTION AND ANTIMICROBIAL RESISTANCE

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Sustainable and target-oriented microbiological water quality management of rivers needs information on whole river systems, especially if catchments are large and international. The microbiological water quality of rivers is of uttermost relevance for human health as river water is used for several purposes (recreation, drinking water production, irrigation). Besides information on faecal pollution levels, the origin of faecal pollution and the assessment of associated infection- and health risks, e g. from antimicrobial resistant bacteria (ARB) are of increasing importance. This contribution summarizes the concepts and main results from the Joint-Danube-Surveys (JDS) and discusses future challenges and perspectives (pollution-scenario modelling, infection-risk assessment) for the Danube River concerning its faecal and AMR pollution status.

Between 2001 and 2019, the whole Danube was sampled four times during the JDS 1 to 4. Beside standard faecal indicator analysis, cutting-edge molecular detection concepts were applied, including microbial source tracking (MST) markers by quantitative PCR (qPCR) and high-throughput amplicon-sequencing of bacterial communities. For AMR-profiling, clinically relevant bacterial species were isolated and tested for resistances and resistance genes were determined via qPCR.

With this, we could impressively demonstrate that the JDS create the required multi-national “big picture” of the microbiological pollution status of the Danube River. Harmonised trans-border microbiological water quality maps for the whole navigable Danube were established. MST marker analysis elucidated that the main faecal pollution source along the whole river is human wastewater. Combined analysis of faecal indicators, MST and AMR-profiles provided a solid basis for assessing the potential health impacts of AMR associated with faecal pollution.

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A NEW MONITORING DATA DRIVEN APPROACH TO EVALUATE THE IMPACT OF SHIPS ON THE FAECAL POLLUTION LEVEL OF THE DANUBE RIVER IN LOWER AUSTRIA

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A new field-monitoring based approach for evaluation of the contribution of Danube River ships on microbial faecal pollution levels was developed, and primarily implemented in Lower Austria.
The basis of the approach is a multi-parameter water quality monitoring with high spatial and temporal resolution in combination with the development of an adaptive ship data assessment tool. Through the use and combination of water quality data and ship activity data, the approach enables impact evaluation through following applications:
Application 1: Status-quo on the faecal pollution level of the river reach. - The spatially highly resolved multi-parametric water quality monitoring, provides a detailed picture on the faecal pollution status of the river reach. Statistical analysis of concentration differences in longitudinal or cross-sectional river profiles, allow for discovery of anomalies in the pollution patterns.
Application 2: Associations between observed faecal pollution and ship activity. - Different time- and distance-area metrics were established for the assessment of ship activity in regard to the fecal pollution dynamics at the cross-sections. Statistical analysis of the number of vessels and the observed faecal pollution were performed using correlation analysis tools.
Application 3: Faecal impact scenario estimation (pollution potential analysis). - Based on the average daily shipping activity, different impact scenarios are derived. The analysis is performed with respect to ship type, specific wastewater treatment and passenger capacities with seasonal variations.
Additional evaluation of the sensitivity of the approach. - To evaluate the sensitivity of the new approach, a local analysis at ship station is performed, by investigation of the number of ships and the potential increase in faecal pollution at the stations.
The approach was primarily carried for the Danube in Lower Austria and would be applicable, for other rivers worldwide, if the required ship data is available.

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APPLICABILITY OF WASTEWATER BASED EPIDEMIOLOGY IN COUNTRIES WITH POOR WASTEWATER TREATMENT – COVID-19 CASE STUDY IN SERBIA

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Pollution of natural water bodies is one of the biggest challenges in developing countries, such as Serbia, where wastewater is discharged directly into the recipients without proper treatment and poses serious threats to surface water quality, general safety and environmental health. Numerous pathogenic microorganisms, bacteria, viruses, protozoa and helminthes may reach surface waters and eventually contaminate groundwater. Despites its extreme importance in this case, implementation of wastewater-based epidemiology is a challenge for developing countries, as the majority of households are not connected to sewerage systems. Within our research, we have placed major focus on recipients of wastewaters as an alternative of targeting raw wastewater. During the fourth COVID-19 wave in Serbia that started in late February 2021 multiple water samples were collected at 12 sites at Sava and Danube Rivers in the Belgrade city area which are under the impact of untreated wastewaters.

SARS-CoV-2 RNA was quantified using RT-qPCR with primer sets targeting nucleocapsid (N1 and N2) and envelope (E) protein genes. Microbiological (standard fecal indicator bacteria and microbial faecal source tracking markers), epidemiological, physico-chemical and hydro-morphological parameters were analysed in parallel. Out of 44 samples analyzed, 31 were positive for at least one of the target regions of SARS-CoV-2. The results indicated that surveillance of SARS-CoV-2 RNA in surface waters in context with the large amount of epidemiological and environmental metadata can be used as epidemiological early-warning tool in countries with poor wastewater treatment.

TRANSPORT AND REMOVAL OF BACILLUS SUBTILIS ENDOSPORES IN AN ALLUVIAL GRAVEL AQUIFER AT DIFFERENT FLOW RATES AND IMPLICATIONS FOR SETBACK DISTANCES

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Abstract

To assure proper protection from fecally transmitted pathogen infections, drinking water wells should have a sufficiently large setback distance from potential sources of contamination, e.g. a nearby river. The aim of this study was to provide insight with regards to microbial contamination of groundwater under different flow velocities, which can vary over time due to changes in river stage, season or pumping rate. The effects of these changes, and how they affect removal parameters, are not completely understood. In this study, field tracer tests were carried out in a sandy gravel aquifer near Vienna, Austria to evaluate the ability of subsurface media to attenuate *Bacillus subtilis* endospores, which were used as a surrogate for *Cryptosporidium* and *Campylobacter*. The hydraulic gradient, and therefore the flow velocity between the points of injection and extraction, was controlled by changing the pumping rate (1, 10 l/s) of a well at the test site, building upon previously published work in which tracer tests with a 5 l/s pumping rate were carried out at the same site. Attachment and detachment rate coefficients were determined using a HYDRUS-3D model and ranged from 0.12-0.76 and 0-0.0013 hr^{-1}, respectively. Setback distances were calculated based on the 60-day travel time, as well as a quantitative microbial risk assessment (QMRA) approach. These two methods showed similar results at this site; setback distances of around 700 m at the highest pumping rate. Removal rates (λ) in the field tests ranged from 0.2-0.3 log/m, with lower pumping rates leading to higher removal. It was shown that scale must be taken into consideration when determining λ for the calculation of safe setback distances with QMRA, as it has a large effect on the end result.

WHAT IS THE EFFECT OF MUNICIPAL WASTEWATER TREATMENT REGARDING THE REDUCTION OF HYGIENICALLY RELEVANT MICROORGANISMS? – A META STUDY

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Global warming and climate change are leading to an increasing water consumption, which particularly affects agriculture. Consequently, treated wastewater for irrigation of agricultural areas becomes more important. The EU directive 2020/741 sets strict requirements for the microbiological-hygienic quality of treated water used for agricultural purposes. The aim of the present meta study was to give an overview of the concentrations of fecal microorganisms and pathogens along the municipal wastewater pathway to acquire baseline data for possible further treatment steps.

Relevant microorganisms were prioritized by their characteristics, health relevance, geographic abundance, persistence, and resistance. The result was a selection of reference pathogens and fecal indicators. While reference pathogens allow assessment of infection risk, fecal indicators can be used to monitor the effectiveness of water treatment measures. The selection of relevant microorganisms covers bacteria, viruses, as well as protozoa. Data about abundance and concentrations of these microorganisms along the municipal wastewater pathway were reviewed and collected from existing literature.

Literature data revealed considerable variation in concentrations of microorganisms, particularly for pathogens. This is due to the use of different, not directly comparable methods across the different studies, like cultivation based and molecular methods. The sporadic abundance and their highly variable concentrations of pathogens can be explained by the health status of the population in the catchment area of the respective sewage system. In contrast to that, fecal indicators, which are continuously excreted showed considerably less variation in concentrations.

As a conclusion further wastewater treatment steps should be selected on the basis of proper risk assessment and always need to be adapted to the local situation, the intended use of the wastewater, and the available disinfection and treatment technologies.

This is a joint effort within the Interuniversity Cooperation Centre for Water and Health (www.waterandhealth.at). The present study was funded by the Austrian federal ministry of agriculture, forestry, regions and water management, project GZ 8900384.

HEALTH-RELATED INACTIVATION REQUIREMENTS FOR UV-IRRADIATED WASTEWATER EFFLUENTS DISCHARGED INTO RECREATIONAL SURFACE WATER BODIES

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Recreational water users can be exposed to a wide range of pathogens, e.g. *Campylobacter jejuni*, pathogenic *E. coli*, *Giardia lamblia* and norovirus. These pathogens derive from faecal, especially human pollution. Effluents from wastewater treatment plants (WWTP) represent a significant faecal source. WWTP are intended to reduce organic carbon, nitrogen and phosphate preventing the eutrophication of receiving waters, but do not diminish the concentrations of microorganisms sufficiently. Thus, the effluents remain infectious. Disinfection of water serves as most efficient tool to protect human health from infectious diseases. Approved methods include chlorination, ozonation and UV irradiation. Especially for the disinfection of wastewater effluents the application of UV irradiation offers eminent advantages, since no chemicals are used resulting in an environmentally and ecologically compatible disinfection process.

In a first step, we investigated the performance of a UV system installed in a municipal WWTP through a validation process. To investigate the effect of photoreactivation of bacteria (e.g. *E. coli, Vibrio cholera*) we developed a standardized protocol for the on-site investigation of the photoreactivation of bacteria in the effluent samples. The second step consisted of a verification and surveillance phase during four bathing seasons.

The results revealed that *E. coli* and enterococci are too sensitive for the evaluation of the disinfection process. Sizing of wastewater disinfection systems based solely on these parameters leads to a false sense of safety. Somatic coliphages and spores of *C. perfringens*, resembling models for pathogens with higher resistance, have proven appropriate tools for the assessment of disinfected wastewater effluent. Insufficient irradiation leads to photoreactivation of UV irradiated bacteria. Most importantly for a safe disinfection is the validation and control of the operational parameters water flow, UV irradiance, water transmittance and turbidity. In combination with faecal source tracking and risk assessment safe recreational water can be assured.

This is a joint effort within the Interuniversity Cooperation Centre for Water and Health (www.waterandhealth.at) and the UV-Team Austria (www.uv-team-austria.at)

GUIDING FUTURE DEMANDS ON MICROBIAL DRINKING WATER SAFETY MANAGEMENT ALONG A LARGE HUMAN WASTEWATER IMPACTED RIVER: A RISK-BASED MODELLING APPROACH

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Rivers are important for drinking water supply worldwide. However, they are often impacted by fecal pollution from wastewater treatment plants (WWTP) and combined sewer overflows (CSO). The aim of this study was to test an integrative approach for an improved understanding of the effects of future changes and wastewater management measures on the microbiological water quality of rivers considering safe drinking water production. The study area was the Danube catchment upstream of Vienna, Austria. We significantly extended QMRAcatch (v1.0 Python), a probabilistic- deterministic model that combines fate and transport modelling with quantitative microbial infection risk assessment. For the model analysis, we focused on human-specific viruses (enterovirus, norovirus), and, bacterial and protozoan pathogens (*Campylobacter*, *Cryptosporidium*) for cross-comparison. The impact of climatic changes until the period 2035–2049 was investigated by a conceptual semi-distributed hydrological model, based on regional climate model outputs. QMRAcatch was calibrated and validated using site- and source-specific data (human-associated genetic microbial source tracking marker and enterovirus). The study showed that climatic and demographic changes had little impact on the microbiological river water quality considering safe drinking water. Preventing CSOs and installing enhanced treatment at the WWTPs together had the most significant positive effect. While demonstrated here for a large, wastewater-impacted river, the approach is applicable at other catchments and pollution sources. It allows assessing future changes and selecting suitable pollution control measures for long-term water safety planning.

Demeter*, K., Derx*, J., Komma, J., Parajka, J., Schijven, J., Sommer, R., Cervero-Arago, S., Lindner, G., Zoufal-Hruza, C.M., Linke, R., Savio, D., Ixenmaier, S.K., Kirschner, A.K.T., Kromp, H., Blaschke, A.P., Farnleitner, A.H., 2021. Modelling the interplay of future changes and wastewater management measures on the microbiological river water quality considering safe drinking water, Science of the Total Environment 768: 144278, DOI: 10.1016/j.scitotenv.2020.144278

A DANUBE BASIN WIDE INVENTORY OF HAZARDOUS SUBSTANCE CONCENTRATIONS IN SURFACE WATERS AND IN MAIN EMISSION PATHWAYS

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A harmonized data base with concentrations of hazardous substances measured in different environmental compartments is a valuable tool to assess the pollution status of water bodies and soil, to derive input and validation data for emission models like MoRE (Fuchs et al. 2017) and to investigate drivers influencing the extent of pollution.
Within the Interreg Danube Hazard m³c project such a data base was developed and filled with the available monitoring data from the entire Danube river basin, not only from surface water, but also from ground water, municipal and industrial waste water treatment plant (WWTP) influents and effluents, storm water from combined sewer overflow and storm sewer outlets, atmospheric bulk deposition and top soil.
A special focus was put on the collection of extensive metadata necessary for an in-depth investigation and usage in modelling, such as the flow volume and suspended solid concentration during sampling, characteristics of the waste water treatment plants - e.g. connected inhabitants or treatment processes applied - and land use and soil properties at soil sampling locations. The technical implementation was realized in a PostgreSQL data base.
By merging and harmonizing data and metadata collected in different countries, with different methods and under different circumstances and pollution pressures, this joint effort strongly capitalizes on past and ongoing national activities and brings a significant added value to them, showcasing how transnational assessment of hazardous substances pollution and emissions could be carried out operatively in the future.
Based on this inventory of concentrations, we evaluated, for which substances and regions in the basin a sufficient data base is available to estimate emissions and where data gaps need to be filled first.
Exemplarily, preliminary results depict, that per- and polyfluorinated compounds (PFAS) in effluents of WWTP shows significantly higher concentrations in municipal than in industrial waste water for PFOA but not for PFOS, but the data base for industrial effluents is rather small (< 100 samples). When looking at the correlation of the size of municipal WWTPs with the effluent concentration, there is a general trend, that bigger plants show higher effluent concentrations, except for some PFAS, where smaller plants show higher concentrations than medium size plants.

Fuchs, S., M. Kaiser, L. Kiemle, S. Kittlaus, S. Rothvoß, S. Toshovski et al. (2017): Modeling of Regionalized Emissions (MoRE) into Water Bodies: An Open-Source River Basin Management System. Water; 9(4):239.

EUTROPHICATION POTENTIAL OF THE STREAM NETWORK OF THE DANUBE BASIN

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Managing eutrophication is a more complicated task in running waters than in lakes and reservoirs, as travel time and the topology of stream networks modulate system response to nutrient supply. The basic paradigm of lake eutrophication management is to force nutrient limitation of algal biomass by the reduction of nutrient loads. In streams, however, application of this paradigm was apparently unsuccessful in many cases, while it worked in others. Complex catchment modelling revealed that proliferation of phytoplankton in streams required the coincidence of three independent factors: an adequately high nutrient supply, an inoculum of fluvial algae from the upstream environment, and a suitable downstream hydromorphology that provides sufficiently long time for algal growth. Standing water bodies in the stream network do not represent optimal habitat for fluvial algae and may disrupt phytoplankton development along the flow direction. At the same time, algae adapted to standing water conditions flow into the streams and may temporarily determine the trophic status of the downstream network. The application of detailed eutrophication models in large river basins requires immense amounts of data and computational power. We elaborated a novel, extremely simplified stream network eutrophication model that targets to approximately quantify eutrophication potential of rivers in large basins. The model focuses only on the most important drivers of stream eutrophication and its data requirements can be easily covered from global and continental databases. A case study is presented for the Danube Basin.

IN SITU GENOTOXICITY ASSESSMENT IN THE WEIGHT-OF-EVIDENCE APPROACH – THE JOINT DANUBE SURVEY 4 CASE STUDY

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Assessment of impact of pollution in the environmental studies requires multi-endpoints approach to properly link cause and effects of pollution with focus on chemical pollution. In this sense systematic weight-of-evidence approach (WoE) with multiple lines of evidence (LoEs) is preferable to apply. The WoE approach highlights the importance to identify strengths and weaknesses of used LoEs. Therefore, in this study we have tested efficacy of genotoxicological endpoints as one of the LoEs in the *in situ* assessment of pollution effects in the freshwater ecosystems using *Alburnus alburnus* (bleak) as a bioindicator species. Additional LoEs that were used in the study are: component-based methods for the assessment of SumTU in water based on monitoring data of the Serbian Environmental Protection Agency (SEPA), effect based methods employing *in vitro* genotoxicological analyses of Joint Danube Survey 4 (JDS4) water extracts and field derived species inventories for the assessment and indication of ecological status/potential based on SEPA and JDS4 data. The study was conducted within the JDS4 campaign at nine sampling sites at the Tisa, Sava, Velika Morava and Danube rivers in the Republic of Serbia. In the case of three sampling sites, the results were uniform, meaning that all four LoEs pointed to pollution pressure. The differences in the LoEs outcomes for other sites indicated the importance of multiple LoEs approach for proper identification of ecological impact. In the case of current study we have identified comet and micronucleus assay to be appropriate for the genotoxicological assessment in the *in situ* studies due to high sensitivity in discrimination of sites in relation to pollution intensity, while RAPD analysis to be more suitable for controlled *ex situ* investigations.

ENHANCED WARMING AND LONG-TERM PHENOLOGICAL SHIFTS IN MOUNTAINOUS TRIBUTARIES OF THE DANUBE

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Water bodies around the world are currently warming with unprecedented rates since observations started, but warming occurs highly variable among ecoregions. So far, mountain rivers were expected to experience attenuated warming due to cold water input from snow or ice. However, air temperatures in mountain areas are increasing faster than the global average, and therefore warming effects are expected for cold riverine ecosystems.

