

PROGRAMME & ABSTRACTS



wetlanet



INTERNATIONAL CONFERENCE

WETLANDS: FUNCTIONING, MANAGEMENT AND RESTORATION

16 – 19 October, 2011

Albena Resort, Varna, Bulgaria

Organised by:

Institute of Biodiversity and Ecosystem Research
Bulgarian Academy of Sciences
Project **WETLANET** (FP7 EC, Capacities, Grant 229802)

SOFIA, 2011



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Programme and Abstracts

Edited by B.B. Georgiev and G.P. Vasileva

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WETLANET INTERNATIONAL CONFERENCE

WETLANDS: FUNCTIONING, MANAGEMENT AND RESTORATION

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(Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences,
2 Gagarin Street, 1113 Sofia, Bulgaria; www.iber.bas.bg)

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PROGRAMME

16 October 2011, Sunday

13:00 - 18:30 Registration (Flamingo Grand Hotel)

19:00 - 21:00 Welcome Cocktail

17 October 2011, Monday

09:00 – 09:30 Official Opening

- 09:30 – 10:30 Plenary Session I
Co-chaired by N. Chipev and J. Duarte
- 09:30 – 10:00 Y. Uzunov: The Water Framework Directive (2000/60/EC) and the wetlands
- 10:00 – 10:30 A.J. Green: Ornitholimnology: a review of the functional role of birds in wetlands

10:30 – 11:00 Coffee Break

11:00 – 12:15 Thematic Session I.

WETLAND ECOSYSTEMS: STRUCTURE AND FUNCTIONING

Co-chaired by A. Protasov and L. Pehlivanov

- 11:00 – 11:15 A. Panova-Karadzova, Å.H. Frostegård, B. Lui: Introducing molecular analysis by studying denitrification bacterial population in soils from wetland Srebarna
- 11:15 – 11:30 R. Kalchev: Primary production and respiration in pelagial of five wetlands from Bulgarian Danube section
- 11:30 – 11:45 S. Kazakov, V. Tzavkova, L. Pehlivanov: Zooplankton diversity in relation to flooding dynamics of some wetlands along the Bulgarian Danube stretch
- 11:45 – 12:00 C. Casagrande, S. Klayn and D. M. Gallego: Macrozoobenthos of Atanasovsko Ezero (Bulgarian Black Sea coast): importance of sediment biodiversity for function and sustainable use
- 12:00 – 12:15 M. Pavlova, L. Pehlivanov: Trophic attributes of ichthyocenosis in Srebarna Biosphere reserve (NE Bulgaria) in terms of changing water level

12:15 – 14:00 Lunch Break

14:00 – 15:00 Plenary Session II

Co-chaired by Y. Uzunov and A.J. Green

- 14:00 – 14:30 A. Protasov: Water techno-ecosystems and wetlands: ideas and research approaches
- 14:30 – 15:00 J. Duarte, C. Freissinet, A. Sombardier, S. Akeraj, P. Huntjens: An IWRM case study in Portugal, France and Thailand including wetland conservation and climate change

15:00 – 15:30 Coffee Break

15:30 – 16:00 Poster Session I. Organisers: R. Fikova and D. Dimitrov

16:00 – 17:00 Thematic Session II. WETLAND CONSERVATION

Co-chaired by J. Matos and V. Biserkov

- 16:00 – 16:15 N. Petkov: On applicability of the ferruginous duck (*Aythya nyroca*) as an indicator species to assess the result of the wetland restoration projects along the Danube River in Bulgaria
- 16:15 – 16:30 D. Gradinarov, M. Gramatikov, S. Nikolov, D. Perez Lopez, T. Michev & V. Biserkov: Long term changes in wetlands cover and the distribution of a flagship species at national level: the case with the White Stork (*Ciconia ciconia*) in Bulgaria
- 16:30 – 16:45 N. Ivanova: The long-term changes in the colony of Dalmatian pelican in Srebarna Biosphere Reserve, NE Bulgaria (a review)
- 16:45 – 17:00 N. Petkov, P. Cranswick, G. Popgeorgiev, G. Hilton: The lakes of Shabla and Durankulak as key sites for the red-breasted goose and first results of local movements studies using GPS radio tags

**17:00 – 20:00 Tour of Varna with a wine tasting
(not included in the Registration Fee)**

18 October 2011, Tuesday

9:00 – 10:00 Plenary Session III

Co-chaired by S. Chankova and P. Zehinjev

- 09:00 – 09:30 S. Bensch: Spread of tropical malaria parasites in a changing climate
- 09:30 – 10:00 J. Matos, C. Borges, D. Mendonça, J. Guimarães, M. Varandas, P. Sá-Pereira, F. Simões: Genetic markers for assessing and preserving biodiversity

10:00 – 10:30 Coffee Break

10:30 – 12:15 Thematic Session III.