In decomposing multi-decadal water temperature data of two Central European mountain rivers (Inn and Großache, two high-order tributaries of the Danube) with different discharge and water source regime this work identified so far unreported a) long-term warming trends (with river-size dependent rates between +0.24 and +0.42 °C decade-1), but also b) seasonal shifts with both rivers warming not only during summer, but also in winter months (i.e., up to +0.61 °C decade in November), c) significantly increasing minimum and maximum temperatures (e.g., temperatures in the glacial river no longer reach freezing point since 1996 and maximum temperatures increased at rates between 0.4 and 0.7°C decade-1) and d) an expanding of warm-water periods during recent decades in these ecosystems.

Our results show a substantial warming effect of mountain rivers with significant month-specific warming rates not only during summer but also in winter, suggesting that mountain river phenology continues to change with ongoing atmospheric warming. Further, this work demonstrates that apart from a general warming, also seasonal shifts, changes in extreme temperatures and expanding warm periods will play a role for ecological components of mountain rivers and should be considered in climate change assessments and mitigation management.

THE ABSORBED DOSE RATE OF INTERNAL IRRADIATION OF FISH IN THE WATER BODIES OF THE CHORNOBYL EXCLUSION ZONE AT THE PRESENT STAGE

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As a result of the accident at the Chornobyl nuclear power plant (ChNPP), a large area of Europe (including the Danube countries) was exposed to radionuclide contamination. But the greatest number of radionuclides fell precisely in the Chornobyl Exclusion Zone (ChEZ). When reaching water bodies, radionuclides are involved in biogeochemical cycles and, moving along trophic chains, are accumulated by fish, which is one of the objects of human nutrition. The main objects of the study were fish species that differ in the type of nutrition, which were selected from the floodplains of the Pripyat River. Reservoirs (of varying degrees of radionuclide contamination) are located on the territory of the Chornobyl Biosphere Reserve in the ChEZ. The paper presents the results of calculating the power of the total absorbed dose from external and internal irradiation of fish due to ^{90}Sr and ^{137}Cs as of 2021. The value of the average annual radiation dose rate was determined using the ERICA Assessment Tool 1.0 software in μGy/h. The highest total dose load on fish was recorded for the Vershyna Lake – 56.2 (sunbleak)–161.5 (Prussian carp) μGy/h, slightly lower values were registered for fish from Azbuchyn Lake and Hlyboke Lake, Yanivskyi backwater of the Pripyat River and the ChNPP Cooling Pond – respectively, 32.7 (sunbleak) –111.3 (tench); 15.3 (sunbleak) – 90.4 (tench); 2.3 (bleak) – 12.2 (tench) and 6.0 (bleak) – 19.3 (Prussian carp) μGy/h, and the smallest – for fish in the channel section of the Pripyat River – 0.070 (bleak) – 0.123(tench)μGy/h.

Thus, the highest levels of dose load from general exposure are received by demersal species of fish - tench and Prussian carp, and the lowest by pelagic ones: sunbleak and bleak. It should be noted that, in contrast to the external exposure of fish by ChEZ, formed primarily by ^{137}Cs, the internal power of the absorbed dose is caused mainly by ^{90}Sr incorporated in the tissues. ^{137}Cs plays a dominant role in shaping the power of the total dose of exposure to fish in most of the studied ponds of the ChEZ. The only exception is the Vershyna Lake. In Vershyna Lake, due to an abnormally high internal dose (formed under the influence of radiation incorporated in the bone tissues of fish ^{90}Sr), radionuclide ^{90}Sr is dominant even for the total dose of fish irradiation. The registered total power of the absorbed dose for fish of the ChEZ significantly exceeds the screening dose of 2 μGy/h. For most of the fish from the lakes of the ChEZ, the limit dose load level of 40 μGy/h, recommended by the UN Scientific Committee on the Effects of Atomic Radiation and the International Commission on Radiological Protection for Vertebrate Animals, was also exceeded.

ISOLATION OF MICROPLASTICS FROM FRESHWATER ASIAN CLAMS CORBICULA FLUMINEA (MÜLLER, 1774) IN THE DANUBE RIVER

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During the Joint Danube Survey 4 in 2019, we investigated plastic debris in Danube River, from Germany to the Black Sea (more than 2,000 km of the river stretch). The main aim of the study was to categorize and to quantify microplastic particles in living systems. Freshwater Asian clams *Corbicula fluminea* (Müller, 1774) was used as test organism. Individuals were collected from 23 sites using a hand net (ap. 25 cm× 25 cm, mesh size 500 µm). In order to isolate plastic particles, the samples were digested by alkaline method, using a KOH 10% solution and incubation at 65 ^{o}C for 12 h. The digested samples were filtrated through a glass microfiber filters, with 0.5 µm mesh size. Collected particles were photographed and categorized based on the size and coloration. Particles were counted manually, photographed using Nikon SMZ 745T Stereomicroscope and measured in program ImageJ. In 216 examined specimens a total of 1,998 microplastic particles were isolated with an average of 5.59 ± 3.71 fibrils and 4.37 ± 2.46 fragments per organism; or 40.77 ± 73.75 fibrils and 25.84 ± 33.17 fragments per g body weight. Dominant microplastic particles were between 0.4 and 0.5 mm in diameter (characterized as medium-sized), with an average length 0.43 mm ± 0.26 in the Danube and 0.49 mm ± 0.26 in the tributaries. In order to confirm chemical composition of isolated microliter, 46 particles of the hard plastic from 14 sampling sites were analyzed using Nicolet iN10 Fourier transform infrared microscope with micro ATR accessory and cooled MCT detector, using 128 scans at resolution of 4 cm^{1}. Analyses revealed presence of five different types of polymers, with the domination of polyethylene-terephthalate.

PRELIMINARY ASSESSMENT OF CONTAMINANTS FROM KILIA BRANCH OF THE DANUBE TO THE BLACK SEA

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The Danube River accounts for more than 60% of the river's inflow into the Black Sea, and more than 35% of the inflow of all freshwaters into it, including precipitation. On average, the Danube annually brings about 200 km^3 of water to the sea. The Kilia branch is separated from the Danube in the Reni area. In 1990, 70% of the Danube water entered the Kilia Branch, in 1957 – 62.5%, in 1985 – 58.7%, and in 1999 – only 55.6%. Thus, the trend determines a sensitive decrease in runoff by an average of 0.173% per year during the 20th century. Calculations for 2005, 2010 and 2015 show the share of the runoff of the Kiliya branch, equal to 51.2%, 49.8% and 48.3% of the total flow of the Danube respectively.

Long-term monitoring of the Danube seaside showed that annually from the Kilia branch to the Black Sea on average come the following amounts of dissolved form of heavy metals: 289.06 kg of copper, 692.39 kg of zinc, 142.03 kg of nickel and 26.68 kg of cadmium, and in suspended form 780.13 kg of copper, 2306.15 kg of zinc, 526.18 kg of nickel and 37.44 kg of cadmium.

Due to its high water content, the Danube has a noticeable impact on the entire northwestern part of the Black Sea. In the Odessa region of the Black Sea, mercury was found at 70% of the stations. The average mercury content here was 2.20 ± 0.05 $\mu g \cdot g^{-1}$ dw, the range was 0.00–0.69 $\mu g \cdot g^{-1}$ dw. Since the total discharge of mercury from local sources (treatment facilities in Odessa, Chornomorsk and Pivdenyi, as well as drainage water in Odessa) is only 31.6 g per year, it is obvious that mercury was brought to the Odessa region of the Black Sea from the Danube.

SURVEILLANCE OF ANTIBIOTIC RESISTANCE GENES IN AUSTRIAN WASTEWATER TREATMENT PLANTS WITHIN THE DANUBE RIVER BASIN

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Antimicrobial resistance (AMR) is one of the major global public health threats nowadays. The urgent need for harmonized AMR surveillance in the context of a One Health approach that also includes environmental compartments has been increasingly recognized. In order to tackle future challenges, it is crucial to reduce AMR spreading over ecosystem boundaries. In this respect, wastewater treatment plants (WWTPs) are of special interest as they can facilitate AMR spread but also act as a barrier to reduce the environmental release of anthropogenic AMR.

In this study, we therefore performed a comprehensive surveillance of selected antibiotic resistance genes (ARGs) in 17 different wastewater treatment plants (WWTPs) within the Austrian Danube River Basin. Besides influent samples, we also included effluents of 9 WWTPs to study the reduction of ARGs during the treatment process. We investigated WWTPs of different sizes all over Austria discharging either directly into the Danube or indirectly via one of its many tributaries. In addition to a spatially well-resolved surveillance approach, we also conducted several temporal monitoring campaigns. Quantitative analysis of selected ARGs (*sul1*, *ermB*, *vanA*, *tetW*, *npt2*, *npt3* und $bla_{\text{TEM-1}}$) by qPCR were complemented by high-throughput gene profiling analysis (Resistomap) to obtain a broader overview of the presence and abundance of ARGs, integrons and mobile genetic elements (MGEs).

Preliminary results of the qPCR analysis showed that all of the seven selected ARGs could be detected in the studied WWTPs. The ARGs *sul1* and *ermB* and *tetW* were detected most frequently, *vanA* and *npt3* least frequently. The reduction of ARG concentrations between influent and effluent of the considered WWTPs was up to 4.5 LOG levels. In the high-throughput gene profiling analysis, ARGs referring resistance to the antibiotic classes of beta-lactams and tetracyclines as well as MGEs were most frequently detected.

THE DANUBE´S WATER AND BIOFILMS: ANTIMICROBIAL RESISTANCE IN THE ENTEROBACTERIACEAE POPULATIONS

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Human induced antibiotic resistant bacteria (ARB) are not only found in clinical surroundings: large rivers are of great concern as regards their spreading. This ongoing study´s aim is to analyse the major propagation pathways and sources of ARB in the Danube, and to compare the results with data obtained in 2013. *Escherichia coli* and *Klebsiella* spp. isolated during the 4th Joint Danube Survey (2019) were tested for their antibiotic susceptibility. 22.24% of 1700 *E. coli* were resistant and 12.35% were multiresistant. 15.23 % of 696 *Klebsiella* spp. were resistant and 1.15% were multiresistant. In comparison the data of 2013 and 2019 of both Enterobacteriaceae showed that the wild type is still predominant. There were significant increases especially to fluoroquinolones and augmentin and a significant decrease of resistances to tetracycline. However, the data of JDS4 showed a significant difference between *E. coli* and *Klebsiella* spp. regarding wild type, resistance and multiresistance. Additionally, data of 1155 *E. coli* showed no seasonal trends in Austria during an annual sampling. The comparison of *E. coli* from biofilms and corresponding water samples revealed several significant differences between the compartments. In conclusion, the preliminary data of *E. coli* from biofilm samples suggest that the biofilm as a stable colonization within waters reflects especially the long term situation. Thus, the stabilizing and destabilizing effects acting on ARG within the biofilm need to be researched in greater detail. Significant differences between the closely related Enterobacteriaceae species seem to point out the dilemma of *E. coli* as a solely model organism for environmental long term effects. *Klebsiella* spp. and their associated ARGs are facing a different selective pressure when encountering the native environmental populations. Finally, the results of the annual sampling campaign suggest that single environmental differences have a higher impact than seasonal events.

OCCURRENCE OF ANTIBIOTIC RESISTANCE GENES ALONG GRADIENTS OF FAECAL POLLUTION IN WATER AND BIOFILM SAMPLES FROM THE WHOLE DANUBE RIVER

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Antimicrobial resistance (AMR) represents one of the top ten global public health threats according to the WHO. The spread of resistances is no longer limited to clinical settings and the natural environment, especially aquatic ecosystems, are also strongly involved in the global spread. Holistic as well as quantitative studies are still scarce. We here present for the first time a large scale study on the Danube River regarding the distribution of AMR along different faecal pollution patterns.

For this study, samples from an international sampling campaign (Joint Danube Survey 4) as well as additional seasonal samples were screened for the occurrence and origin of faecal pollution and for the concentrations of nine representative antibiotic resistance genes (ARGs). In addition to water samples also river biofilms were monitored to account for both, temporal and permanent river habitats. Analyses were amended by a set of different cultivation-based and non-cultivation-based microbiological and environmental data to explain the observed pattern in faecal pollution and ARG concentrations.

Faecal pollution exists and varied strongly along the whole Danube river; hotspots could be identified downstream of metropolitan areas at which also substantial concentrations of ARGs could be detected. Quantifying concentrations of ARGs conferring resistance to different antibiotic classes revealed strong differences between the different genes. Comparing their presence in water and biofilm samples, allowed to assess how stably present these genes already are in the Danube River ecosystem.

Environmental surveys are necessary to establish environmental baselines, to be able to guide future AMR monitoring as well as to enforce useful management strategies. This integrative study therefore provides first insights in the antimicrobial resistance situation in the most international river in the world and second largest river in Europe.

IMPACT OF FLOODING ON ANTIBIOTIC RESISTANCE GENE CONCENTRATIONS IN SOILS OF THE DONAU-AUEN NATIONAL PARK

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The spread of antimicrobial resistance (AMR) over ecosystem boundaries has become a global health concern for individual and public health. The environmental resistome has been identified as source and sink for clinically relevant antibiotic resistance genes (ARGs). The goal of the presented study was to analyse the impact of a flooding event on the naturally occurring background levels of clinically relevant antibiotic resistance genes in the soils of the Donau-Auen National Park.

Samples were taken before and after a heavy rainfall and associated flooding event in the Donau-Auen National Park. For each sampling time point, 26 different ARGs were quantified by TaqMan qPCR. Additionally, a *16S rRNA* gene microbiome analysis was performed to characterize the bacterial soil community at several locations in the Park.

Flooding by water from the river Danube increased the concentration and prevalence of 8 ARGs (*aph(3')-IIIa*, *blaOXA-10*, *ermB*, *qacEdelta1*, *sat-4*, *sul1*, *tet(W)* and *vanA*) and the mobile genetic element (MGE) *ISPps* in the investigated soil samples. Especially the sulfonamide resistance gene *sul1* was detected at extremely elevated concentrations after flooding, with a 117 – 2,893-fold increase compared to the values observed before the rainfall. However, 3 ARG targets (*intl1*, *cmxA* and bla_{TEM-1}) as well as the *16S rRNA* gene didn't show significant deviations compared to naturally occurring baseline levels before flooding.

Certain taxa occurred more (*e.g. Bacillota*, formerly *Firmicutes*) or less often (*e.g. Pseudomonadota, Acidobacteriota*) in the impacted samples compared to the control samples.

The gathered soil data will be extended by ARG analysis drawn from Danube water samples.

This research scrutinizes how the naturally occurring ARG background of a region with presumably little human impact such as the Donau-Auen National Park is contaminated by the Danube River if a flooding and heavy rain event occurs.

OCCURRENCE OF ANTIBIOTIC RESISTANT GENES IN TWO TRIBUTARIES OF THE DANUBE ALONG DIFFERENT ENVIRONMENTAL GRADIENTS

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Antibiotic-resistant bacteria (ARBs) as well as antibiotic resistance genes (ARGs) have become increasingly important in recent years. In particular, the spread and occurrence in the environment should not be ignored. ARBs and ARGs can enterour surface waters by different routes, with wastewater treatment plants (WWTPs) and agriculture being important entry paths. From the Danube, as the second longest river in Europe, there are already some studies in this respect. However, the situation in its tributaries is not well understood yet. The aim of this research was to investigate ARG concentrations at several locations following different environmental gradients along two rivers in Lower Austria discharging indirectly (Liesing) and directly (Schwechat) into the Danube River. In the course of this research, water and biofilm samples of the two streams were sampled both in winter and summer. Environmental gradients which were studied included different levels of biodiversity, influence of agriculture or WWTPs, inhabited and uninhabited areas etc.. High-throughput gene profiling analysis (Resistomap) were conducted to obtain a comprehensive overview of the presence and abundance of antibiotic resistance genes, integrons and mobile genetic elements in the investigated tributaries. Additionally, selected ARGs were quantified by qPCR (*sul1*, *ermB*, *vanA*, *tetW*, *npt2*, *npt3* und *bla*$_{\text{TEM-1}}$) and related to the mentioned gradients and also in seasonal aspects. Biodiversity was assessed by amplicon sequencing of the 16S rRNA gene, which also provided valuable insights into the composition of the bacterial biocenoses. From preliminary results we can already see that e.g. sampling sites located directly downstream of a WWTP usually have higher concentrations of ARGs compared to the sampling sites upstream. At the conference, we want to go into more detail. It is planned that the data will be extensively statistically analyzed to identify relationships of measured ARG profiles, abundances, and concentrations with various environmental gradients.

ANTIBIOTIC RESISTANCE OF *ESCHERICHIA COLI* ISOLATED FROM WATER AND BIOFILM SAMPLES OF THE KAMP RIVER

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Microbiological contamination, e.g. with antibiotic resistant bacteria, of rivers can pose a threat to human health as river water is used for diverse human applications (e.g. drinking water production, recreation and irrigation). Bacterial input into the river environment is mainly caused by different effluents (e.g. wastewater treatment) and run-offs (e.g. agriculture, storm water). The Kamp River is a tributary of the Danube River in Lower Austria, with an average discharge of 8.9 m3/s and a catchment area of 1750 km2. The origin of the Kamp River is at the Upper Austrian / Lower Austrian border. After approximately 153 km of a partly dammed and naturally meandering course, receiving the treated wastewater of approximately 50 treatment plants with in total 150.000 population equivalents (PE) including two hospitals, the river enters the Danube River at Altenwörth (rkm 1980).
To assess the acquired antibiotic resistance rates in the river with respect to human health, *Escherichia coli* as model organism was isolated from water and submerged biofilm samples. Alongside the river course, samples were taken downstream of a small wastewater treatment plant (WWTP, 1.600 PE), downstream of one WWTP receiving hospital wastewater (40.000 PE) and upstream and downstream of a WWTP without hospital wastewater (55.000 PE).
In total, 989 water isolates and 904 biofilm isolates were phenotypically tested against 20 antibiotics out of seven antibiotic classes (aminoglycosides, beta-lactams, chinolones, chloramphenicol, folic acid antagonists, polymyxins and tetracyclines) according to EUCAST criteria 2020. First results indicate that isolates from water have a slightly higher resistance rate in comparison to biofilm isolates, independent from the sampling site and local influences. The most common detected resistance in both sample sets was to beta-lactam antibiotics, an antibiotic class frequently used in human therapy in Austria. Additionally, isolates showing multiple beta-lactam resistances were screened if they are already producing extended-spectrum beta-lactamases, a resistance mechanism against modern beta-lactams with high clinical impact.

HIGH LEVELS OF TOTAL SUSPENDED SOLIDS IN DANUBE FLOOD WATER SAMPLES AS A FACTOR FOR REDUCED DNA EXTRACTION EFFICIENCY AND POTENTIAL BIAS IN MOLECULAR DETECTION APPROACHES

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Molecular methods such as quantitative PCR (qPCR) are increasingly used for faecal pollution diagnostics and microbial source tracking (MST) in environmental waters. However, the basis of any molecular investigation is an efficient DNA extraction step from the very often complex sample matrix. In the present study, we investigated the effect of total suspended solids (TSS) on the DNA extraction efficiency of samples from the Danube River. TSS describe inorganic particles stirred up from the bottom of the river and particles flushed into the water stream from run-offs. These often carry charges on their surface providing potential binding sites for DNA molecules during the process of DNA extraction and thereby reducing DNA yields.

To evaluate the effect of TSS on DNA extractability, TSS enriched samples containing 9 - 1000 mg sediment L^{-1} water were prepared and spiked with known concentrations of an in-house prepared sample process control (10^6 cells of an *E. coli* strain carrying an artificially designed sequence). DNA was extracted using a standard protocol based on bead beating and phenol-chloroform. Moreover, we tested a modified DNA extraction protocol using salmon sperm DNA as an additive to improve DNA extraction efficiency. Results showed that sediment concentrations of 300 mg sediment L^{-1} and above, drastically decreased the amount of recovered DNA (1.6 to 3 orders of magnitude). The addition of salmon sperm DNA (≥ 5 mg per g TSS), however, was able to restore DNA yields to control levels by potentially blocking charged surfaces before cell lysis.

In conclusion, the present study shows that TSS in water samples can severely affect DNA retrieval, potentially introducing a bias in the results from molecular detection methods. Such matrix effects can have severe implications not only for qPCR-based faecal pollution diagnostics but also for antibiotic resistance gene surveillance and next generation sequencing approaches.

WETLAND DYNAMICS OF LAKE NEUSIEDL AND SODA PANS MEASURED BY USING HIGH RESOLUTION PROBES

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A network system of online-measurement of water quality for the water bodies Lake Neusiedl and soda pans has been installed in 2017 (Austria, Burgenland), recording raw data at a three-minute time interval. Peak values and the range between maximum-minimum values on a daily basis on the one hand and the annual development of daily means with seasons over years on the other hand are used to identify abiotic stress by natural environment most relevant for the inhabiting biota. Daily high-resolution data are used to identify environmental stress throughout the dial cycle as exemplified for the day-night time range of temperature on surface water of the soda pan. The seasonal changes tracked by daily means illustrate the high intra- annual temperature dynamic, as e.g., shown for soda pan Unterer Stinkersee controlled by the water level. Finally, an annual cycle of inverse development of water level and conductivity in Lake Neusiedl underpins the vulnerability of this soda lake against temperature in extreme warm years. In this poster presentation we provide just a few examples on tracking habitat change, which are relevant for the wetland district Seewinkel due to recent impact of global warming.

IMPACT OF WASTEWATER DISCHARGES ON FATTY ACID PROFILE OF ROACH (*RUTILUS RUTILUS*) FROM DANUBE RIVER, BELGRADE

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Pollution of freshwater ecosystems by discharges of untreated municipal wastewater represents a major threat for aquatic organisms and thus human health. Serbia discharges wastewater without previous treatment. In recent years, studies have shown that fatty acids are sensitive to alterations in organism homeostasis, supporting their use for biomarkers of toxicant exposure. Fish species are an important source of biologically valuable proteins, fats, fat-soluble vitamins, and n-3polyunsaturated fatty acids. The purpose of this study was to investigate the diferences of fatty acid composition in fish from urban sites of the Danube River. A total number of eight specimens of roach (*Rutilus rutilus*) were collected from two localities - Višnjica, which is exposed to the discharge of the largest wastewater collector in the city of Belgrade and Veliko Ratno Ostrvo, which is at the confluence of Danube and Sava River, and is considered as control location. Fatty acid methyl esters (FAMEs) were analyzed using gas chromatography–mass spectrometry (GC-MS). A total of 28 fatty acids were found in the muscle tissue of the studied fish species. The results showed no significant differences in fatty acid profile between polluted and control localities. All examined fish species contained essential fatty acids (EPA, ALA, DHA) with DHA levels significantly higher in specimens from control site. The proportion of total saturated fatty acids (SFAs) and monounsaturated fatty acids (MUFAs) was almost the same while polyunsaturated fatty acids (PUFAs) were higher in control specimens. It is shown by previous studies that the main reason of changes in PUFAs is that they could be oxidized under oxidative stress conditions induced by metals or organic compounds. Even though anthropogenic load exerted on Višnjica locality has not significantly affected the fish fatty acid profile, changes in PUFAs indicated the presence of some xenobiotics in their environment.

COMPREHENSIVE ESTIMATION OF HEAVY METALS CONTAMINATION OF ECOSYSTEMS OF SMALL RIVERS FROM WESTERN PODILLYA (DNIESTER RIVER BASIN, UKRAINE)

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It was investigated the content of heavy metals (iron, cobalt, manganese, zinc, copper) in water, bottom sediments, liver, and gills of freshwater fish (carp, crucian carp, pike, perch) from small rivers of Western Podillia (Seret, Strypa, Zolota Lypa). These rivers differ in the nature of anthropogenic influence. Therefore, Zolota Lypa river is an urban-loaded zone, while Seret is an agriculturally loaded zone, and Strypa is a conditionally clean zone. High concentrations of iron and manganese were found in the water and bottom sediments of rivers, which is due to the supply of these metals from bottom sediments under conditions of oxygen deficiency. The high content of the mobile form of iron, cobalt, and manganese in the bottom sediments of Zolota Lypa river can lead to secondary pollution of the water column and pose a potential danger to hydrobionts. Individual mechanisms of accumulation and distribution in the body of fish were established for various metals. Higher concentrations of iron, manganese, and zinc in the liver and gills of the studied fish species, and significantly lower concentrations of cobalt and copper were noted. The content of metals in fish tissues was characterized by high variability and had pronounced tissue and species specificity. The analysis of correlations between the content of metals in water, bottom sediments and fish tissues from small rivers of Western Podillya showed positive values of Pearson correlation coefficients (r) between the content of the gross form of iron in bottom sediments and gills of crucian carp, perch and pike, liver of perch and pike (r=0.7-0.96). The concentration of manganese in the water was positively correlated with the content of the metal in the gills of carp and pike. The increase in the amount of zinc in bottom sediments led to its accumulation in the gills of all fish species, as well as in the liver of perch and pike, as evidenced by high positive values of Pearson's coefficients (r=0.71–0.91). Copper content in water and bottom sediments (gross form) correlated with their amount in the liver of perch and pike (r=0.67-0.97). The obtained indicators can be used for bioindication of contamination of water ecosystems with metals.

DIFFERENCE IN ELEMENT ACCUMULATION AND HISTOPATHOLOGY OF PONTIC SHAD (*ALOSA IMMACULATA*) MIGRANTS CAUGHT IN THE DANUBE RIVER IN INTERVAL OF ONE DECADE

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Pontic shad (*Alosa immaculata*) is an anadromous species that lives in the Black Sea and Sea of Azov and migrates into the Danube, Don and other rivers to spawn. It is still economically important fish species in the Danube River. As the North-Western part of the Black Sea is heavily polluted investigation was performed to determine heavy metal and element accumulation in muscle tissue of Pontic shad as well as to record the level of histopathological changes. Pontic shad specimens were caught on 863 river kilometer of the Danube and the first investigation was performed during 2007 and repeated one decade later in the period 2017-2019.

Element analysis was performed by inductively-coupled plasma – optic emission spectroscopy (ICP-OES). In both sampling periods, only concentrations of arsenic (As), copper (Cu), iron (Fe), magnesium (Mg), strontium (Sr), and zinc (Zn) were above detection limit. Higher concentrations of As, Cu, and Zn were detected in 2007, while higher concentrations of Fe, Mg, and Sr were measured in 2019. Differences in concentrations of these elements, between sampling periods, were statistically significant.

The gills of sampled fish were assessed using histopathology as a marker of general fish health state, using semi-quantitative scoring system. The histopathological results revealed different pattern of histopathological alterations in the gills of fish sampled during two distinct time periods. According to the method used, there were no difference in total gill histopathological index, but alterations were specific for fish sampled at two time points. Hyperemia and hyperplasia of respiratory epithelium dominated in fish sampled at the year 2007, while necrosis of branchial tissue prevailed in fish sampled a decade later.

UPSCALING THE FATE AND TRANSPORT OF BACILLUS SUBTILIS ENDOSPORES AND COLIPHAGE PHIX174 IN HETEROGENEOUS POROUS MEDIA FROM THE COLUMN TO THE FIELD SCALE

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Groundwater contamination and transport of viruses and bacteria in aquifers are a worldwide concern. To assess the ability of aquifers to remove these pathogens, tracer tests with microbial surrogates are carried out. These tests are laborious and may require special permits, and therefore, column tests are often carried out instead. Unfortunately, results from column tests tend to grossly overestimate removal rates when compared to the field scale, which can lead to an underestimation of groundwater contamination risks. Scale is an important consideration when examining pathogen transport through porous media, as pathogen removal is rarely a linear process. In this study, field tests were carried out with endospores of *Bacillus subtilis* and coliphage phiX174 over a distance of 25 m in an alluvial aquifer near Vienna, Austria. The sandy gravel material from the field site was also used in column tests with the same tracers, as a comparison. Both attachment-detachment and colloid filtration theory were used to model these tests, as well as log-removal rates per meter. The results show that the spatial removal rate (log/m) is approximately 2 orders of magnitude higher on the column scale, when compared to the field. A comparison with the literature on field and column scale removal rates showed a correlation between the heterogeneity of the porous media and the difference in removal rates between the column and field scale. This comparison implies that porous media structure influences upscaling more than the type of microbial tracer.

DISPROPORTIONAL VULNERABILITY AND DIFFERENTIAL RESPONSE WITHIN AQUATIC INVERTEBRATE COMMUNITIES IN MOUNTAINOUS HEADWATERS OF THE DANUBE

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Mountain freshwater communities are generally considered very sensible to accelerated climatic changes in these ecoregions, while the degree of the vulnerability of these communities – and differences among taxonomic groups and within mountain ecoregions - have not been evaluated. Yet, individual species or species groups are expected to cope differently with changes due to their different adaptations and traits, but this has not yet been distinguished. In this work, we used the climate change vulnerability scores (ccvs) of European Ephemeroptera, Plecoptera, and Trichoptera (EPT) species (n=1940) to (i) compare the vulnerability between species pools of different ecoregions including Alpine species and Alpine endemics, (ii) contrast the vulnerability of different insect orders Ephemeroptera, Plecoptera, and Trichoptera, and (iii) assess the relationship between vulnerability and altitude within mountain regions.

We revealed 50 Alpine Plecoptera and Trichoptera species being categorized as highly vulnerable to climate change effects (31% of all highly vulnerable European species are Alpine species) with highest proportions in species inventories of Alpine endemics and high-altitude waters (51 % of high-altitude species are classified as highly vulnerable).

The mountain-specific analysis of the climate-change vulnerability score (ccvs, www.freshwaterecology.info) demonstrates that climate change will affect a disproportionally high number of Alpine species and Alpine endemics in particular and reveals a better potential of Ephemeroptera for the expected changes than Plecoptera and Trichoptera. Generally, this trait-based evaluation indicates disproportional restructurings of mountain stream invertebrate communities as response to climate change effects due to higher ratios of potentially vulnerable species.

BIOACCUMULATION OF HEAVY METALS IN COMMON REED (*PHRAGMITES AUSTRALIS*) IN GORGOVA - UZLINA DEPRESSION, DANUBE DELTA

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Heavy metal contamination of aquatic ecosystems directly threatens the health, production and biodiversity of aquatic and surrounding terrestrial ecosystems, and it represents a serious global problem. Aquatic macrophythes have a major role in absorption and accumulation of heavy metals and thereby in natural water purification. In the present study, we analysed the concentrations of $CaCO_3$, TOC, Fe_2O_3, minor components (MnO) but also of some elements (metals) with genetic significance - Rb, Sr, Zr or toxic and potentially affected by anthropogenic influences - Cu, Pb, Zn, Cr, Ni, As and Hg from sediments and from *Phragmites australis* plants, in the ecosystems of the Danube Delta lakes. The aims of the study were to define chemical properties of the Danube Delta lakes, determine the concentrations of heavy metals in different plant organs and assess the phytoremediation potential of *P. australis* based on bioaccumulation and translocation factors. We have analysed 125 sediment samples and 188 reed samples (roots, rhizomes, stems and leaves) from Gorgova - Uzlina Depression area. The highest amounts of almost all metals investigated in plants from all analysed ecosystems were found in the roots, their concentrations being positively correlated with the quantities of their forms available in the corresponding sediment. Much higher concentrations of metal in the roots compared to other organs of the plant clearly indicate that the metals were strongly sequestered in the cortical tissues of the root and were not transferred through the endoderm. Overall, the presence of the largest amounts of metals in the roots, the high bioaccumulation factor and the low translocation factor show that *P. australis* is an excluding plant species with a good phytostabilization potential. This work was carried out as partof the project "Analysis of the potential for sustainable use of vegetation specific to the Danube-Delta system Danube-Black Sea - D3MN" POC/78/1/2.

METALS IN THE WATER OF THE KILIYA DANUBE DELTA IN MODERN CONDITIONS: CONCENTRATION, SPECIATION, LABILITY AND BIOAVAILABLE

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Metals significantly affect the state of the natural water environment, the development and activity of hydrobionts. The toxicity of metals depends significantly on their species in the aquatic environment. Metals can be in a dissolved state and in the composition of colloidal and suspended particles. The labile fraction of metals includes free (hydrated) ions, hydroxocomplexes, and weakly stable complexes with inorganic and organic ligands. They are considered the most toxic and bioavailable. The maximum concentrations of metals in the water of the Kiliya Danube Delta were observed in the second half of the 80s and early 90s of the last century. The content of Fe, Mn, Cu, and Cr in 2012–2013 decreased somewhat compared to the 1980s and 1990s. The concentration of dissolved Al, Fe, Mn, Cu, and Cr during this period fluctuated in the range of 24–95, 35–230, 1.9–21.5, 5.5–55.7, and 4.3–21.5 μg/L. Their concentration in the spring-autumn period of 2018–2021 was already in the range of 2.6–69, 61–575, 6.6–266, 3.2–12.5, and 2.0–50 μg/L. Thus, we again observe a tendency to increase the content of dissolved Fe, Mn, and Cr in modern conditions. The studied metals, except Cu(II), migrate mainly in a suspended state. The content of suspended Al, Fe, Mn, Cu and Cr is in the range of 600–9830, 130–2820, 3.6–81.5, 0.6–9.8 and 4.8–23.5 μg/L. Al, Fe and Mn are predominantly transported in the composition of suspended solids, while for Cu and Cr this is less characteristic. The share of the labile fraction of dissolved Al, Fe, Mn, Cu, and Cr is on average 34.7, 31.1, 68.8, 28.5 and 33.2%. In the composition of complexes with humic substances 51.6–63.9% of $Al_{dissolved}$,, 44.7–63.0% of $Fe_{dissolved}$ and 29.2–55.3% $Cu_{dissolved}$ were detected. Therefore, the metals in the water of the Kiliya Danube Delta are in a bounded state due to the complexation with DOM and adsorption on suspended solids.

BIOGENIC SUBSTANCES IN THE WATER OF THE KILIYA DANUBE DELTA IN MODERN CONDITIONS

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Compounds of nitrogen and phosphorus determine the degree of pollution of surface waters by domestic wastewater, and their high concentrations lead to eutrophication of water bodies. Permissible concentrations have been developed for nitrogen and phosphorus compounds, as well as for many other chemical elements. The concentration of ammonium nitrogen, nitrite ions, nitrate ions and inorganic phosphorus in water should not exceed 0.3, 0.01, 0.5 mg N/L and 0.05 mg P/L according to the method of ecological assessment of water quality developed at the Institute of Hydrobiology of the NAS of Ukraine. Similar concentrations of inorganic forms of nitrogen and phosphorus have been used in the evaluation of the water quality of the Danube River by the European Union countries. In this case, their concentrations should not exceed 0.3, 0.06, 3.0 mg N/L, and 0.1 mg P/L, respectively. The highest content of ammonium nitrogen, nitrite ions, nitrate ions and inorganic phosphorus in the water of the Kiliya Delta of the Danube was observed from the late 70s to the early 90s of the last century. During this period, their concentration averaged 0.44–0.62, 0.044–0.074, 0.98–1.66 mg N/L, and 0.160–0.280 mg P/L. The concentrations of ammonium nitrogen, nitrite ions, and nitrate ions in the water of the Kiliya branch upstream of Vilkovo in August 2014 did not exceed 0.010, 0.003, and 0.560 mg N/L, respectively. The content of ammonium nitrogen, nitrite ions, nitrate ions, and inorganic phosphorus in the summer-autumn period of 2018–2021 was within 0.016–0.480, 0.003–0.034, 0.040–1.031 mg N/L, and 0.028–0.096 mg P/L. Thus, we observe a decrease in the concentration of nitrite ions, while the content of ammonium nitrogen and nitrate ions is still subject to fluctuations in modern conditions. The content of inorganic phosphorus also decreased compared to the 1970s–1990s and does not exceed 0.1 mg P/L.