WETLANDS BIODIVERSITY: POPULATIONS, COMMUNITIES, INTERSPECIFIC INTERACTIONS

Co-chaired by S. Bensch and V. Peneva

- 10:30 – 10:45 M. Ilieva, S. Bensch, O. Oparina, M. Oparin, B. Hansson, S. Åkesson, D. Dimitrov, A. Križanauskiene, P. Zehntindjiev: Range expansion of Pad dyfield warbler (*Acrocephalus agricola*) in wetlands along the Black Sea coast: population differences in genetics, parasite diversity and behaviour
- 10:45 – 11:00 P. Zehntindjiev, S. Hahn, V. Amrhein, M. Ilieva, D. Dimitrov, A. Križanauskiene, A. Bobeva, M. Marinov, S. Bensch: Connectivity of Bulgarian wetlands: outcomes from bird malaria research and high technology in bird migration studies
- 11:00 – 11:30 D. Dimitrov, P. Zehntindjiev, M. Ilieva, S. Bensch: Bird malaria and related haemosporidian parasites at Kalimok wetland area
- 11:30 – 11:45 P. Gil de Mendonça: Emerging infectious diseases and wetland conservation: the key to a can of worms?
- 11:45 – 12:00 B.B. Georgiev, M. Sánchez, S. Redón, G.P. Vasileva, P.N. Nikolov, P. Pankov, Y. Dimitrova, F. Amat, A.J. Green: Brine shrimps, water birds and avian cestodes: ecological consequences of parasitism in hyperhaline wetlands during an ongoing biological invasion
- 12:00 – 12:15 F.M. Bazigou, R. Merken, N. Koedam: A migratory corridor for wetland birds requires internationally coherent policies: the role of Greece in the Adriatic-Ionian Flyway

12:15 – 14:00 Lunch Break

14:00 – 15:00 Thematic Session IV.

COASTAL MARINE ZONES: FUNCTIONING AND RESTORATION

Co-chaired by G. Hiebaum and G. Daskalov

- 14:00 – 14:15 D. Berov, V. Vasilev, D. Deyanova, B. Gyosheva, G. Hiebaum: *Cystoseira* sp. macroalgal communities in SW Black Sea (Burgas Bay, Bulgaria): distribution, community structure, and possible long-term impact of eutrophication
- 14:15 – 14:30 D. Deyanova, S. Klayn, J. Georgieva, D. Berov, V. Valchev, V. Georgiev, S. Coneva, V. Karamfilov, G. Hiebaum: Sea-grass meadows in a eutrophic gradient: preliminary study of infauna and plant biomass from Burgas Bay to Ropotamo River mouth
- 14:30 – 14:45 S. Klayn, C. Casagrande, D.M. Gallego: First results on abundance and

population structure of two deposit feeders in a man-made poikilohaline lagoon on the Black Sea coast, Atanasovsko Lake (Bulgaria)

- 14:45 – 15:00 G. Hiebaum, S. Bayalcaliev: Estimation of primary production of a wide polygon in the marine coastal zone
- 15:00 – 15:15 G. Daskalov: Integrated analysis and environmental status evaluation of marine ecosystem perturbed by regime shifts: the Black Sea

15:15 – 15:30 Coffee Break

15:30 – 16:00 Poster Session II.

Organisers: E. Varadinova and S. Kazakov

16:00 – 17:15 Thematic Session IV.

WETLAND MONITORING, MANAGEMENT, RESTORATION AND SUSTAINABLE USE
Co-chaired by J. Dušek and G. Vasileva

- 16:00 – 16:15 S. Chankova, D. Miteva, Z. Mitrovska, N. Yurina: Stress response of *Chlorella* species isolated from contrasting habitats
- 16:15 – 16:30 M. Kerakova, R. Soufi, E. Varadinova: New developed functional indices based on macroinvertebrate communities – adaptation and establishment on Bulgarian river ecosystems
- 16:30 – 16:45 P. Cudlín, H. Čížková, J. Pokorný, L. Štěrbová: Catalogue of measures to increase carbon deposition in wetlands
- 16:45 – 17:00 H. Soyhan: Enhancing emission characteristics of heat exchangers used in desalination of sea water
- 17:00 – 17:15 P. Borisova, Y. Uzunov, J. Liem: A Qualitative Reasoning Approach to modelling fish mortality due to algal blooms in wetlands nearby urban areas

17:15 – 17:45 Round Table. LONG-TERM RESEARCH OF WETLAND ECOSYSTEMS

Co-chaired by P. Cudlín and S. Bratanova-Doncheva

17:45 – 18:00 Concluding Session.