- PROGRAM DAY 2 -

BIODIVERSITY AND ECOLOGY

Keynote lecture:

FROM DONETS TO DANUBE: HYDROECOLOGICAL PROBLEMS AT THE BACKGROUND OF HOSTILITIES

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The efforts to gain access to the Dnieper waters to provide the occupied Crimea are considered one of the reasons of the Russian aggression in Ukraine. Besides, Russia does not hide its plans to occupy all south of Ukraine, connect with Transnistria and exit to Danube.

Actually in Ukraine 60 th. rivers, 20 th. lakes, 7 big reservoirs of total volume above 45.7 km3, about 50.5 km of dams and 2400 km of levees, of which above 800 km are in the Danube basin, are under threats.

The dam explosion on February 26 was aimed at flooding of the Irpin River flood land and protection of Kyiv. From the Zhytomyr reservoir about 7 million m3 were discharged to disrupt the pontoon crossing of Russian troops. Explosion of the Oskil reservoir dam – the water source of the Siverskiy Donets – Donbas channel resulted in total denudation of its lodge.

The missile strikes on August 14-16 destructed the Karachuny reservoir dam, and part of the Kryvyi Rig town was flooded.

The WWTP destruction and disorders of their electric supply resulted in polluted wastes discharges. The pumping stop resulted in mine waters flow to rivers.

The hostilities around the Zmiiniy Island affected the Danube navigation. Impact on unique ecosystems of it's the Danube delta significantly increased. The herring commercial catches also were badly affected.

So, this war has already affected and still affects the water ecosystems of Ukraine, from the Siverskiy Donets basin in East to the Danube basin in West.

The most actual is development and realization of the natural riverbeds restoration, providing free meandering in the flood land, phyto- and ichthyoamelioration, construction of the flood-protective facilities with bio-positive properties, construction of progressive fish passes over the dams' reconstruction, under bridges, in spillways, design and construction of artificial rapids, etc.

Keynote lecture:

CASCADING DROUGHT EFFECTS ON STREAM ECOSYSTEMS' FUNCTIONS AND COMMUNITIES

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Over the past thirty years, the frequency and duration of droughts has increased dramatically across Europe, impairing the ecological state and the integrity of river systems. Headwater streams are especially sensitive due to their low water mass and their strong linkage with the catchment. Prolonged summer droughts expose streams to low or intermittent flow and warming stress, affecting both the metabolism of these ecosystems and their community. Increased water temperatures alter the various biogeochemical and microbial processes at the water-sediment interface, potentially leading to internal eutrophication of streams and rivers during summer droughts. Intermittency, warming and the deterioration of the water quality, in turn, impact the composition, abundances, and performance of the benthic micro- and macro-fauna. Furthermore, global warming prolongs the vegetation period and changes the composition of the riparian vegetation, affecting the organic matter supply of the stream community. Cascading effects may occur within the biota of headwater streams, across the stream-riparian zone interface, and downstream to large rivers and their floodplains, thus requiring strong interdisciplinary research.

ABOVEGROUND BIOMASS AND CARBON STOCK OF FLOODPLAIN FORESTS AND REED BEDS IN THE DANUBE DELTA, ROMANIA

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Intact wetlands can act as carbon sinks and mitigate increased amounts of CO_2 in the atmosphere following climate change. In addition to the organic soils for example in reed beds, floodplain forests play an important role in the carbon storage within wetlands.
In the context of the project 'EDAPHIC-BLOOM Danube', actions for greenhouse gas (GHG) mitigation as well as dialogues with authorities and stakeholders in the Lower Danube region in Romania are developed. The project with Romanian and German partners is managed by the Danube Delta National Institute for Research and Development in Romania. It is part of the European Climate Initiative (EUKI).
One project part deals with the biomass and carbon stock of the floodplain forests and reed beds in the Danube Delta. The different vegetation types were investigated in the vegetation periods of 2021 and 2022 using a plot design in which vegetation and habitat parameters were measured.
Field parameters were used to calculate the aboveground woody biomass (AGWB) of the trees and estimate the carbon content (with 50% of the AGWB; Clark et al., 2001). Furthermore, tree core samples of the dominant tree species were taken to measure annual increments for estimating carbon sequestration.
In the reed beds, the aboveground biomass was harvested on 1 m^2 plots and analysed on carbon and nitrogen content.
The results show differences in biomass and carbon content between natural softwood and hardwood riparian forest types and the plantations. The AGWB and carbon stock of forest types will be compared to the huge reed beds of the Danube Delta.

Reference

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MORPHOFUNCTIONAL ASSESSMENT OF MACROALGAE FOR MONITORING OF THE ECOLOGICAL STATUS OF THE UKRAINIAN DANUBE AVANDELTA

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The Danube avandelta belongs to the Transition Zone in the "river-sea" system and therefore the monitoring and achievement of the Good Ecological Status should be carried out here simultaneously of requirements of the Water Directive (WFD, 2000/60/EC) and the Marine Strategy (MSFD, 2008/56/EC). The areas of connection with river and sea waters are characterized by high dynamism of processes. For monitoring under these conditions, integral functional indicators of fixed biological communities receive the greatest advantage.

To monitoring the Ecological Status Class (ESC) macroalgae were used, growing on navigation and port constrictions with a constant location point. Continuous series (2004-2021) of the values of the specific surface of population (S/Wp) and the Surface Index (SI) of communities and corresponding to these indicators the ESC categories (Minicheva, 2013) in the area of the Danube-Black Sea Channel and the Ust'-Dunaysk Port were obtained. It possible to obtain the long-term dynamics of ESC categories associated with the river flow volume and abnormal climatic conditions.

Ander pass from low- to high-water years in the Danube avandelta, the intensity of autotrophic process increases by almost 2 times, and the SI increases from 40 to 70 (units). In the period 2004-2021, in the Danube avandelta, low- and medium-water years were characterized by the ESC category - "Good", and high-water years were assessed by the "Poor" category. In periods of abnormal, the worsening of the ESC category occurs due to the increase in the concentration of trophy substances that stimulate the autotrophic process and reduce the ecological status of the aquatic environment. In the abnormal 2010, due to the high volume of river runoff and temperature, the category of ESC fell to "Bad".

ECOLOGICAL STATUS OF THE DANUBE DELTA COASTAL AREA (UKRAINIAN PART) BASED ON THE ANALYSIS OF THE MEIOBENTHOS AND NEMATODE COMMUNITIES

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This study is based on the results of benthic surveys carried out in November 2015 and August 2018 and 2020 in the area of the "Danube-Black Sea" navigable canal. The area is divided into three conditional sites: directly in the sites of dredging (Bystry branch) (depths 3-7 m), dumping (depths 8-13 m) and in water areas remote from dredging and dumping, which can be considered as background where the impact of dredging operations is presumably minimal (depths from 10 to 25 m). Meiobenthos was characterized by 11 taxonomic groups. The values of the taxonomic richness of the meiobenthos varied from 6 taxa in the dredging sites to 9 taxa at background stations. Applying an ecological quality classification (EQS) based on this meiobenthos variable, the water area under study falls into a class ranging from Poor (dredging) to Moderate EQS (background and dumping areas).

The Shannon index (H ') of the nematodes in the dredging sites varied from 0 to 1.8. Low values of these indices indicate Bad ecological status in the dredging sites and Poor in the rest. There was a high percentage of c-p2 (r-strategists) in all sites. Average values of the maturity index (MI) varied from (1.5 ± 0.2) in the dredging sites to 2.3 ± 0.1 at dumping and 2.6 ± 0.1 at background stations. The Maturity Index also indicates that the dredging site is in Bad condition, the dumping one is in Poor and the background stations are in Moderate. Non-selective deposit feeders (1B) dominated at most stations. According to the values of the trophic diversity index (ITD), the dredging and dumping area can be classified as Poor class, the background - to the Moderate class.

VARIABILITY OF THE DANUBE RIVER FLOW AFFECTS THE DISTRIBUTION OF CHLOROPHYLL IN THE NORTH-WESTERN BLACK SEA

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The river inflow into the Black Sea drives its productivity due to the enrichment of water with nutrients, dissolved organic matter, detritus, etc. The northwestern part of the Black Sea is the largest shelf zone of the Black Sea. More than 80% of the total river runoff of the entire Black Sea comes here. The largest of the rivers is the Danube, which brings 3/4 of the total river flow of the North-Western Black Sea. Since the annual runoff of the Danube varies from 127 km^3 (in 1921) to 302 km^3 (in 1970), having an uneven intra-annual distribution, its effect on the adjacent sea is also obviously changing. For detection of the Danube discharge variation we analyzed annual and monthly values for lower Danube river over 1921-2021. Based on long-term series, we divide the amount of annual discharge into three ranges: Low-, Mid- and High-runoff. We also used sea-surface chlorophyll data derived from MODIS Aqua images for the 2003-2021 time series with a spatial and temporal resolution of 1 km and 8 days, respectively. We separated this period into three ranks according to the runoff value and analyzed the averaged seasonal distribution of chlorophyll in the sea. The average annual concentration of chlorophyll in the Danube-adjacent sea, as well as the zone of distribution high-chlorophyl in the sea, positively correlates with the runoff (4.5, 5.4 and 5.8 $mg \cdot m^{-3}$ for Low-, Mid- and High-runoff, respectively). Maximum concentrations are observed in spring during all runoff-periods, then in summer. Mid-runoff provides maximum chlorophyll (compared to Low- and High- ones) in the spring and autumn. The highest concentrations of chlorophyll in winter are observed during the Low-runoff period. Seasonal dynamics in different runoff periods in the Danube estuarine zone differs from the Dnieper and Dniester estuarine zones due to different morphology (delta-sea and semi-closed system-sea, respectively).

THERMAL REGIME OF THE LOWER COURSE OF THE DANUBE RIVER

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The Danube River is a unique natural object that is influenced by natural and human factors. One of the main parameters of the river is the water temperature. The thermal regime of the lower course of the river was researched on the basis of regular monitoring data as well as remote sensing data.
As a result of air temperature increase, the increase of water temperature is observed as well. During 1961–2021 the mean annual water temperature of the lower course of the river (Izmail station) increased by about 0.38 °C per decade.
It was defined that water temperature in the lower course of the Danube River is much higher than air temperature – especially in autumn. In spring this excess is about 1 °C, in October – it reaches 4 °C.
Generally, the water temperature in the river is higher than in nearby lakes and the adjacent part of the Black Sea. It has been determined that water temperature is affected not only by air temperature, but also by water flow and wind impact. With a large water runoff the mixing of water intensifies and it causes the decrease of surface water temperature during the main part of the year with the exception of the coldest months. The largest impact of water runoff on the water temperature is observed in June.
It was defined the possibility to use remote sensing to track the changes of water temperature along the Danube River. In turn, it helps to identify the phase of the water regime. The differences of water temperature along the river can be used to evaluate the features of the river channel. During summer the water temperature on the shallow sections usually is cooler than on deep ones and vice versa.

CHANGES IN THE HYDROLOGICAL REGIME OF THE WETLANDS OF THE DANUBE DELTA (ON THE EXAMPLE OF STENSOVSKO-ZHEBRIANSKY PLAVNI)

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Stentsivsko-Zhebriyansky Plavni (floodplain) (SZhP) are especially valuable wetlands of the Danube delta in terms of biodiversity. Their modern total area is about 78,11 km2, of which 72,34 km^2 have been part of the Danube Biosphere Reserve (Ukraine) since 1998. This is a complex of reservoirs, watercourses and wetlands, formed approximately 2 000 years ago. The main abiotic factor that influenced the biotope features of floodplains is a certain nature of water exchange.

Today, the ecosystem of these wetlands is subject to significant anthropogenic stress. Due to local anthropogenic influence and global climate change, all components of the natural water balance of SZhP have undergone changes. Due to the creation of dams and the transformation of a large part of wetlands into agricultural land, the natural flow of Danube water has stopped. The construction of the Prymorske-Vylkovo highway caused the regulation of the flow from the SZhP to the sea. Also, this, together with the human-induced change of the landscape within the scope of the sea coastline, prevented the natural intrusion of salt water from Zhebryanska Bay of the Black Sea during autumn storms. Disruption of the internal water exchange occurred due to the construction of the Danube-Sasyk canal, which divided the waterways into two almost isolated parts.

Today, the hydrological regime of the floodplain is fully regulated. Because of this, the water level in reservoirs has dropped significantly, the territory is actively overgrown with macrophytes, and the salinity of water and soil has increased in some areas.

The presentation introduces the current challenges in the hydrological regime of the wetlands. It presents the analysis of retrospective and monitoring data, the results of the study of the modern hydrological regime based on calculations and field research data.

NATURAL ASSURANCE SCHEME DEVELOPMENT IN THE LOWER DANUBE: FROM NBS DESIGN PROCESSES TO CO-BENEFITS CAPITALIZATION

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The Lower Danube wetlands, one of the most important European wetland ecosystems, lost nearly 80% of its surface over the last century due to river dredging, land reclamation and flood control (www.icpdr.org). Anthropic interventions along the Danube River water course, such as construction of the hydropower plants Iron Gates I and Iron Gates II and alterations along its banks, have generated high bank erosion processes as well as riverbed changes with negative impact on navigation. The negative effects induced by anthropic interventions coupled with climate change impact have intensified the flooding and drought events.

We propose a wetland restoration project in the Lower Danube by designing a Nature Based Solution (NBS) for dealing with flood risk. Our research is focused on the Dabuleni-Potelu-Corabia (DPC) enclosure, a land reclamation area dammed in 1965 against catastrophic floods, having a safety reserve height of 1 meter. This area along with other Lower Danube stretches have been heavily impacted by the catastrophic flood of 2006 and their resilience to such events is even more weaken by less destructive but more frequent floods. We propose different scenarios for the restoration of the DPC enclosure based on a hydraulic model of the catastrophic flood from 2006. Furthermore, we explore the potential of implementing this NBS discussing the generated benefits and co-benefits and describe the different steps to develop a Natural Assurance Scheme for the Lower Danube.

MEDIUM- AND LONG-TERM MONITORING OF HYDROLOGY AND FLUVIAL MORPHODYNAMICS OF A NEAR-NATURAL BYPASS STREAM ALONG THE UPPER DANUBE BETWEEN NEUBURG AND INGOLSTADT (BAVARIA/GERMANY)

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In the context of the restoration project 'River and floodplain restoration on the Upper Danube by re-establishing river continuum and ecological flooding' between Neuburg and Ingolstadt (Bavaria/Germany)' in 2010, a near-natural bypass stream was constructed and two additional measures for the vitalisation of a 1,200 ha riparian forest were implemented. The aim of the project was to support and re-initiate the dynamic processes for the promotion of floodplain-typical species in the still existing riparian forest and to restore the longitudinal connectivity of the river system.

The project was scientifically supported within the framework of the short-term monitoring 'MONDAU I' (Monitoring Danube Floodplain) from 2009 to 2013 to assess the changes of biotic and abiotic factors. In one sub-project, the influence of the dynamisation on fluvial morphodynamics, soil moisture and groundwater was documented and analysed. The results of the survey indicated how strongly the processes depend on the control and implementation of the dynamisation measures. Already after a few years of monitoring, the end of the 'adaptation phase' in terms of fluvial morphology became apparent which was visible by major hydromorphological adaptations.

After twelve years of re-establishing the lateral and longitudinal connectivity, a new examination of the long-term development of abiotic factors is currently being realised within the framework of the project 'MONDAU II'. Using a combination of different methods, the spatio-temporal changes in the river and the floodplain system are to be comprehensively documented and analysed again. A special focus is on the extent to which hydromorphodynamics, as an important element of habitat development, is maintained even after the 'adaptation phase' or whether a development towards geomorphological equilibrium is detrimental to habitat quality.

GROWTH AND LENGTH-WEIGHT RELATIONSHIP OF THE PIKEPERCH (SANDER LUCIOPERCA) FROM COMMERCIAL CATCHES IN THE RIVER DANUBE NEAR BELGRADE (1162–1163 RKM)

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Pikeperch (*Sander lucioperca*) individuals (n=48) from commercial catches in the Danube River near Belgrade (1162–1163 rkm) were sampled in July, August, and September of 2019. The mean total body length (*TL*) of the analyzed fish was 45.19 ± 7.52 cm, the mean body weight (*W*) was 824.96 ± 371.08 g, the mean weight of liver was 7.74 ± 4.47 g, and the mean weight of gonads was 2.94 ± 2.48. Twenty-five percent of the sampled fish were below the minimum landing size prescribed by the national legislation. Four age classes were present in the sample, from 5+ to 8+. Back-calculated length-at-age analysis shows that growth is fastest in the first year of life. The total body length defined according to the parameters of the von Bertalanffy growth curve can be calculated at any given time t as $L_t = 72.19(1 - e^{(-0.23(t-3.15))})$. The value of the length-weight regression coefficient (b<3) indicates a negative allometry. LW realtionship can be calculated with the equation $logW = 0.02 + 2.77logTL$. The phi-prime growth performance index was ϕ'=3.09. Mean value of Fulton's condition factor (FCF) was 0.84±0.11 SD. The highest value of this parameter was observed in the age class 5+; however, differences in FCF between the age classes were not statistically significant. The mean value of the hepatosomatic index (HSI) was 0.97 ± 0.34 SD, and of the gonadosomatic index (GSI) 0.40±0.37 SD. The highest values of both HSI and GSI were observed in the 6+ age class; however, differences between the age classes were not statistically significant.

INTERMITTENT STREAMS – NEWLY RISING AND SIGNIFICANT PHENOMENA IN THE DANUBE BASIN

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Progressing climate change brings to Central Europe higher climate instability, which is manifested by extreme floods or long-lasting stream drying. Small streams up to fourth Strahler order dominate the Czech river networks and are frequently exposed to repeating dry episodes when water stops flow, only residual pools remain or surface water completely disappears. Contrary to more arid regions, the temperate stream biota is predominantly not adapted to desiccation, thus dry episodes are strong environmental filters selecting only limited pool of taxa. Long-term persistence in intermittent streams is enabled by mechanisms related to taxa resistance (*in situ* survival) or resilience (fast recolonization after flow resumption). Important role in successful survival play also refuges in perennial reaches, residual pools or saturated hyporheic zone hosting "seedbank" of persisting stages.