Co-chaired by B.B. Georgiev and A.J. Green

19:00 - 23:00 Official Dinner

19 October 2011, Wednesday

09:00 – 17:00 Tour to Durankulak Lake and Balchik

ORAL PRESENTATIONS

Official Opening

(17 October 2011, 9:00 – 09:30)

THE PROJECT “WETLANET – ENHANCING RESEARCH POTENTIAL BY STRENGTHENING A LOCAL NETWORK OF LABORATORIES FOR STUDYING WETLAND ECOSYSTEMS FUNCTIONING, RESTORATION AND MANAGEMENT”

Boyko B. Georgiev, Gergana P. Vasileva, Elena Semerdjieva

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WETLANET is a project implemented during April 2009 – March 2012 by the Central Laboratory of General Ecology (CLGE-BAS), which is now in the frames of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (IBER-BAS). This project is funded by the program CAPACITIES (FP7), with co-funding provided by the National Science Fund (Ministry of Education, Youth and Science, Republic of Bulgaria). The aim of the project is to enhance the research potential of the CLGE-BAS by strengthening a local laboratory network for studying wetlands ecosystem functioning, restoration and management. The local network includes three remote field stations situated at wetlands of major ecological importance (Srebarna Biosphere Reserve at the Lower Danube, Atanasovsko Lake Reserve at Burgas and in the town of Sozopol) as well as the specialised laboratory units at the headquarters of the institute in Sofia. Significant part of the tasks has been achieved during the last 30 months. (1) Improving the human capacity: in total 15 outgoing visits of young scientists for specialisation and training and 14 incoming visits of foreign experts were organised for exchange of know-how and experience; six specialists with international experience were employed and involved in wetland studies – five biologists experienced in studying biodiversity and ecosystems of wetlands, and a chemist with skills and knowledge in using gas-chromatography for environmental risk assessments in coastal zones. (2) Upgrading the technical and IT capacity of the WETLANET laboratories: a public auction procedure for purchase of new research equipment was successfully accomplished; as a result, the laboratory units at the headquarters and those of the field stations were renewed with optical devices (microscopes, binoculars), GC/MS spectrophotometer, growing chamber, ICP

analyser, a boat for coastal investigations, new IT equipment, etc. (3) Achieving better integration of CLGE-BAS (IBER-BAS) in ERA: 4 workshops (“Genetic monitoring”, “QR modelling”, “Lower Dabube wetlands” and “Coastal marine communities”) and 4 training courses (“Database creation and management”, “Multivariate statistics”, “Molecular and biochemical markers in ecotoxicology”, “GIS in wetland studies”) were organised; participants were young scientists from our institute and related academic units, MSc students, and lecturers were renown foreign experts; these scientific and training events helped in promotion of new research collaborations and establishment of multilateral partnerships for further participation in consortia and joint research projects; in total, 29 persons participated in international conferences and training courses. (4) Dissemination of achievements of wetland science (including recent developments in WETLANET laboratories) in the society: the main tool is the website of the project (<http://wetlanet.org>); two bilingual brochures and organisation of the 4 open-doors days targeting academic institutions, students, industry, authorities and nongovernmental organisations. Further work of WETLANET project is aiming: (i) successful promotion and utilization of the new research capacity (especially that of the field stations) in order to strengthen the overall research performance of the institute (in terms of publications, visits, participation in scientific events); (ii) organisation of promotional events in view of increasing visibility of the research activities, improving their response to socio-economic needs of the country and improving the participation in new research projects.

Plenary Session I

(17 October 2011, 9:30 – 10:30)

THE WATER FRAMEWORK DIRECTIVE (2000/60/EC) AND THE WETLANDS

Yordan Uzunov

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The report is aiming a brief review on how the Water Framework Directive (WFD 2000/60/EC) implements the basic principals and definitions of the Ramsar Convention (1971) on Wetlands of International Importance especially as Waterfowl Habitats. What the wetlands are under the WFD? What is the difference between “wetland” and “water body”? Where is the role of wetlands within the River Basins Management Plans? How to perform the monitoring of the ecological status of wetlands? Is the Ramsar’s “wise use” the same as sustainable development and management?

In 1995 the Commission approached to the Council and the European Parliament a Communication on the Wise Use & Conservation of Wetlands, and recognised the very critical situation of Europe’s wetlands and the very urgent need for action. It underlined the widespread loss and degradation of wetlands that has resulted in a significant reduction of the beneficial functions they perform in renewing natural resources. By promoting the wise use and conservation initiative the Commission stressed the EU’s involvement in wetland protection and enhancement and its commitment in setting up strategic policies for sector integration. The WFD identified the protection, restoration and enhancement of the water needs of wetlands as part of its purpose at Article 1(a): “. . . to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. . . which prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems”. However, the WFD did not provide any specific definition of what a wetland is, nor did it clearly state the extent to which wetlands should be used for the achievement of the Directive’s environmental objectives (achieving good status of all water bodies by 2015).

Wetlands are not defined as a separate water category or water body type within the WFD. There are, however, explicit references to wetlands within the Directive. Wetlands could be considered as relevant under the Directive in three contexts:

As part of the structure and condition of riparian zones of rivers, shore zones of lakes and intertidal zones of transitional and coastal water;

As directly dependent (on water) terrestrial ecosystems in the definition of good ground-water quantitative status and good groundwater chemical status; and

For use in supplementary measures, which MSs may use where cost-effective, to achieve the Directive’s environmental objectives.

ORNITHOLIMNOLOGY: A REVIEW OF THE FUNCTIONAL ROLE OF BIRDS IN WETLANDS

Andy J. Green

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Since Hurlbert published a seminal paper on ornitholimnology in 1983 (PNAS 809: 4766-4769), surprisingly little attention has been paid to the role of birds in aquatic systems. Birds are more important than fish in many freshwater systems, especially shallow or temporary ones. Using examples from Spain and elsewhere, we present a review of the limnological role of birds in the hope of stimulating further research. As predators, grazers and ecosystem engineers they have a profound effect on the abundance of other organisms and on ecosystem functioning. They influence sediment stability and suspension, and the switch between clear water and turbid water states. Owing to their mobility, they play an important role in nutrient cycling and eutrophication. They can have a major role in carbon cycling, especially during the breeding season. As ideal vectors for the dispersal of plankton, macrophytes and macroinvertebrates they have a central role in maintenance of biodiversity and in metapopulation dynamics. They also disperse parasites, pathogens and invasive species between aquatic systems. Collaborative research between limnologists and ornithologists can improve our understanding of aquatic systems.

Thematic Session I. Wetland ecosystems: structure and functioning

(17 October 2011, 11:00 – 12:15)

INTRODUCING MOLECULAR ANALYSIS BY STUDYING DENITRIFICATION BACTERIAL POPULATION IN SOILS FROM WETLAND SREBARNA

Antoaneta Panova-Karadzova¹, Åsa Helena Frostegård², Binbin Lui²

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Wetlands play important roles for nutrient cycling and contribute to ecosystem functioning more than most other ecosystems, measured per unit area. They provide ecosystem services such as flood control and water purification, and are also habitats for a large biodiversity. Wetting and drying cycles are frequently occurring in the ecotonal zones of wetlands and microorganisms living in such environments are therefore regularly challenged with fluctuating oxygen levels. It is generally assumed that organisms increase the chances of survival during anoxic spells by switching to anaerobic respiration. Microbes play major roles in the biotransformation of N_2 and many types of prokaryotes, and some eukaryotes, are able to use nitrogen oxides as alternative electron acceptors through the process of denitrification. Complete denitrification, by which nitrate is reduced to N_2 , involves four reductases; nitrate reductase (NAR/NAP), nitrite reductase (NirK/NirS), NO reductase (NOR) and N_2O reductase (N_2OR). In addition to the reductases, the denitrification regulatory network consists of several regulatory enzymes and ancillary factors. Denitrification leads to emissions of NO, N_2O and N_2 , depending on the relative activity of the enzymes catalyzing the reduction. N_2O is a potent greenhouse gas implicated in global warming and destruction of the ozone layer. N_2O accounts for 6% of the total amount of the green house gases in the atmosphere and has 320 times stronger global warming potential than CO_2 . The main sources for N_2O are agricultural and native soils, in which predominantly denitrification and to some extent also nitrification, are responsible for its production. The levels of N_2O are currently increasing by approximately 0.3% per year and may significantly affect the global climate over the next 100 years. Several factors may affect the levels of N_2O emitted from a soil, including the size and composition of the denitrifier community, the relative number of denitrification genes, their gene sequences, the transcriptional control as well as post-transcriptional effects, and direct effects on the reductases by environmental factors such as O₂ levels or pH. Our approach is to combine refined gas kinetics analyses performed under controlled laboratory conditions, with molecular analyses of denitrification genes and transcripts, to understand factors that control N_2O/N_2 product ratios.

We here present a study of two transects in a wetland in Bulgaria (Srebarna Biosphere Reserve) with respect to distance from water (flooded vs non-flooded soils), and soils from the surrounding agricultural lands (natural vs anthropogenically influenced soils). We analyzed the quantity and distribution of 16S rRNA gene copies (as a measure of total number of prokaryotes) and *nirS*, *qnorB* and *nosZ* encoding the respective enzyme. In one of the transects the number of denitrification genes was highest in the water front and decreased with distance from the water, indicating that frequent changes in O₂ concentrations and redox potential as a result of flooding will favor populations of denitrifying bacteria. Such a relationship was, however, not seen in the second transect. In relation to land use, the number of denitrification genes was higher in the soil from the wheat field compared to soil with natural vegetation, but this was not found for the village soil, indicating that nitrogen fertilizers influenced the size of the denitrifier community. A positive correlation was also found between the numbers of denitrification genes and the NO₂-N and total nitrogen concentration. To further understand factors that affect the regulation of denitrification in these soils we plan to perform detailed analyses of gas kinetics using a specialized, robotized incubation system, as well as quantitative analyses of transcription levels for the genes coding for the denitrification reductases.