In the last 15 years, we have studied different effects of stream drying on biota in natural or anthropogenically affected intermittent streams in the Czech Republic and neighbouring countries in Central Europe. We have developed a tool for retrospective bioindication of dry episodes based on macroinvertebrate community analysis (BIODROUGHT index), which allows reliable stream site classification to three flow categories (perennial, nearly-perennial or intermittent) with accuracy over 80 %. Contrary to our expectations, we observed harsher impacts of organic pollution and eutrophication on macroinvertebrate communities in perennial than intermittent streams, indicating that drying could surprisingly mediate negative effects of these anthropogenic stressors.

Because water managers searching for effective tools to mitigate impacts of ongoing climate change, we also tested effects of commonly applied measures (small reservoirs, riparian buffer zones and land-use changes) aimed to mediate effect of stream drying. In general, we identified predominantly negative effects of small reservoirs and high representation of agricultural land-use on biota in intermittent streams (macroinvertebrates, algae, fish and terrestrial plants), while the extensive buffers, good channel hydromorphology and natural land-use substantially mediate some impacts of stream drying.

BLACK ALDER (*ALNUS GLUTINOSA*) FOREST STANDS ON THE LOWER STRETCH OF THE SFÂNTU GHEORGHE BRANCH OF THE DANUBE DELTA

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From the Danube Delta is known only a single small enclave of a natural Black Alder (Alnus glutinosa) forest stand in the Erenciuc area of the Sf. Gheorghe branch. Due to its uniqueness it was declared as a protected area. During recent researches on the lowest stretch of the Sfântu Gheorghe branch near to the mouth into the Black Sea we studied in the year 2022 this up to the present unknown forest stand of Black Alder of the area, the species composition, its biodiversity, ecology and the phytocoenology concluding that it is unique and with biogeographical importance not only for the Danube Delta, but also for the Danube river at the whole.

LANDSCAPE ASSESSMENT OF THE UKRAINIAN DANUBE REGION

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The Ukrainian Danube region has a wide range of landscape conditions. In contrast, although there is the network of nature reserves with wetlands of international importance – an unbalanced and unstable landscape-economic structure. Ploughing of land for arable land is 67%, including water bodies, and 75% of land. The amount of arable land exceeds the maximum ecological balance values for the district by 10-15%. The number of forest belts is insufficient to perform environmental protection functions, to reduce wind and water erosion. Lands in natural and semi-natural states make up only 20%, including water areas, which indicates the discrete, local and fragmented nature of the ecological network, and does not ensure sustainable development of the region. At the same time, the terrain is characterized by high ruggedness and density of erosion channels, especially in the central and northern parts of the district. According to the risk of plane erosion processes, it is advisable to withdraw 13% (1100 km^2) of the total arable land area from ploughing for hayfields, pastures or perennial plantations. On 36% of the land, it is necessary to carry out measures to reduce water erosion processes and form a framework of runoff-regulating forest belts along the slopes. The highest density of eco-stabilizing functions and contour landscapes are concentrated in river valleys, but their natural conditions have been transformed into arable land, settlements, industrial facilities and artificial ponds by 50%. A facial and landscape classification with an appropriate typology was carried out, which provided functional information for the development sustainable nature management schemes.

DISTRIBUTION PATTERNS OF ALGAE IN RIVERINE LANDSCAPES

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Distribution patterns of phytoplankton and phytobenthos, related species composition and structure of local communities of algae and related species traits aiming to elucidate metacommunity aspects are being analysed within the "Christian Doppler Laboratory for Meta Ecosystem Dynamics in Riverine Landscapes (MERI)". Ten sites from different water bodies along the Austrian Danube, including floodplain sites and main channel sites along the Danube in Lower Austria and Vienna, were studied for one year. Algal samples from the selected water bodies were collected to define what are the driving factors of species distribution, analysing the importance of local habitat factors and secondly, regional factors related to different connectivity and network properties. We expect that the exchange of species between hydrologically connected waterbodies will be high as indicated by a high similarity of communities of planktonic groups, while local habitat conditions are of less importance. For benthic communities, we suppose that local habitat factors are primarily explaining algal communities related to species traits, local substrate structure and strength of attachment of algae to these substrates. To unfold the question, we are studying the spatial complexity on different spatial scales applying a meta-ecosystem approach, and the similarity of the communities with regard of hydrologically connected waterbodies with an emphasis on habitat diversity. In turn, we also consider the importance of the connectivity of the waterbodies and spatial diversity that are responsible for the species distribution of algae and its role in the interactions between different groups of organisms. The result of the project will complement existing ecological models in riverine landscapes applied to species occurrence and abundance matrices to identify the significant temporal change and the local colonization/extinction patterns of algae.

COLLECTING DATA ON INVASIVE ALIEN SPECIES THROUGH BIOBLITZ SURVEYS IN THE DANUBE AND BLACK SEA BASINS IN BULGARIA

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Series of BioBlitz surveys on invasive alien species (IAS) were organised in Bulgaria in the frame of the Alien CSI COST Action CA17122. The aim of the surveys was to collect data on IAS of concern to the Union, Bulgaria and the Danube River Basin (DRB) by taking photos and record observations with mobile phone applications, and thus, to raise awareness about the IAS issues in Bulgaria.

The preparation activities included information campaigns and publication and dissemination of information materials, such as IAS identification guides, flyers, species factsheets, instructions for users of phone applications, banners, etc. Target groups were mostly students from Universities and high schools, teachers, and scientists, as well as competent authorities, NGOs, and nature lovers. The surveys were conducted in May 2022 in the region of Pancharevo Lake, DRB, and Varna City Garden, the Black Sea Basin (BSB). According to their interests participants were divided in thematic groups: plants, terrestrial invertebrates, aquatic invertebrates, fish, and marine species. Different methods for sampling were demonstrated and applied. The phone apps 'Invasive Alien Species in Europe' and 'iNaturalist' were used for recording the observations of IAS.

About 120 participants were involved in the surveys. A total of 44 records were made with the 'IAS in Europe' app and 139 records with 'iNaturalist'. Four IAS of Union concern and six IAS of concern to Bulgaria and DRB were recorded at Pancharevo Lake, while two IAS of Union concern and 10 other alien species and IAS were observed in the BSB. The results showed that the BioBlitz surveys, preceded by detailed and careful planning and preparation, can be a successful tool to collect data and raise awareness and engagement on IAS issues in Bulgaria.

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NEW RECORDS ON DISTRIBUTION OF NATURA 2000 HABITAT TYPE 3130 ISOËTO-NANOJUNCETEA IN THE CROATIAN DANUBE REGION

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Habitat type 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoëto-Nanojuncetea* is listed in Annex I of the EU Habitats Directive 92/43/EEC. The National Habitat Classification of the Republic of Croatia designate it with a code A.4.2.1. Dwarf cyperious vegetation (Alliance *Nanocpyerion* Koch 1926). The habitat type 3130 is characterised by the amphibious, ephemeral annual vegetation, developed under the environmental conditions of prolonged drought period in summer or autumn and low water levels, on drying wet deposits of mud and sand. It is typical for the flat banks along the Danube and the Drava Rivers, and in the standing water bodies, such as peirphery of lakes, dried fish ponds, swamps, channels, and ditches. Floristic field survey was carried out from July to September 2022, within four Natura 2000 Sites of Community Importance (SCIs) in Croatia: HR2001309 Danube North of Kopački rit, HR2000394 Kopački rit, HR2001308 Lower Drava course, and HR2000372 Danube-Vukovar. During the survey, following *Nanocyperion c*haracteristic plants were recorded: *Cyperus fuscus, C. glomeratus, C. michelianus, Gnaphalium uliginosum, Lindernia dubia*, *L. procumbens*, and *Marsilea quadrifolia*, some of which are classified as endangered and vulnerable species in the Red Book of the Vascular Flora of Croatia. The new localities were recorded for the habitat type 3130 and its characteristic species, which contributes to broader knowledge on their presence and distribution in the Croatian Danube region.

PHYTOPLANKTON PRIMARY PRODUCTION IN RIVERS AND STREAMS – A REVIEW

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Phytoplankton production in riverine systems is regulated by hydrologic processes and coupled light availability during transit. Resulting net primary production is a fundamental ecological process that reflects the amount of carbon synthesized within river ecosystems, which is ultimately available to consumers. Nutrients affect the physical, chemical, and biological components of large rivers and hence the response of the ecosystem. The direct consequences of nutrient loading are an increased primary productivity. The ultimate driver of aquatic primary production in streams, however, is light availability. Rivers also function to transport nutrients to downstream ecosystems, and some of the impacts of nutrients on large rivers are transported to downstream lakes, reservoirs, estuaries, and coastal waters affecting phytoplankton biomass and production in these systems.

Here, data on photosynthetic activity, primary production and growth from rivers and streams have been extracted from the literature, compiled, and compared with special attention on the River Danube and European Rivers.

THE DISTRIBUTION OF MACROPHYTES IN ALPINE LAKE BOHINJ (SLOVENIA) AND CONTENT OF SELECTED ELEMENTS IN SEDIMENT, WATER, AND MACROPHYTES

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Alpine lake Bohinj is the largest natural lake in Slovenia. It is located in Triglav national park, providing protection and limiting activities in its catchment area. Lake Bohinj belongs to the Danube basin. In the present study, we determine the aquatic macrophyte richness in lake Bohinj and the content of Cu, Pb, Cr, Cd, Co, Mn, Fe, Zn, and Ni in the sediment, water, and macrophyte samples. The following species were found in the lake: *Myriophyllum spicatum*, *Potamogeton alpinus, P. crispus, P. filiformis, P. lucens, P. perfoliatus, P. pusillus, Ranunculus circinatus, Phragmites australis,* and *Chara aspera* and *C. delicatula*. The most diverse genus in lake Bohinj is *Potamogeton*. Rooted macrophytes can take up elements from the water and sediments and accumulate them in their tissues. The contents of elements, especially in the sediment and plants, were surprisingly high. Mining activity in the past is the possible reason for the high content of elements in the lake sediment. Translocation of elements was generally high (Bioconcentration factor (BCF) >1). The contents of elements and bioconcentration factors (BCF) were higher in *M*. *spicatum* than in stone-worts (Characeae), confirming the suitability of this species in the phytoremediation of polluted waterbodies.

HALF A CENTURY OF PHYTOPLANKTON RESEARCH IN THE KOPAČKI RIT FLOODPLAIN –CONTRIBUTION TO NATURE PROTECTION AND INTERNATIONAL RECOGNITION THROUGH THE IAD

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Kopački rit is one of the largest floodplains in near-pristine condition along the Danube in its middle section (river 1,383–1,410 km) with conserved hydrological connections between the main river bed and the floodplain area. The first serious hydrobiological investigations focused on phytoplankton were conducted in Kopački rit by Dragica Gucunski in 1972 and the results were alarming due to the established strong negative impacts of the wastewater from surrounding agricultural farms on water quality. This contributed to raising the protection status of Kopački rit and in 1976 the restricted «Nature Reserve Management Area» was assigned the status of a Special Zoological Reserve, and its greater area the status of a Nature Park. The numerous results of phytoplankton research carried out during the following decades warned of the possible consequences of the rapid eutrophication of floodplain waters. After the war in Croatia, phytoplankton research continued in 2003 focusing on the verification of different ecological, i.e. morpho-functional, classifications of phytoplankton, instead of the traditional taxonomic approach, in the evaluation of the ecological state of river and different floodplain habitats. Nowadays, extreme hydrological events such as strong rainfall floods have become more frequent and intensive in the Danube River Basin, indicating global climate changes. Therefore, current phytoplankton studies are focused on defining potential climate impacts of hydrological alternations of the Danube on the natural resources of the Kopački rit floodplain.

Presentations of results given at numerous IAD conferences (Novi Sad, 1979; Basel, 1981; Konstanta Mamai, 1988; Warna, 1990; Kiev, 1991; Osijek, 2000; Vienna, 2006; Sofia, 2014; Neuburg/Donau, 2021) made a significant contribution to the international recognition of the ecological importance of Kopački rit. Moreover, participation in a network of scientists from different riparian states of the Danube contributed to the understanding of biodiversity-driven functions and services for improving wetland management, with special regard to water quality and nature conservation of wetlands in the Danube River Basin.

LIMNOMYSIS BENEDENI (CRUSTACEA: MYSIDAE) IN THE NATURE PARK KOPAČKI RIT: THE FIRST COMPREHENSIVE STUDY ON DISTRIBUTION

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The Kopački Rit Nature Park floodplain is situated between the Danube and Drava river. The area is under the Ramsar Convention, included in the list of Important Bird Areas and part of Natura 2000 network. With its influence on the changes in the hydrological regime, Danube affects the biological diversity of the floodplain. Through river transport, invasive species can spread to new environments and cause changes in biodiversity. *Limnomysis benedeni* (Czerniavsky, 1882) is an invasive mysid shrimp, native to the Ponto-Caspian region, who after a deliberate introduction into several accumulation lakes (as fish feed), has spread throughout Europe. In Croatia, *L. benedeni* was first recorded in Kopački Rit in 2004.

During the research conducted from July 2020 to May 2022, sampling of macrozoobenthos was seasonally performed using a benthos hand net at 15 sites. At all sampling sites Oligochaeta, Chironomidae and Ephemeroptera larvae were the dominant macroinvertebrate representatives. The presence of *L. benedeni* was recorded at 12 sites with a total of 2288 ind./m2, whereby a maximum of 432 ind./m^2 was registered in the spring of 2021. Seasonally, higher abundance was recorded in spring and summer of both years. Higher abundance of *L. benedeni* was recorded in the border areas of the Park, while at inner sites individuals were found only periodically or not at all. Danube (mouth of channel Petreš, 1398 rkm) and Vemeljski Dunavac (a side arm) are sites where the highest abundance and frequency was recorded, respectively. Both sites are important channels for the inundation of the floodplain.

With this research, we bring new data on the distribution and abundance of *L. benedeni* in the Danube catchment. Its re-appearance indicates an anthropogenic impact on the environment, and further monitoring and research of the impact of this invasive mysid shrimp on the indigenous aquatic invertebrates is of the essence.

Acknowledgements: This study was supported by five partners: “Hrvatske Šume”, Ministry of the Interior, “Hrvatske Vode”, Public Institution “Kopački Rit Nature Park” and Ministry of Regional Development and EU Funds under the name “Demining, reconstruction and protection of forests and forestland in the protected and the ecological network Natura 2000 areas in the Danube-Drava region – NATURAVITA”.

FISH SPECIES DIVERSITY OF THE UPPER TYSA RIVER (UKRAINE) – THREATS AND WAY OF SOLVING

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The economic activity often causes deterioration of the biodiversity in the river ecosystems. The low ecological consciousness of local residents plays an equally important role in this process. The Tysa River is the biggest left tributary of the Danube, so preservation of the rare local fish communities in the upper part of its basin is essential for preservation of high biodiversity in the Danube basin on the whole.

The fish fauna of the Upper (Ukrainian) Tysa was surveyed over the years 2001–2020. The considered region is characterized by high fish species diversity, 66 fish and lamprey species of 16 genera were detected. Portion of the rare species is very high, most of them are endemic. Of the total species number, 27.3% (18 species) are listed in the Red Data Book of Ukraine, 40.9% (27 species) are listed by the Bern Convention, and 60.6% (40 species) are included in the IUCN list. Unfortunately, over the last 80 years, the number of alien species has continuously and uncontrollably increased in the upper Tysa basin, and actually amounts 18.2% (12 species), whereas portion of native species decreases.

Significant anthropogenic pressure on populations of many rare fish species, protected at different levels, is caused by the rivers' regulation, poaching, gravel extraction from the river beds, intensive forestry, as well as garbage discharge by local population into the river beds. Taking into account, that the upper reaches of the Tysa River serve a natural reserve for many rare aboriginal fishes, we consider increase of the special ichthyological protected areas' number and monitoring of the Transcarpathian fish fauna the most effective measures for their conservation.

FIRST RECENT RECORD OF PRICKLY WATERLILY (*EURYALE FEROX*) SALISB. (NYMPHAEACEAE) IN FRESHWATERS OF EUROPE

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Euryale ferox Salisb. (Nymphaeaceae), an aquatic plant, is the only species of the genus *Euryale* native to eastern Asia, and has been found from India to Korea and Japan (Jha et al, 1991; Song et al, 2011). *E. ferox* is ecologically classified as floating leaf emergent macrophyte or as a rooted floating macrophyte - aerohydatophyte (Sodi and Kumar, 2020). *E. ferox* is regarded as an extinct Tertiary aquatic plant of Europe (Tralau, 1959). Also *E. ferox* seeds were found in the Pleistocene of Poland (Sobolewska, 1970). The present study aimed to provide data on the first finding of *E. ferox* in freshwaters of Europe, at the site of the Main drainage canal system near the Plavna village (South Bačka District: the Vojvodina Province, Serbia). This record can be regarded as the first species finding in natural habitat of Europe, out of its current distribution range. *E. ferox* was recorded at this site on September 25, and then on November 02 2022. Otherwise, there are 9 confirmed species records in botanical gardens and parks of Europe (plantnet.org; gbif.org). The Main drainage canal system in Plavna village is 10 km long lowland artifical waterbody. This canal is characterized by heavy silty clay, irregular side slopes and bottom as well as entire section filled with trees and bush, mainly with willows and quite uniform cross section, and dense aquatic vegetation (Salvai et al, 2003). We assumed that this non-indigenous aquatic plant in Serbia could be dispersed into the drainage canal via endo-/epizoochory; it is most likely the species' seeds were accidentally dispersed by migratory bird species which has been previously found for some other nymphaeid macrophytes (Smits et al, 1989; Reynolds, 2016).