PRIMARY PRODUCTION AND RESPIRATION IN PELAGIAL OF FIVE WETLANDS FROM BULGARIAN DANUBE SECTION

Roumen Kalchev

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Primary production and respiration in pelagial of five wetlands from Bulgarian Danube section were studied. These were two water bodies of canal type (in Kalimok and Brashlen area) and three marshes or shallow lakes, i.e. Dyuleva Bara, Murtvo Blato and Pischinsko Blato (Belene Island). The plankton primary production and respiration in the pelagial were measured by changes of dissolved oxygen in light and dark glass bottles. The oxygen concentration was determined by the classic Winkler titration. The sampling frequency has encompassed three seasons of the year (spring, summer and autumn), with start in autumn 2009 and envisaged termination of studies in autumn 2011. In most cases, the photic zone of these very shallow water bodies stretched over the whole pelagial space reaching the bottom, with few exceptions predominantly during the summer. The shape of the photosynthetic depth profile varied between surface light inhibition (mainly in high water spring and low water autumn seasons) and intense surface shading during the summer. The same seasonal difference in depth profile was reported for primary production measurements in another Danube wetland, the Srebarna Lake (Kalchev R.K., Vasilev V.P., Tzavkova V., Beshkova M.B., in press, Changes of water transparency, plankton primary production and chlorophyll a in the course of Srebarna Lake recovery).

The geometric mean values obtained for gross plankton primary production per m² placed almost all studied water bodies in the mesotrophic range (Likens G.E., 1975, Primary production of inland aquatic ecosystems. In: Lieth H. & Whittaker R.H. (Eds) *Primary Productivity of the Biosphere, Ecological Studies 14, Springer Verlag, Berlin et al.*, pp. 185-202). However, this trophic estimation did not correspond to the actual ecological status, which obviously was of higher productivity, because the phytoplankton as primary producer played a subordinate role compared to the macrophytes. Therefore the oxygen concentration in the waters did not depend primarily on photosynthetic activity of phytoplankton but on macrophyte abundance in water surface and in water column, on water level variations, availability of thermal stratification, horizontal flow movements, etc.

The percentage of macrophyte surface coverage correlated significantly and negatively with oxygen concentrations. On one hand, the oxygen was consumed by decomposing macrophytes and abundant animal life. On the other hand, the emerged macrophytes suppressed phytoplankton photosynthesis and physical oxygen diffusion. Therefore, except for single case of extreme shallowness and lack of macrophytes, the oxygen concentrations never reached 100% saturation and under stratified conditions the bottom layers and even the whole water column of waters rich in macrophytes showed no oxygen and strong odour of sulphur hydrogen. In such cases, we detected no respiration, because under anoxic conditions the intensity of anaerobic decomposition of organic matter could not be measured by the oxygen method.

We might conclude again that the proper functioning of considered aquatic wetland ecosystems could not be approached without at least partial periodical removal of accumulated and still accumulating organic substances.

ZOOPLANKTON DIVERSITY IN RELATION TO FLOODING DYNAMICS OF SOME WETLANDS ALONG THE BULGARIAN DANUBE STRETCH

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Studies on the dynamics of species diversity and abundance of zooplankton communities under variable flooding conditions in six riparian wetlands along the Lower Danube were carried out. The marshes Belene, Brashlian, Kalimok, Orsoya and the lakes of Srebarna and Malak Preslavets were studied during 2010-2011. In total, 81 quantitative zooplankton samples were collected and analysed. Studied wetlands in the floodplain of the Danube River belonged to various hydromorphological types. Some of them had groundwater and/or surface feeding (including more or less regular flooding by the river), while others dried up completely through the low-water periods. In the spring of 2010, high water levels in the Danube flooded a lot of riparian wetlands. In the next year, during the spring of 2011, no inundation of the floodplains was observed. During the present study, over

50 taxa were identified at the species level. The highest species richness was found in the Rotatoria. During the flooding period, the Copepoda were the most abundant group while during the low-water period, in some of the studied sites, the abundance of the zooplankton communities was formed mainly by the Cladocera. The highest total species richness of the zooplankton was found in the Srebarna Lake, and the lowest number of species was counted in the lake of Malak Preslavets. Analysis of the biodiversity and the abundance of the zooplankton of the Danube River showed much lower values compared with those of the floodplain areas.

MACROZOOBENTHOS OF ATANASOVSKO LAKE (BULGARIAN BLACK SEA COAST): IMPORTANCE OF SEDIMENT BIODIVERSITY FOR FUNCTION AND SUSTAINABLE USE

Caterina Casagrande, Stefania Klayn, David Martín Galego

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The Bourgas Wetlands play an important role for the Western Palaearctic migrating and wintering waterbirds through its specific biogeographical position. Together with the Danube Delta, they constitute a rest and concentration place on the Western Palaearctic migratory route *Via Pontica*. Atanasovsko Lake is the most important site of the Bourgas wetlands with bird densities of up to 2 times more than on the other sites, e.g. Pomoriysko, Vaya and Mandrensko lakes. The total numbers and diversity are much higher during migrations and wintering than during the breeding season and consist mainly of waders. Birds moving within or through Atanasovsko Lake are vectors that transport nutrients and organic matter across terrestrial, freshwater and marine interfaces. As such, Atanasovsko Lake is a critical transition zone that link land, freshwater habitats and the sea. It provides essential ecological functions, including nutrient production, decomposition and nutrient cycling, as well as regulation of fluxes of nutrients, water, salt, particles, pollutants and organisms to and from land and sea. Sediment-associated biota is integral to these functions. Nevertheless, functioning of its aquatic ecosystem is poorly known. This constitutes an important handicap to update the management plan as well as to implement the NATURA'2000 directive and the current Ramsar Strategic Plan.

The objectives of this study are to quantify the life resources of the lagoon and to identify the waterbird – macrozoobenthos trophic relationship. This will be done by regular quantitative sediment coring at 6 sites and bird activity budgets from May 2011 to January 2012. Four sampling campaigns have been carried out on the lagoon and data from three campaigns are available. Present functional groups include deposit feeders and bioturbators, as well as phytoplankton, benthic micro- and macroalgae, heterotrophic bacteria and fungi. Macrophytes, shredders, suspension feeders and fish are absent. All sites were characterized by a remarkable low zoobenthos diversity and abundance, i.e. even lower than inherently usual for such environments. On a whole, only

8 species have been identified, not counting chironomid larvae, which must be determined by a specialist. All sites were dominated in numbers by the meiobenthos. The trophic state of the sample sites was evaluated in terms of total N and Chl *a* values as advanced eutrophic-hypertrophic. Incoming seawater can be classified as oligo-mesotrophic.

Since 1906, Atanasovsko Lake is used for salt production. For this purpose, it has been successively transformed in a complex of evaporation and crystallization ponds for salt-extraction. The construction of drainage canals in the surrounding marshes, an encircling channel connected to the Black Sea around the permanent waterbody and a system of dykes, embankments and wooden locks has transformed a formerly brackish estuarine wetland into an entirely man-made shallow coastal poikilohaline lagoon. Even though at present we do not have statistically validated data, the influence of the water interchange used for salt production on the biological processes in the lagoon is evident. With the movement of water from pond to pond, nutrients, particles, sediments, organisms (from phytoplankton to zoobenthos, adults and larvae) are carried away. The repeated change in the environmental conditions all year long makes the formation of a species rich and stable biocenosis impossible. Increasing summer temperature favors phytoplankton blooms, oxygen deficiency, release of nutrients from the sediment followed by mass perishment. The man-made isolation from land and sea and the defecation of birds that use the dykes as resting places are likely to have put the lagoon over the last century under a regime of self-purification. We hypothesized that the cumulative amount of benthic biomass removed by feeding waterbirds is in the long term limited by the renewal rate of benthic food stocks. Because biotic diversity in such ecosystems is inherently low whereas their functional significance is great, shifts in diversity are likely to be particularly important. Single-species changes can have overt, sweeping effects on ecosystem structure and function. Hardly another place such as Atanasovsko Lake could be found where habitat alteration is both so attractive and repulsive for waterbirds. The positive aspect is that the saltworks themselves are interested in improving the water quality. The complexity of interactions among species and feedbacks with ecosystem functions suggests that comparative (mensurative) and manipulative approaches will be required to elucidate policy options available for protecting and restoring biodiversity and ecosystem function.

serve ecosystem under anthropogenic pressure and impact. A complex of trophic attributes was used for revealing interrelationships within the lake ichthyocenosis. Standard recent methodology for fish trophic studies was used. Eleven fish species sampled during the period 1998-2008 were examined. Fifty seven food components were found in the studied fish digestive tracts. Three main trophic levels and 5 trophic groups (guilds) were defined within the ichthyocenoses on the basis of their frequency of occurrence and volumetric contribution in the gut content. Statistical processing of the raw data was made using software PAST, Primer v6 and Canoco 4.5. A model of trophic net in the fish community of Srebarna Lake ecosystem was built using PowerPlay software for Loop analysis (qualitative modelling of trophic webs). The trophic net consists of 2 interrelated trophic webs, which are relatively spatially divided: one in the central open water body and another one in the periphery pools. The values of diet breadth, niche overlapping and trophic indices have shown significant differences for the periods with low- and high-water levels. This fact focused the study on the examination of environmental factors affecting the fish feeding. The principal component analysis certified considerable influence of both water level and eutrophication rate. Alterations in fish feeding were characterised as a corresponding response of this kind of pressure. The diets of predators (pike, asp, pike-perch) and phytoplanktivorous bitterling remain relatively stable. On the other hand, low-water levels are associated with changes in the feeding of bleak, rudd, gibel carp and nine-spine stickleback. High-water level is connected with changes in the diets of roach, bream and perch. Differences are mainly in the trophic levels of food components.