INTERGENERATIONAL LEARNING AS A TOOL FOR TRAINING NATURE GUIDES IN THE LOWER DANUBE

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The protection of the rivers and lakes does not only rely on the existence and implementation of the legal framework, but also on the environmental knowledge, dedication to environmental protection and possibilities for involvement of local residents and communities. Learning and better understanding of the complex ecological and socio-ecological linkages that are typical for aquatic ecosystems can thus support more engagement of citizens for them, which is needed to reach respective legal management goals and to secure their functions for human wellbeing.
The Danube basin encompasses a broad variety of landscapes with an outstanding rich biodiversity, but which is under great pressure due to a range of human activities. In particular, the societal, economic and environmental value of the water bodies and wetlands are not well recognized by local people, especially in the lower part of the Danube.
The on-going project 'Danube Nature Guides' aims to improve the knowledge and understanding, as well raising awareness and appreciation of the social and economic benefits of the Danube ecosystems. For this purpose, educational material was developed and field courses performed. Already trained adult guides on aquatic ecology ("wbw Gewässerführer") from Upper Danube in Baden-Württemberg (SW Germany) were teaching young people, motivated teachers and personal from Natural Parks from the Lower Danube in Romania. Then educational concept thus also benefitted from establishing bridges between generations and from lifelong learning approach. Graduates from those courses will also have a multiplicator function, as they are able to raise of the visibility of nature-based tourism and to support the future establishment of certified nature guides in Romania, too.
Educational materials were developed for different age groups for use in Danube guides courses, as the 'Lower Danube Biodiversity: Teaching Guide', after identifying the specific needs for such materials during a workshop organised at the Lower Danube parks in Romania and Moldova.
The thematic field courses in Germany and Romania took place first in the nature park „Upper Danube"in Baden-Württemberg (Germany) and second in the Lower Danube in south-east Romania. Here, visites to the Lower Prut Floodplain Natural Park, the Small Wetland of Braila, and the Macin Mountains National Park were organized. Participants consisted of 15 young adults at the age of 16 to 24 years from Romania which were trained together with 7 nature guides from Baden-Württemberg. During these trips, ecological field methods there are applied on the assessment of river hydromorphology, water-dependent biodiversity, on the ecological status of a riverine landscape, on human impacts and, as well as, on nature-based values of touristic destination. Recently an educational brochure "*Lau will laugh again – her adventurous trip along the Danube*" has been produced in the format of a fairy tale for school children up to 12 years of age. The story addresses the Danube's function of linking different cultures and of hosting various aquatic biodiversity, but also human impacts, and shows as possible solutions in an attractive, partly amusing and easily understandable way. The project is financed within the framework of the EU Danube Region Strategy by the Baden-Württemberg Foundation (March 2017-March 2022).

MICROALGAL CULTIVATION ON DIFFERENT DIGESTATE CONCENTRATIONS FOR BIOGAS PRODUCTION

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Microalgae, as a diverse group of microorganisms, are becoming increasingly interesting for biofuel production due to the high biomass yield rich in valuable compounds. A modern approach for microalgae cultivation could be based on combining with digestate, a by-product of anaerobic fermentation. In this way, sustainable waste management is achieved while reducing the environmental impact. This type of digestate utilization closes the production cycle and creates biomass that can be reused for further production. The aim of this research was to compare the amounts of biogas produced from the microalgae biomass, which were cultivated on different digestate concentrations. The biomass used in the research was obtained by cultivating microalgae on two different digestate concentrations of 31.06 and 53.60 mg/L. The experiment was performed in triplicate. Qualitative analysis of the obtained biomass determines the dominance of the green chlorococcal algae *Coenocystis* and the cyanobacteria *Lyngbya*. The process of anaerobic fermentation was carried out using cow manure in codigestion with the obtained biomass in thermophilic conditions (55°C) for a period of 22 days. Biogas production for experimental group were 259.74 mL/g volatile solids (VS) with biomass grown at a lower digestate concentration and 270.55 mL/gVS with biomass grown at a higher digestate concentration, accompanied by average methane concentration around 65%. Results showed no statistically significant differences in the amount of biogas obtained (Δ=10.81 mL/gVS) or in the average methane concentration (Δ=0.20%) between the researched groups. Based on the obtained results, it is concluded that different digestate concentrations used in microalgae cultivation had no significant effect on biogas production or methane concentration.

MACROINVERTEBRATE FAUNA ALONG THE SERBIAN STRETCH OF THE DANUBE RIVER

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The aim of this study is to present the principal features of macroinvertebrate fauna along Serbian stretch of the Danube River (588 km that belongs to middle and partly lower Danube) and its main tributaries, revealed as a part of the Joint Danube Survey 4 (JDS4). The research was carried out in 2019 at 12 locations (five at the Danube and seven at tributaries – the Tisa, Sava, Velika Morava and Timok Rivers). To collect confident information, different sampling techniques were used: Kick and Sweep, multihabitat sampling, Deep-Water Dredging and free diving for mussel collection. A total of 202 macroinvertebrate taxa were identified, with insects as the most diverse component (114 taxa), followed by Mollusca and Annelida (32 taxa each), and Crustacea (20 taxa). Among insects Diptera, family Chironomidae was the most diverse (65 species). In respect to abundance, Mollusca was found to be dominant group with share of 37.46% of the total community, followed by Annelida (25.04%), Crustacea (19.83%), and insects with 17.63%. Other groups were represented with less than 1% participation. As expected in fluvial type rivers, potamophilous species dominate in macroinvertebrate community. Active filter feeders and gatherers/collectors are principal components in respect to feeding preference in investigated rivers which is a typical situation for the river type. Our study revealed presence of rare and protected taxa such as *Unio crassus* Philipsson, 1788 and *Theodoxus transversalis* (Pfeiffer, 1828), but also presence of 22 alien taxa, of which 14 are characterized as invasive in this stretch. This result indicate that macroinvertebrate community is dynamic and that it deserves persistent screening.

COMPARATIVE EVALUATION OF LIVER ENZYMES ACTIVITIES IN VIMBA BREAM AND COMMON NASE LIVING UNDER THE SAME ECOTOXICOLOGICAL CONDITIONS

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The present study was carried out to investigate the differences in some enzymatic components of liver in vimba bream (*Vimba vimba)* and common nase (*Chondrostoma nasus)*. For this purpose, 33 healthy vimba bream and 20 common nase were collected from commercial catches on the Danube River, near Belgrade (1172-1173 rkm), in 2016. The blood samples were taken and after separation of serum, the values of Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) enzymes activities were measured. Based on obtained results, the values of AST and ALT enzymes activities were slightly lower in the common nase compared to vimba bream, which is a possible indicator of better health and physiological status, and greater resistance to environmental pollutants present in the habitat. This difference was, however, not statistically confirmed. Considering that the selected fish were captured by the same method, having a similar ecology, living in similar habitats and under similar ecotoxicological conditions, it is not surprising that the differences in the activity of the measured liver enzymes were minimal. Since common nase is important bioindicator species, similar results could indicate that vimba bream could be considered as replacement species for this types of research, if future studies indicate the decline or endangerment of common nase populations.

CASES OF MASS VEGETATION *OF DIDYMOSPHENIA GEMINATA* IN UKRAINIAN PART OF THE TYSA RIVER BASIN

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The diatom *Didymosphenia geminata* was considered as inherent to the cool oligotrophic fresh waters of the northern hemisphere. However, recently it has started to expand its range, and in some cases reach extremely high abundance in the sites, where it usually occurred as single cells. It was included into the Global Invasive Species Database.

Over the years 1999–2015 in the upper section of the Tisa River basin it was detected in many brooks and rivers, at the density not more than 20 th. cells/10 cm^3. However, since 2016 cases its mass development in periphyton on the hard substrates were noted in the tributaries of the Tysa River – Teresva, Tereblia, Shopurka, Brusturianka. As it was noted in other regions of the world, the intensive development was often associated with change of the hydrological condition, namely the flow deceleration.

The cells' number reached 24–150 th. cells/10 cm^2, at this the cells' biomass 1.0–7.0 mg/10 cm^2, its portion in total phytoperiphyton biomass often exceeded 98%. It should be noted, that the cells are attached to the hard substrates by branched stalks, which form thick mats. In the considered cases the estimated mass of the stalks reached 1.5–2.2 g/10 cm^2.

In view of the planned construction of the small hydropower units in the Carpathian rivers, the mass development of *Didymosphenia geminata* seems to become more often and intensive, and thus this species needs special monitoring.

FIRST REPORT ON NATURAL REPRODUCTION OF RAINBOW TROUT ONCORHYNCHUS MYKISS IN BULGARIA BASED ON DNA ANALYSIS OF REDD MATERIAL FROM THE OGOSTA RIVER

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The rainbow trout *Oncorhynchus mykiss* has established self-sustaining populations across Europe. Despite the numerous registrations of this species in surface water bodies from Bulgaria, no data about its natural reproduction have been reported. In 2020 and 2021, we observed spawning behaviour of mature fish and found fry of rainbow trout together with recently introduced brown trout *Salmo trutta* in the Ogosta River, downstream of Ogosta Reservoir, Northwestern Bulgaria. In order to verify the complete process of spawning, fish material at different stages of egg development was sampled from the trout redds and identified with DNA analysis. The results showed that eight redds contained material from the introduced brown trout, while the rest twelve redds contained material from the rainbow trout. This is the first report on an established, naturally reproducing population of rainbow trout in Bulgaria.

ASSESSMENT OF THE MACROINVERTEBRATE INVASION IN WATER BODIES OF THE DANUBE RIVER BASIN, BULGARIA

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The study of the role of invasive alien species (IAS) on native aquatic invertebrate communities has come a long way - from a registration of simple occurrence/findings to risk analysis and assessment of biocontamination at different scales. Presenting new data on the occurrence and abundance of aquatic invasive and alien macroinvertebrate species in different freshwater environment, we aimed to assess the level of invasion in water bodies within Bulgarian Danube River basin. During large-scale research, conducted in 2020 and covering more than 20 sampling objects, we found five IAS – *Girardia tigrina* (Turbellaria), *Branchiura sowerbyi* (Oligochaeta), *Physella acuta* (Gastropoda), *Corbicula fluminea* and *Sinanodonta woodiana* (Bivalvia). All of them are included in a national list of priority alien species (ESENIAS-TOOLS project). Apart, two introduced, locally invasive species were also found – *Dikerogammarus villosus* and *Dreissena polymorpha*.

Most distributed were *P. acuta* and *B. sowerbyi* with frequency of occurrence 75% and 55% resp., inhabiting more often standing waters. All other species were found preferably in lotic environment. The values of abundance contamination index (ACI) and ordinal richness contamination index (RCI) were relatively low. Their maximum was 0.26 and 0.20 resp., which resulted in low to moderate level of site-specific biocontamination (SBCI≤2) and seven sampling objects were assessed as non-contaminated (SBCI=0). The relationship between the distribution and abundance of the IAS, basic environmental factors and ecological status is also discussed.

Acknowledgements: The authors are grateful to the World Bank, project № 71 957 35/17-4-2020, DICON-UBA and the National Science Programme "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters", № DO-230/06-12-2018

LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF THE WHITE BREAM (*Blicca bjoerkna*) IN THE DANUBE RIVER NEAR BELGRADE (1168-1170 RKM)

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White bream is an important species in commercial and sport fishing that is caught in nets throughout the year. The analyzed samples of white bream (n = 377) came from commercial catches carried out between December 2014 and May 2015 at two locations in the Danube near Belgrade, Jojkića Dunavac (JD) – an armlet of the Danube, with slow water flow and Veliko ratno ostrvo (VRO) – the main channel of the Danube, with fast water flow. Total body length (TL, cm) and body weight (BW, g) of each fish were measured, and Fulton's condition factor ($K = W/L^3 \times 100$) was calculated.

Average TL of the fish samples from the JD and VRO were 23.1±1.7 and 23.8±2.4, respectively, and average BW were 164.4±42.2 and 201.0±73.0, respectively. In general, fish from VRO were in better condition (K=1.44±0.16) compared to sample from JD (K=1.31±0.11). Individuals in the sample from JD had a negative allometric growth (a = -1.79, b = 2.93, r^2 = 0.85), while those from VRO have a positive allometric growth (a = -2.22, b = 3.28, r^2 = 0.89). Based on the results of this study, positive allometric growth (b > 3) and fish condition indicated that individuals from VRO increased body mass more than body length. The source of food, its availability, and better habitat conditions at VRO could be the reason for the differences in the growth and condition of the fish from the investigated locations.

A PRELIMIARY STUDY ON SEASONAL CHANGES OF FISH DIVERSITY IN COMMERCIAL CATCHES IN THE RIVER DANUBE NEAR BELGRADE (1162–1163 RKM)

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Fish abundance and diversity from commercial catches in the Danube River near Belgrade (1162–1163 rkm) were analyzed during summer and autumn (July–November 2019). A total of 605 individuals from 21 species, belonging to families Cyprinidae, Siluridae, Esocidae, and Percidae were sampled. Diversity of species was analyzed using alpha diversity indices (Shannon index, Pielou's evenness, Simpson index, Margalef's index, and Berger-Parker index). Differences in diversity between seasons were analyzed using beta diversity indices (Sørensen and Jaccard indices). Cyprinid fish were the most abundant group in the catch (73.5% in summer and 69.8% in autumn), with the highest biomass (90.04 kg in summer and 58.63 kg in autumn). Regarding the species biomass, pikeperch (*Sander lucioperca*) had the highest biomass in the catch in both seasons (34.7 kg in summer and 38.2 kg in autumn), followed by freshwater bream *Abramis brama* (31.7 kg in summer and 13.1 in autumn). The highest catch frequency (F=1) was observed for four species – Prussian carp *Carassius gibelio*, European perch *Perca fluviatilis*, pikeperch, and northern pike, and the lowest (F=0.2) for two species – zope *Ballerus ballerus* and zingel *Zingel zingel*. Similar values of alpha diversity indices were observed in both seasons. Pielou's evenness index (0.75 in summer and 0.78 in autumn) indicates that species are equally distributed in both seasons in the catch. Low values of Berger-Parker index (0.30 and 0.28 in summer and autumn, respectively) indicate the absence of a dominant species. Values of beta diversity indices (0.92 for Sørensen and 0.86 for Jaccard) indicate a high similarity between summer and autumn species diversity.

MORPHOFUNCTIONAL INDICATORS OF PHYTOFOULING OF NAVIGATION CONSTRUCTION IN THE UKRAINIAN PART OF THE DANUBE DELTA

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Monitoring of phytofouling of navigation constriction in the Danube Delta area was carried out at two test sites: of the port of Ust'-Dunaisk and the Danube-Black Sea Channel from 2017 to 2021. Methods of morpho-functional assessment of aquatic vegetation were used to analyze macrophyte communities (Minicheva,1989). Empirical values of phytoindicators were used to assess the ecological status-class of monitoring polygon in accordance with the standards of the Water Directive (WFD, 2000/60/EC) and the Marine Strategy (MSFD, 2008/56/EC). The 33 species of macrophytes were found on the two polygons of the Danube delta as part of phytofouling communities. Almost 50% of the species composition of the consist of representatives the Chlorophyta (15 species), Rhodophyta –12% (4 species), Bacillariophyta – 12% (4 species) and Cyanophyta – 30% (10 species). The Cyanophyta algae are widespread in the study area due to the high concentration of substances and low salinity values. The intensity of the autotrophic process at the Ust'-Dunaisk polygon was higher than in the Danube-Black Sea Channel. This due to the fact that the port water area is a semi-protected bay, which has the effect of reducing the speed of the river flow, the accumulation of organic matter, which stimulates the primary production process. The Danube-Black Sea Channel is characterized by a high water flow rate. On average, over five monitoring years, the Ecological Status Class of the Danube avandelta based on the value of the morphofunctional indicator - the Surface Index of composition was assessed for different seasons by the categories from "Good" to "High".

- PROGRAM DAY 3 -

44th IAD Conference Krems, Excursion LIFE-Projects Wachau

Date : 08. February 2023
Starting point : Karl Landsteiner Universität, Dr.-Karl-Dorrek-Straße 30, 3500 Krems / Donau

Schedule:

Travel from KL University Krems → to **Rossatz**, parking place Mettenerplatz Travel time: 15 min	09.00 - 9.30
Visit of project LIFE+ Auenwildnis Wachau (Access to the side branch and circuit) approx. 2 hours	09.30 - 11:30
Continue to **Schallemmersdorf** with a view of the Aggsbach-Dorf old branch and the Schönbühel side branch. Distribution of lunch packages Travel time: 15 min	11:30 - 12:15
Visit side branch System Schallemmersdorf-Grimsing (Visit **side branch** Schallemmersdorf and walk to side branch Grimsing inkl. beautiful view of Schönbühel Castle) Approx. 1 1/4 hours	12: 15 - 13:30
Travel to **Loisium/Langenlois** Loisium 60 min	13:30 - 14:30
Loisium Langenlois Wine tasting and tour of the wine cellar Approx. 90 min	14: 30 - 16:00
Return to Krems 30 min	16:00 - 16:30

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- PROGRAM DAY 4 -

MANAGEMENT AND RESTORATION

Keynote lecture:

THE DANUBE RIVER BASIN MANAGEMENT PLAN: MANAGING PRESENT AND FUTURE ENVIRONMENTAL CHALLENGES TOWARDS ECOSYSTEM RESTORATION IN THE DANUBE RIVER BASIN

Dr. Edith Hödl

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The Danube River Basin covers more than 800,000 square kilometres – 10% of continental Europe – and extends into the territories of 19 countries. This makes it the most international river basin in the world. To mark their commitment to transboundary cooperation for the protection and sustainable use of the Danube River, the main Danube countries signed the Danube River Protection Convention in 1994. 14 Danube Basin countries and the European Union are "contracting parties" of the International Commission for the Danube River (ICPDR). In 2000, the EU Water Framework Directive (WFD) came into force, establishing a legal framework to protect and enhance the status of aquatic ecosystems, prevent their deterioration, and ensure the long-term, sustainable use of water resources throughout the EU. In response, the ICPDR countries, including non-EU Member States, agreed to implement the WFD throughout the entire basin. River Basin Management Plans are the key tools for implementing the WFD. The Danube River Basin Management Plan Update 2021 – addressing the management cycle 2022-2027 – includes latest assessments on significant pressures, water status and a programme of measures jointly agreed by the Danube countries. Hydromorphological alterations are significantly impacting water bodies in the Danube River Basin and often hindering the achievement of environmental objectives. Numerous hydromorphological measures related to improvements of impoundments, water abstractions, hydropeaking, continuity interruptions, reconnection of floodplains/wetlands and to water bodies affected by morphological alterations are planned by Danube countries until 2027.