TROPHIC ATTRIBUTES OF ICHTHYOCENOSIS IN SREBARNA BIOSPHERE RESERVE (NE BULGARIA) IN TERMS OF CHANGING WATER LEVEL

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The study aimed to establish the main trophic characteristics of fish community in the Srebarna Biosphere Re-

Plenary Session II

(17 October 2011, 14:00 – 15:00)

WATER TECHNO-ECOSYSTEMS AND WETLANDS: IDEAS AND RESEARCH APPROACHES

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Techno-ecosystems are systems of both natural and technical biotopes and populations inhabiting them. These elements are in close interrelations and interactions. Cooling reservoirs and water supply systems of thermal power plants, reservoirs of hydroelectric plants, etc., are typical examples of aquatic techno-ecosystems. Important elements of such systems are wetlands, which include both water body and surrounding lands. A typical case study is the evolution of the reservoir of Chernobyl NPP as a water techno-ecosystem and its transformation towards a wetland. The latter is compared with technogenic wetlands around a thermal power plant. The basic features of these ecosystems are discussed. The wetland types are different according to the patterns of connections between terrestrial and aquatic biotic elements. The main properties and structural characteristics of the wetland ecosystems are discussed.

AN IWRM CASE STUDY IN PORTUGAL, FRANCE AND THAILAND INCLUDING WETLAND CONSERVATION AND CLIMATE CHANGE

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Water managers all over Europe and Asia are facing the challenge of implementing and facilitating processes of public participation in decision-making. Within the context of the European Water Framework Directive (WFD)

the public should be consulted at three stages during the planning process and “the active involvement of all interested parties should be encouraged”. The EU Member states and the European Commission have developed a common strategy for the implementation of the WFD. One of the outcomes of this strategy is the “Guidance on Public Participation in relation to the Water Framework Directive; active involvement, consultation, and public access to information on public participation”. The guidance urges water managers not to forget the requirement to encourage active involvement. It describes active involvement as “a higher level of participation than consultation”. Active involvement implies that stakeholders are invited to contribute actively to the planning process by discussing issues and contributing to their solution.

In this work, we argue that the best way to “encourage active involvement” is to foster social learning. Social learning means learning together to manage together. It emphasizes collaboration between different stakeholders, starting at the earliest possible moment. It helps to build trust, develop a common view on the issues at stake, resolve conflicts and arrive at joint solutions that are technically sound and actually implemented in practice. It helps all stakeholders to achieve better results that they would achieve otherwise.

Social learning is required whenever: 1) different stakeholders depend on each other to reach their goals; 2) there is no agreement on the problems at stake; 3) the issues are important enough for the stakeholders to invest the necessary time (and therefore money).

The main question addressed by this study is: What are obstacles and opportunities for stakeholder participation in water resources management in Thailand, Portugal and France? In this paper we critically reflect on the experiences of several processes of stakeholder participation in Europe and Asia. Our purpose is primarily to raise questions about what has been learnt so far, including identifying major pitfalls and opportunities, as well pointing to the needs for further experimentation and research to improve practices. (This study was developed under the EC funded FP6-project ASEMWATERNET, WP5.)

Thematic Session II. Wetland Conservation

(17 October 2011, 16:00 – 17:00)

ON APPLICABILITY OF THE FERRUGINOUS DUCK (*AYTHYA NYROCA*) AS AN INDICATOR SPECIES TO ASSESS THE RESULT OF THE WETLAND RESTORATION PROJECTS ALONG THE DANUBE RIVER IN BULGARIA

Nicky Petkov

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The potential of the Ferruginous Duck (*Aythya nyroca*) for tracking ecological changes in wetlands has been discussed in view of the development of the species population in Srebarna Lake. This population showed strong correlations with ecological parameters of the wetland, i.e., oxygen level, turbidity and water level, thus confirming its potential as an indicator for changes in eutrophic wetlands (Petkov, 2006). According to various authors, diving ducks are amongst the species fit for indicators of water level changes (Frederikson & Taylor, 1982; Frederikson & Ried, 1988; Short, 1989). On other hand, Kantrud & Steward (1984) suggested that most sensitive to wetland changes are those birds that: 1) nest in the periphery of the wetland or the water, 2) forage in mudflats, 3) require structured vegetation of the wetland and certain water regime. These characters fit well to the profile of the Ferruginous Duck. This species has been demonstrated as having habitat preferences towards mudflats and well structured vegetation in wetlands (Petkov, 2004; Petkov, *in press*). An important prerequisite for the applicability of this species as a bioindicator is the wetland to support a viable population during the breeding season. So far, there have been three major Danube River wetlands subject to restoration projects in Bulgaria. These are Srebarna Lake, Kalimok-Brushlen Marshland and the marshes on the Belene Island. The wetland restoration there has revealed some controversies associated with the effect of the restoration activities. For many of those, the immediate effect of the reconnection with the Danube River was reviving; however, following the initial success, the lack of active water management resulted into fast overgrowing and deterioration of the conditions. All three wetlands are known to have been inhabited by large and viable breeding populations. Therefore, the monitoring is well applicable for them and can serve as early warning for changes in the ecological conditions. The inclusion of the species as one of the key objects monitored in the wetland may give a lot of insight in the results of the restoration activities. As an example, this year when low water level of Danube River resulted into low water level in the riverside marshes and wetlands, there was a decrease in population density in all three wetlands. In the case of Belene Island, where major parts of the wetlands dried up, the species was again dispersed in wetlands around as in the years when the marshes were drying up regularly. Similarly, the situation in Kalimok-Brushlen was bad and fatigued population of the species was observed in Srebarna. It is to be studied how sustainable are these restorations without accompanying management activities in long terms.