HOW CAN THE META-ECOSYSTEM APPROACH IMPROVE THE MANAGEMENT OF LARGE RIVER NETWORKS?

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Rivers are vital ecosystems providing many ecosystem services (ES) essential for human societies. In addition, rivers have high strategic importance for global ecological functions and biodiversity. Like many large rivers in the world, the Danube River is a highly complex socio-ecological system and a hotspot of biodiversity and ecosystem services but is also affected by multiple human activities like flood protection, land-use changes, navigation, hydropower, urban development or agriculture. Conservation and restoration of ecosystem functions, biodiversity and service provisioning is an urgent task but challenging due to the diversity of human activities and resulting environmental problems, diverging policy targets, scarcity of data compared to the complexity of the system, different socio-economic conditions along the river and legacies of past interventions that often require management measures and determine potential options for the future. We build on different concepts by combining a meta-ecosystem framework with hydro-morphological components (also including major human interventions) and integrate these with ES as an essential link to human society. The meta-ecosystem framework incorporates metacommunity aspects and food web structures; it describes how spatial flows of energy, materials (abiotic and biotic transport of resources), organisms (dispersal, life-cycle migrations, and movements) and environmental conditions between and within different spatial units determine ecosystem functioning, community composition and biodiversity, also considering the temporal dynamics. Such a riverine meta-ecosystem framework will complement current assessment approaches with a more process-oriented perspective. Studying the role of spatial flows at several scales provides tools to understand the spatial dynamics of regional biodiversity, but also ecosystem functions and services. Therefore, in this presentation, we explore the potential of the meta-ecosystem approach to understand the dynamic interactions and the effects of past interventions to project the future development of connected river networks and guide future management interventions.

INTEGRATED WATER MANAGEMENT: LINKING THE DANUBE RIVER WITH THE BLACK SEA

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The five Co-Authors act as Editors of an ELSEVIER-Book entitled “Danube River and Western Black Sea Coast: Complex Transboundary Management” in the series “Ecohydrology from catchment to coast”. The book encompasses 18 chapters grouped into three parts and shall be published towards the end of 2023. This contribution will focus on a selection of three specific topics emphasizing the interlinkage between riverine and marine ecosystems, reflecting theory and practice, major pressures as well as main obstacles for implementation of restoration and conservation (including politics and management): (1) Hydromorphology, sediment transport and input by the Danube and shore erosion in the Black Sea, (2) Nutrient load and eutrophication, and (3) Drastic decline of anadromous sturgeons due to disrupted connectivity and overfishing. Environmental protection of aquatic ecosystems includes, amongst other elements, ecosystem services, biodiversity, floodplain ecology, climate change, and sustainable use. In view of implementing Integrated Water Resources Management (IWRM), the challenge of decision makers and politicians is manyfold: to have procedural knowledge, to support and trust science, to understand and rate expert debates, to finance the development and harmonization of new methodology and proper monitoring programs, to have a holistic view of the social-ecological systems, and to cope with inherent conflicts of interest. Basic managerial tools are learning by doing, adaptive management, transparent communication, early involvement of relevant stakeholders to discuss and co-design solutions (sound public participation), and public awareness. In the long term, the prevailing primacy of economy, exploiting ecosystems for profit, must be ended and the environmental costs of any business should be internalized. The key message is that fighting the causes provides much better solutions than fighting the negative effects themselves (end-of-pipe solutions).

DANUBE LANDSCAPES – HISTORY, DIVERSITY, CONFLICTS, IDENTITY; BUT NO LOBBY!

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"Landscape" means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (ELC 2004: Article 1a). Cultural landscapes have never been static ecosystems but geographic mirrors of economic, technological and social conditions. Twenty years have passed since starting the implementation of the European Landscape Convention and 28 years of implementing the NATURA2000 network: these are milestones to have a look at the history and diversity of cultural landscapes in the Danube region, covering the total catchment.

What we consider that "typical" in cultural landscapes is often connected to a specific period. Feudal and totalitarian political systems have left their traces over millenia as well as language and handcraft. Local geological and environmental resources brand cultural landscapes and create the strongest imprint on cultures and identity. The unleached population development of the last century has raised the pressure on landscapes and all their resources in an unprecendented dimension. Most conflicts in nature conservation and sustainable land use needs find their origin in this fact. Managing this continuous change in cultural landscapes needs practical implementation in every project in an integrated way comprising quality of life (human recreation…), diversity of life (species and habitats) and the fundaments of life (soil, water, climate).

Within a Danube Landscapes Task Force a network is developing as an exchange platform between academic institutions and local initiatives to support the implementation of the European Landscape Convention (ELC), to encourage actors on policy and governmental level to raise awareness on the vulnerability of cultural landscapes and to contribute to the work of the macroregional EU strategy for the Danube region (EUSDR), especially the priority area 6 biodiversity, landscape, quality of soil and air. Austria is one of the last countries to ratify the ELC within Danube region.

RIVER AND WELL-BEING: A PERMA CONCEPTUALIZATION ON URBAN DWELLERS PERSPECTIVE

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The well-being is an integral part of the concept of sustainability. Indicators that capture key features related to different dimensions of the well-being can provide a context for measuring progress and can be a useful guidance and monitoring mechanism for policy and decision making. Moreover, Well-being is one of the basic prerequisites for development and most important fields of study in different countries, which due to its increasing importance, is an effective tool in managing and planning development issues and urban and regional studies. River has been affirmed as a socio-ecological system that promotes well-being. The purpose of the present study is to present a confirmatory analysis of the PERMA model in a sample of urban dwellers who live in the vicinity of the Danube River in the city of Budapest. Socio-demographic questionnaire and PERMA Profiler were applied to the dwellers that lived along the Danube (12 regions). PERMA (Positive Emotions, Engagement, Relationships, Meaning, and Achievement) psychological model of human flourishing was adopted to analyses well-being. The results of this study support the use of well-being theory in the context of citizens who live in the vicinity of natural factors and highlight that the experiences of citizens when visiting the Danube significantly contribute to their well-being.

INTEGRATIVE FLOODPLAIN MANAGEMENT BASED ON ECOSYSTEM SERVICES AND ITS POTENTIAL TO IMPROVE WATER QUALITY - THE IDES PROJECT

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Natural floodplains are capable of retaining plant nutrients that come either from upstream or from the riparian area. Thus, they can improve water quality. Lower retention rates in degraded or disconnected floodplains can be increased either by restoring a diverse river channel morphology, reconnecting floodplains, or through a more sustainable land use of the floodplains. Moreover, such nature-based solutions offer the opportunity to not only address singular issues, i.e., just water quality, but to holistically seek solutions that integrate multiple societal needs. Thus, improving the ecological status of rivers and floodplains also enhances the many services the ecosystem provides for human well-being. Although numerous potential floodplains have been identified in the Danube River Basin, implementation at the local or regional levels is often slow due to the many conflicting interests in floodplains.

The IDES project, funded by the Danube Transnational Programme, aimed to promote a solution-oriented and multifunctional management of rivers and floodplains instead of a sectoral and technical approach to water management problems. The key is to put a value on ecosystem services and thus highlight the multiple benefits of near-natural floodplains. To identify hotspots and deficits of ecosystem services at a large scale, IDES developed a common framework and methods for the assessment of 25 different ecosystem services along the entire Danube and selected tributaries (see also contribution Tschikof). In order to jointly develop integrative water management concepts for five pilot areas (Danube river in Austria, Serbia, Romania, Mura river in Slovenia, Tisza river in Hungary), we applied these methods at the local scale, but also integrated stakeholders' perceptions and knowledge by jointly creating fuzzy cognitive mappings. In doing so, the needs of other stakeholders, and more importantly, the ecosystem with all its interconnections at the local level, could be better understood by everyone collectively. Here, we provide an overview on the project results and lessons learned on how to move from a sectoral to an integrative approach in water management.

ANNUAL RIVERBED CHANGES IN THE LOWER DANUBE: HUMAN IMPACT VERSUS MORPHODYNAMIC FEEDBACKS

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The Danube is one of the largest fluvial systems within the European Union in terms of length, drainage area, discharge and sediment load. Multiple anthropogenic pressures in the Danube basin have led to evident hydromorphological alterations, amongst which the most heavily disturbed component is the sediment regime. Like many temperate zone rivers, the sediment load of the Danube River has been substantially reduced due to the combined impact of flood protection, navigation and hydropower measures applied over a long period of time.

In this study, annual changes in riverbed morphology were analysed between 2018 - 2022 using various data recorded from single-beam bathymetry, river discharge and sediment load measurements. We investigated five reaches located downstream of the Iron Gates I and II Dams, displaying various representative landscapes for the Lower Danube sector such as wide sections with large or small islets, narrow sections or large meanders. The analyses revealed an accelerated riverbed incision compared to previous trends (i.e. 1985-2005 interval) which is discussed in relation to anthropogenic actions such as water level maintenance and dredging for navigation, floodplain embankment and hydropower generation.

LARGE-SCALE MULTIFUNCTIONALITY ASSESSMENTS IN DANUBE FLOODPLAINS USING ECOSYSTEM SERVICES

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Rivers and their floodplains are among the most severely threatened ecosystems worldwide, yet they provide vital ecosystem services (ES) for human societies. Anthropogenic activities have altered the structure, hydrological conditions, and ecological processes and hence, impacted the types and extent of ES provided by these socio-ecological systems. In this changing world, objective decision-making and smart solutions for rehabilitation are required to support sustainable development. Recently, considering multifunctionality in floodplain management using ES has been proposed to accommodate the goals of biodiversity conservation and the fulfillment of human needs. However, there are still significant ambiguities in evaluating multifunctionality and using this information to set priorities across spatial scales, particularly concerning floodplain systems.

We present a new concept of using ES evaluations (adapted from Podschun et al. 2018 in the IDES project) to assess the multifunctionality in river-floodplain systems at the segment and river scale. This is the first approach to our knowledge that deals with the spatial configuration of multiple ES along the Danube and major tributaries. Furthermore, we demonstrate its large-scale application by applying hypothetical river rehabilitation scenarios and exploring the changes in the α- and β-diversity of provided ES and other indices of multifunctionality. We then discuss the potential and limitations of strategies that maximize the β-diversity at the regional scale and the α-diversity when implementing measures at the local scale. The success of such approaches inherently depends on the harmonization of the respective spatial levels of consideration and ultimately requires the active involvement of stakeholders participating in an objective and integrative decision-making process.

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MACROPHYTE HABITAT ARCHITECTURE AND LAKE RESTORATION: PHOTIC DEMAND FOR SUSTAINED MACROPHYTE DEVELOPMENT

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Underwater light conditions that are required during sustained lake restoration for transforming a hypertrophic algal-turbid shallow lake into a macrophyte dominated ecosystem are rather related to optimum (>12% surface ambient light, depth of light_optimum) than to minimum light requirements (>1% surface light, euphotic_depth; >3% surface light, depth of minimum_light_requirement for macrophyte develpment; Teubner et al., 2020, 2021, 2022). For the oxbow lake Alte Donau in Vienna (Austria), the achievement of the photic>12% benthic habitat condition for more than half of the sediment surface area was found to be a threshold for initializing the growth of remarkable macrophyte yield. Thus, passing this ecological threshold serves as an important step in sustained restoration of a hypertrophic lake, i.e., is an indicator of significant progress of lake treatment. A delay in the light exposure of the lake bottom area compared to the lake water volume is implicitly related to lake basin morphometry (identified by photic hypsographic curve, Teubner et al. 2022) and might thus differ among lakes. Only the time span (in case of Alte Donau it has taken 8 years after restoration start) that is required to overcome this delay depends on the efficiency of restoration measures and thus relates to a sustained lake treatment in the long-term. Firstly, mature macrophyte stands have a huge storage capacity of phosphorus (macrophyte tissue as significant sink for phosphorus) being one order of magnitude higher than peak concentrations of TP of the whole lake water body. Secondly, mature macrophyte stands provide a huge structural bio-surface that is one order of magnitude larger in size than the whole lake sediment area, and thus provides additional living space in the spatial context for harbouring an enhanced number of further freshwater biota from attached living biota to fish (Dokulil et al, 2018; Teubner et al, 2022).

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IDENTIFICATION OF AREAS WITH POTENTIAL SIGNIFICANT FLOOD RISK IN THE RENI AREA IN THE LOWER REACHES OF THE DANUBE RIVER

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The lower part of the Danube River Basin, located in southern Ukraine, is regularly flooded. An important problem in hydrology is the identification of areas with a potentially significant risk of flooding (APSFR), as well as the construction of maps of flood hazards and risks. According to the results of hydrodynamic modeling, it is possible to determine the APSFR of the study area. The APSFR chosen for modeling flood zones is located near the Reni city in the lower reaches of the Danube and according to the Danube Hydrometeorological Observatory, it suffers from floods almost every year. Data on the maximum runoff of a rare probability of excess during spring flood and rain flood, as well as a calculated hydrograph and a pre-built digital terrain model were used as initial data for modeling flood zones. The construction of a DEM was carried out using SRTM 1 Arc-second data. Flood modeling of the study area was performed using the HEC-RAS 6.3.1 application. Based on the DEM, flow models were created in HEC-RAS and hydrodynamic parameters such as roughness coefficient were set. Manning's roughness coefficients were set for individual sections of the watershed, namely, for the channel and part of the floodplain. The coefficients for the study area range from 0.04 for the channel to 0.10 for the floodplain. After entering all the necessary initial data and checking the calculated parameters, layers are created showing the water depth. Based on the results of modeling, a methodology was obtained for determining flood zones during the passage of maximum water discharges in the lower reaches of the Danube River using the example of the APSFR in the area of Reni.

HALF A CENTURY OF PHYTOPLANKTON RESEARCH IN THE KOPAČKI RIT FLOODPLAIN –CONTRIBUTION TO NATURE PROTECTION AND INTERNATIONAL RECOGNITION THROUGH THE IAD

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Kopački rit is one of the largest floodplains in near-pristine condition along the Danube in its middle section (river 1,383–1,410 km) with conserved hydrological connections between the main river bed and the floodplain area. The first serious hydrobiological investigations focused on phytoplankton were conducted in Kopački rit by Dragica Gucunski in 1972 and the results were alarming due to the established strong negative impacts of the wastewater from surrounding agricultural farms on water quality. This contributed to raising the protection status of Kopački rit and in 1976 the restricted «Nature Reserve Management Area» was assigned the status of a Special Zoological Reserve, and its greater area the status of a Nature Park. The numerous results of phytoplankton research carried out during the following decades warned of the possible consequences of the rapid eutrophication of floodplain waters.

After the war in Croatia, phytoplankton research continued in 2003 focusing on the verification of different ecological, i.e. morpho-functional, classifications of phytoplankton, instead of the traditional taxonomic approach, in the evaluation of the ecological state of river and different floodplain habitats. Nowadays, extreme hydrological events such as strong rainfall floods have become more frequent and intensive in the Danube River Basin, indicating global climate changes. Therefore, current phytoplankton studies are focused on defining potential climate impacts of hydrological alternations of the Danube on the natural resources of the Kopački rit floodplain.

Presentations of results given at numerous IAD conferences (Novi Sad, 1979; Basel, 1981; Konstanta Mamai, 1988; Warna, 1990; Kiev, 1991; Osijek, 2000; Vienna, 2006; Sofia, 2014; Neuburg/Donau, 2021) made a significant contribution to the international recognition of the ecological importance of Kopački rit. Moreover, participation in a network of scientists from different riparian states of the Danube contributed to the understanding of biodiversity-driven functions and services for improving wetland management, with special regard to water quality and nature conservation of wetlands in the Danube River Basin.

RIPARIAN ZONES - A KEY FACTOR IN PURSUING JOINT CONSERVATION EFFORTS FOR TERRESTRIAL AND FRESHWATER ECOSYSTEMS

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The EU Biodiversity Strategy (BS) follows the aim of protecting nature and reversing the degradation of ecosystems. While rivers and landscapes are naturally intertwined systems, they are often handled independently, thereby neglecting the co-benefits of terrestrial and freshwater conservation actions. In this context, riparian zones represent important transitional areas between land and freshwater ecosystems which provide a multitude of ecosystem services and support the objectives of several European directives and policy initiatives (e.g. BS, Water Framework Directive, Habitats and Birds Directive). However, due to multiple uses they are often highly impacted and restricted in terms of their expansion and dynamics. Based on the BS, more than 25,000 km of free-flowing rivers and their linked floodplains and wetlands have to be restored by 2030. In order to reach that goal, strategies for prioritisation, restoration and conservation are needed.
Within the recently started Horizon Europe project “NaturaConnect”, we combined spatial data from the Austrian National River Basin Management Plan, Copernicus riparian zones and land-use data, IUCN red lists, protected areas and floodplains in a GIS-based modelling approach. With an integrative analysis we identified multiple human stressors, biodiversity values and the current conservation status of actual and potential riparian zones. The detailed assessment of current threats to riparian zones and their hinterland will support the formulation of restoration activities to better target BS goals. Furthermore, the identification of riparian areas with high conservation value serves the protection of both freshwater and terrestrial ecosystems. Related strategies are not only important for Austria but may also be useful for the achievement of multiple EU directives within the Danube-Carpathian region and beyond.

SHALLOW WATER BODIES IN A DANUBE FLOODPLAIN, AN IMPORTANT HABITAT FOR CHIRONOMIDAE (DIPTERA) AND OTHER AQUATIC MACROINVERTEBRATES

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Small temporary water bodies are often neglected when studying biodiversity in different segments of a river watershed. Since the Danube has been highly anthropologically impacted in numerous regions, many such habitats have disappeared. In the Kopački Rit Nature Park in Croatia, pond ecosystems are created depending on the Danube water level, enclosing various microhabitats, particularly those with assorted macrophytes, which support diverse invertebrate communities.

The research on benthic and epiphytic macroinvertebrate diversity was conducted in the autumn of 2020, in eight ponds and at two channel locations. At each location macroinvertebrates were sampled at three sites, from sediment using a benthos hand net (500 µm mesh), and macrophytes were sampled using a cylinder (Ø 10,5 cm). Invertebrates were separated and counted, and Chironomidae larvae were identified to the genus/species level. Although somewhat higher diversity was recorded in the epiphytic communities, Chironomidae and Diptera in general, were more diverse in the benthos. Chironomidae and Oligochaeta were the dominant groups in the sediment, indicating a highly productive system, whilst in the epiphyton Heteroptera and Odonata were also present in higher percentages, depending on the macrophyte species. Sampled macrophyte species were: *Ceratophyllum demersum, Myriophyllum spicatum, Salvinia natans, Trapa natans* and *Utricularia vulgaris*. Most abundant benthic chironomids (29 taxa) were represented by the *Chironomus* genus, *Tanypus kraatzi*, *Polypedilum nubeculosum* and *Cladotanytarsus* sp. In the epiphyton (18 taxa), *Cricotopus* gr. *sylvestris*, *Paratanytarsus* sp. and *Endochironomus tendens* were dominant. According to BIO-ENV and RDA analyses, conductivity and depth were the most important parameters influencing community structure, alongside water temperature and oxygen concentration, which reflects different conditions at sampling locations in sense of available food, oxygen, primary and secondary production.

Ponds are biodiversity-important areas, harbouring rare as well as invasive species migrating through different waterways from the Danube, e.g. *Limnomysis benedeni* which was currently recorded. Thus, we find it important to indicate the value of small floodplain water bodies and their biodiversity research.

CONSERVATION ASSESSMENT OF AQUATIC HABITATS IN THE TEMPERATE WETLAND MOSAICS USING UAV PHOTOGRAMMETRY (MIDDLE DANUBE)

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Development of cost-effective approaches for monitoring and conservation assessment of aquatic ecosystems along the huge floodplain mosaics can be a challenging task. One of potential solutions are UAV assisted ecological indicators based on macrophytes vegetation. Therefore, the aim of this study was to select macrophyte-based variables that reflect the conservation value of aquatic ecosystems along the five Middle Danube wetlands in Serbia using UAV photogrammetry. Data for aquatic vegetation, fish, and macroinertebrate communities were collected simultaneously at the 47 sampling sites (20 lentic water bodies). Conservation value, species richness, and diversity indices were calculated using fish and macroinvertebrate community data for each sampling site. RGB UAV imagery of water bodies was acquired by Phantom 4 FC330 (12.5MP) RGB camera within the altitude range of 60-125m. Obtained orthomosaics were processed using the object-based image analysis to develop a single layer containing different macrophyte functional groups. Further, conservation metrics were correlated with macrophyte variables, which were extracted from the layer, within the circular polygons around the sampling site (radiuses 2.5m, 5m, 10m, 15m, 20m, and 30m). The analysis revealed that the total cover of aquatic vegetation, the number of macrophyte communities (dominant macrophyte species), and the cover value of floating-rooted and amphibian macrophytes were significant predictors of ecosystem conservation variables. The most relevant polygon radius for the assessment of fish conservation indices was 30m, and the range of 15-20m for macroinvertebrate indices. These results demonstrated that UAV-based macrophyte variables can be used in conservation assessment of aquatic habitats in complex wetland mosaics.

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ECOLOGICAL RESIZING THROUGH URBAN AND RURAL ACTIONS & DIALOGUES FOR GHG MITIGATION IN THE LOWER DANUBE FLOODPLAIN & DANUBE DELTA - EDAPHIC-BLOOM DANUBE

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The "Edaphic-Bloom Danube" project aims to develop actions and dialogues both regarding the conservation of organic soils that have the ability to fix and store Carbon, one of the most harmful greenhouse gases, as well as the use of land in the context of a regenerative biodynamic agriculture, paludiculture and permaculture, thus contributing to the reduction of the carbon footprint and its impact.

The project addresses the reduction of the ecological footprint and the importance of organic soils in GHG mitigation, through 4 steps: a DPSIR (Drivers Pressures State Impact Response) analysis, an ANN (Artificial Neural Network) type process, ensuring functionality by creating a Sustainable Development Cluster, solutions of planning for EBM (Ecosystem Based Management).

Moreover, the most important challenge is the exit from the citadel of Science and Innovation in a Living Lab of the Floodplain and the Danube Delta, precisely implementing the knowledge of the collaborators from KIT, Karlsruhe University, Steinbeiss, the Research Institute of Pedology and Agrochemicals ICPA, URBAN-INCERC, ASE, the Municipalities and The County Councils of the Floodplain and Danube Delta geographic area, an area that has undergone major changes in the last hundred years and which, through adaptive and ecosystem management, will contribute to the reduction of greenhouse gases and the reduction of the ecological footprint.

The analysis of carbon reserves and flows from the soils of the Danube meadow is carried out, their mapping and scenarios of conservation, soil restoration, modification of the type of activities through Land-Based Management (e.g. modernization of agriculture through agricultural methodologies) will be developed.

Master Plan and WEB Platform for experience exchanges in organic soils management will be drawn up for the reduction of GHG in the Floodplain and the Danube Delta and guidelines for good practices of organic soils management.

MANAGING WATER AND SEDIMENT (DIS)CONNECTIVITY IN FLUVIAL SYSTEMS: SOME PRINCIPLES AND APPLICATIONS

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Globally, fluvial systems are under considerable and increasing threat from a multitude of anthropogenic stresses. These include different types of direct (e.g. river engineering) and indirect human impacts (e.g. land cover/use or climate change) that alter water and sediment dynamics, further affecting fluvial ecology. It is widely known that (dis)connectivity relationships in river and catchment systems determine the source, timing and rates of water and sediment flux and thus their geomorphic sensitivity and response to disturbance. However, in many river and catchment management plans the role of water and sediment (dis)connectivity is not fully considered. Here we use examples from different environmental settings with different water- and sediment-related problems to show how understandings of water and sediment (dis)connectivity can inform catchment-based management and floodplain ecology. Specifically, we focus on concerns for river conservation and recovery. Moreover, we present questions for practitioners to appropriately contextualise (dis)connectivity concepts in system-specific place-based river and catchment management applications.

LONG-TERM MONITORING OF AQUATIC AND RIPARIAN VEGETATION ALONG A BYPASS WATERCOURSE IN A FLOODPLAIN FOREST BETWEEN NEUBURG AND INGOLSTADT (BAVARIA/GERMANY)

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In 2010, a large restoration project was implemented in a floodplain forest of 1,200 ha between Ingolstadt and Neuburg (Bavaria/Germany), which diverts water from the Danube into the floodplain forest continuously and during ecological floodings.
From 2009 – 2013, the MONDAU I-project addressed the short-term development of the fluvial morphodynamics of the new water course, as well as the vegetation and floodplain fauna (fishes, arthropods, molluscs). In a sub-project, we investigated the aquatic and riparian vegetation along the floodplain stream and in the adjacent floodplain. The short-term monitoring revealed an increase in aquatic plants and indicators of changing water level including endangered species. Furthermore, willow species were able to re-establish, especially in newly created river sections. Already in the first years with ecological flooding events, the aquatic and riparian vegetation quickly reacted to the more natural conditions.
After 12 years of restoration, a repeated survey addressing the long-term development of the vegetation is now being carried out in the MONDAU II-project. In addition to the long-term development of the aquatic and riparian vegetation, the differences between different pre-restoration conditions of the watercourse were also investigated. For the survey of aquatic and riparian vegetation, 19 cross-profile transects as well as 99 permanent observation plots both already established in 2008 were observed in 2022 again. In this way, the long-term development indicating the success of the restoration project can be separated from the short-term changes, also driven by strong construction activities. The contribution will present the method and the current results of the long-term monitoring of the aquatic and riparian vegetation along the new watercourse. We observed that some riverbanks widened though fluvial and geomorphic processes. Furthermore, reed beds and target species established in flat streambanks and the proportion of macrophytes increased. The species composition differed between the sections with different pre-restoration conditions.

ESTIMATIONS OF STERLET POPULATIONS BASED ON MONITORING DATA IN THE AUSTRIAN DANUBE

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Anthropogenic impacts along the Danube led to declining sturgeon populations. In the Austrian Danube, only two free-flowing sections remained due to the construction of a chain of ten hydropower plants (HPP). As a result, the sterlet (*Acipenser ruthenus*) is the only remaining sturgeon species and classified as "critically endangered". Its population size was estimated at <1000 spawners based on expert judgement but monitoring-based estimations for the Austrian Danube are unavailable. This study aims to describe the population structure and to estimate the size of the remnant population in the free-flowing section east of Vienna using Capture-Mark-Recapture techniques and to estimate the population size below the HPPs Jochenstein and Freudenau based on population genetics. A four-year net fishing campaign at Freudenau resulted in 38 captured sterlets, whereas 132 individuals were captured below Jochenstein since 2011. The Freudenau population composed of 27 females, 7 males and 4 fish with unknown sex. Females were larger and heavier (total length (TL) = 800 mm (SD = 62 mm); weight (W) = 3294 g (SD = 1324 g)) than males (TL = 660 (SD = 73 mm); W = 1350 g (SE = 358 g)). The estimated population size based on a POPAN model (53 individuals (95% CI = 43-80)) and the closed population model M_t (48 individuals (95% CI = 42-63)) overlapped to some extent. Genetic based population estimates amount to 75 individuals (95% CI = 46-146) for Freudenau and to 99 (95% CI = 74-136) for Jochenstein assuming random mating. This study provides the first monitoring-based population estimates for the sterlet in the Austrian Danube and represents a base for future monitoring. Low numbers of mature sterlets and missing evidence of natural reproduction pose an urgent need for action like the re-opening of migration corridors and habitat protection.

EFFECTS OF CHANGES IN LONGITUDINAL CONNECTIVITY ON POTAMODROMOUS FISH IN THE UPPER DANUBE CATCHMENT

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In central Europe and many other parts of the world rivers have commonly been subjected to severe human interferences. As a result, the aquatic as well as the riparian flora and fauna is impacted by stressors such as morphological alterations, pollution or water abstraction. Therefore, the ecological resilience of the overall river meta-ecosystem increasingly depends on its interconnectedness in order to compensate for local habitat loss or degradation. However, the constructions of dams, hydraulic structures for navigation as well as flood protection measures have led to a severe fragmentation of most river networks. Only during the past 20 years, measures to improve the connectivity have been implemented. While continuum interruptions have to be considered as a four-dimensional stressor (longitudinal, lateral, vertical, temporal), we focus on the longitudinal dimension using the concept of the meta-ecosystem as a theoretical background. Here we investigate both long-term changes and recent conditions, evaluating whether or not some of the ecological effects of river fragmentation or potential effects of restoration measures can be quantified on the reach and catchment scale. For this purpose we calculate and compare connectivity indices with parameters that characterize the status of biological quality elements such as the fish fauna using the Austrian Danube and its tributaries as a study site. Many fish taxa act as highly suitable indicators for interruptions of the longitudinal continuum due to their mobility patterns while at the same time their dispersal pathways are almost exclusively located along the river network. Finally, we give implications for future studies and draw conclusions regarding the importance of connectivity for management plans.

MODELLING NUTRIENT RETENTION UNDER CONSIDERATION OF CURRENT DISCHARGE AND INUNDATION IN THE GERMAN DANUBE

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River basin management plans in Europe aim to reduce nutrient emissions and concentrations in rivers. Retention in the river and the adjacent floodplains is still not completely understood due to its complexity. There are few nationwide models that either consider in-stream retention only or the contribution of floodplains as temporal wetlands to nutrient retention on the basis of proxy values. However, an approach specifically for floodplains that considers hydrology and as such days of inundation, incoming nutrient load and retention time is missing.

Based on the work of Natho (2013) we developed a nationwide approach to model nutrient retention in floodplains. Therefore, nutrient concentrations, water temperatures and discharges of more than 140 monitoring stations and gauges (years 2000 to 2019) as well as long-term statistics of discharges were considered. We built a random forest to predict daily nutrient concentrations as well as water temperatures for each location because data frequency was not sufficient. Flood hazard maps serve as an input for the relevant floodplain area. The model developed consists of three sub-models. First, the inundated area and second, the incoming load and discharge are calculated dependent on the daily discharge. These daily models serve as input for the empirical monthly retention model considering simple retention terms for both nitrogen and phosphorus.

We modelled nutrient retention in floodplains along 60 rivers including the Danube and several tributaries. Floodplains can serve as hot spots of retention when inundated and retain more nutrients than the river itself during higher floods.

Our approach allows to model incoming load and inundated floodplains on a daily basis, representing current hydrologic conditions and finally nutrient retention in floodplains specifically during inundation. The results help river basin managers to better understand, where, when and how much of the nutrient emissions is retained in rivers and floodplains.

Reference

Natho, S. (2013) Modelling nutrient retention in floodplains - Development of a concept to empirically derive the average inundated floodplain extent and incoming nutrient loads, Humboldt University.

EFFECTS OF PESTICIDES TO BENTHIC INVERTEBRATE COMMUNITY IN THE SERBIAN DANUBE STRETCH USING THE SPEAR INDEX

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Pesticides are frequently detected in surface waters, sometimes at levels exceeding ecotoxicological guidelines (Bighiu et al, 2020). Pesticide residue contamination of surface water in agricultural areas can have adverse effects on the ecosystem (Lundqvist et al, 2019). Most pesticides in water are originated by surface runoff, or leaching through soil affecting different biological communities in aquatic ecosystems. The $SPEAR_{pesticides}$ index is a pesticide-specific bioindicator based on biological traits sensitive to pesticide effects (Liess et al, 2008). The Serbian Environmental Protection Agency (SEPA) conducts regular surface water monitoring in the entire territory of Serbia. The present study aimed to provide data on effects of pesticides to non-target freshwater organisms (benthic invertebrates) using the SPEAR index at 9 sampling stations of the Serbian Danube stretch: Bezdan, Bogojevo, Novi Sad, Zemun, Smederevo, Banatska Palanka, Tekija, Brza Palanka, and Radujevac, over a six year period (2014-2019). During 2014 extreme rainfall and floods were registered in Serbia, and in 2017/2018 extreme drought, respectively. Since the SPEAR index has been primarily developed for small to medium streams, the main goal of the study is to test the use of the SPEAR index in large rivers (the Danube River). Most commonly detected pesticides in higher concentration in the water of the Serbian part of the Danube River are: metolachlor, atrazine, terbuthylazine, desethylterbuthylazine, terbutryn and isoproturone. Benthic invertebrate community composition and structure varied from the Danube River entering to Serbia (Bezdan) to its leaving (Radujevac). As conclusion, lower SPEAR index values were calculated at sampling stations situated in the Danube River backwater zone, whilst the SPEAR index values were higher along the main course of the Danube River in Serbia. Also the Danube River backwaters could act as refugia for more tolerant benthic invertebrate taxa to pesticide pollution.

ALTERATIONS IN THE ALGAL DIVERSITY TO BE USED AS AN INDICATOR OF THE FORTY-YEAR TRANSFORMATION OF THE HYDROLOGICAL REGIME OF THE SASYK ESTUARY TO THE RESERVOIR (THE DANUBE RIVER BASIN)

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Forty years ago, the transformation of the coastal estuary of the Black Sea to a freshwater dominated reservoir was started with the connected of the Danube River by the Danube-Sasyk Canal. Today, the inflow of Danube water into the Sasyk is the main component of the water balance, affecting the internal and external water exchange and, in general, the quality of the aquatic environment. In addition, the channel is a migration route for hydrobionts and the main source of invasion. We describe the algal composition changes in Sasyk, which were converted from an estuary to a reservoir during three intervals (stages). It was determined that one of the important factors was the decrease in the salinity levels. A comparison of salinity levels taken from historical data and different hydrological transformation stages of the studied waterbody revealed that its level reduced from 1967–77 till nowadays. Analysis of the algal communities revealed salinity as the main controlling parameter of diversity. Rare marine and freshwater taxa that were present in algal composition during the modern era of the reservoir and their transformation have been discussed. The ecological analysis during different periods of Sasyk transformation from an estuary into a reservoir testifies as an improvement of the ecological status of the studied waterbody nowadays. To keep the current ecological status of the reservoir and its hydrological stability, the role of the Danube River should be considered.

FLY, FLY BIRDIE: TOWARDS A UAV ASSISTED MONITORING OF AQUATIC MACROPHYTES WITHIN LARGE RIVERS

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Compared to traditional methods, UAV assisted technologies offer a time and cost-effective framework for assessment and monitoring of aquatic habitats. The aim of the study was to develop an UAV-based acquiring and GIS-based image processing workflow for the detection and monitoring of aquatic macrophytes in large temperate rivers.

According to the Joint Danube Survey (JDS) protocols and CEN EN-14184:2014 standard, assessment of macrophytes along large rivers such as the Danube River should be conducted by 1km long transects along the riverbank. Therefore, seven distinctive river transects of the Middle Danube area in Serbia were included in the study. Macrophytes were simultaneously assessed using standard plot and transect field methods, but also using the RGB and multispectral cameras carried by a fixed-winged drone. UAV images were processed and orthomosaics were classified using Object Based Image Analysis (OBIA), producing digital GIS maps of the river transects.

The relative abundance of 22 macrophyte species was recorded along the transects using standard monitoring methods. On the other hand, UAV - OBIA approach detected eight aquatic macrophytes classes, defined based on dominant macrophytes species. Aquatic vegetation was 'almost perfectly' distinguished from the orthomosaics with classification accuracy of 0.84 for RGB and 0.95 Kappa index for multispectral approach. Classification accuracy of individual macrophytes classes varied between 0.5 and 1 Kappa and was generally higher for the multispectral imagery approach.

Although inferior when it comes to the taxonomic data resolution, UAV monitoring approach provided the necessary spatial context of the macrophytes distribution and absolute area occupied by macrophytes. Furthermore, it also provided information about the diversity and distribution of habitats along the river. Therefore, UAV assisted monitoring approach described in this study can be effectively incorporated in macrophytes monitoring in large river expeditions such as JDS.

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