LONG TERM CHANGES IN WETLANDS COVER AND THE DISTRIBUTION OF A FLAGSHIP SPECIES AT NATIONAL LEVEL: THE CASE WITH THE WHITE STORK (*CICONIA CICONIA*) IN BULGARIA

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The White Stork (*Ciconia ciconia*) is a typical flagship species for Bulgaria, where about 5% of the breeding European population is recorded. Its current distribution covers the lowlands of the country (<1300 m a.s.l.) and it was found to be related mainly to the settlements in vicinity of wet areas or various wetlands. While a small decrease in the south-eastern European population was reported for the 1990s, there was a slight increase of the number of breeding pairs in Bulgaria. So far, there has been no empirical research to investigate what factors influence the trends of the White Stork distribution on a national level. This study aims to investigate the relationship between the shifts in species distribution in Bulgaria for the last 25 years and the changes in wetlands cover for the same period. White Stork distribution in the country was compared between 1979-1981 and 2004-2005 on the basis of national counts of the species for these periods. Changes in species distribution were related to the alterations in landscape characteristics of wetlands. Wetlands cover was analysed on the basis of satellite images and existing data bases. Obtained results broaden the knowledge on the sustainable wetland management with the aim to keep the favourable status of the White Stork breeding population in the country.

THE LONG-TERM CHANGES IN THE COLONY OF DALMATIAN PELICAN IN SREBARNA BIOSPHERE RESERVE, NE BULGARIA (A REVIEW)

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A review of the long-term changes in the breeding colony of Dalmatian Pelican (*Pelecanus crispus*) in the Srebarna Biosphere Reserve is presented and the conservation measures, which have been implemented for this species are discussed. This colony has been known since 1880 (Hodek, 1882; Kalbermatten, 1891;

Lorenz-Liburnau, 1893; Reiser, 1894). In the first half of 20th century, there are only single reports published by Petrov (1947) and Patev (1950). Since 1954, the numbers of breeding pairs in the colony have been documented annually (Paspaleva-Antonova, 1961a, b; Michev, 1981, 1984; Michev et al., 1998; Kambourova, 2005a, b). In the period 1981–2000, the breeding numbers varied between 40 and 93 pairs (average 66). For the period 2001–2009, the number of pairs is between 60 and 150 (average 103 pairs), or av. 36 pairs more in comparison with the 1954–1980. There are also spatial changes of the colony. In the past (even before 1882), the nests were situated in the far north part of the lake. In 1940s, the colony was dispersed and separate breeding pairs bred on floating islets (Petrov, 1947). In present days, the colony is situated in the southern part of northern reedbeds, close to the central open water. In the past, Dalmatian Pelican spent the winter months mostly in Greece (Porto Lago) and Turkey (Manias Giol National Park) and other wetlands in Asia Minor but currently is also known from Bourgas Wetlands (Black Sea coast) and Ovcharitsa Dam (Bulgaria) (Michev and Profirov, 2003). Some conservation measures were implemented in the colony. In 1985, regular ringing of young pelicans was initiated. For the period 1985–1993, every year pelicans were ringed and the total number of ringed young pelicans was 359. For the 1996, 2001 and 2002, the overall number of ringed young pelicans was 201. Totally, 560 individuals were ringed. In 1991 the fens around the pelican colony was built to protect the colony against predators (wild boars, foxes, jackals). In 1998, a partnership between Swarovski Optik and the Foundation “Le Balkan” was established, with the main goal of improving the breeding conditions in the colony at the Srebarna Biosphere reserve. As a result, between 1998 and 2003, a joint team of Le Balkan and Bulgarian Academy of Sciences implemented several important measures at the site. Two pile platforms and also a hide for observations near the colony were built.

Anser albifrons. This causes hunting problems leading to increased mortality and disturbance at the roosting and foraging grounds. Larger goose concentrations also cause conflict with farmers claiming crop damages. The lake of Durankulak is by far more important during the second half of the winter, while Shabla is more important during the first half of the winter. Some bays are also frequented as roosting sites during the species stay in Bulgaria. The studies on the phenology of the species in the region of the two lakes show some shift towards late arrival of the species, almost one month later in the recent years. Birds usually take off in the morning to forage in the inland crop field areas. However, movements between the lakes and within the region are little known and linkages are only suspected. During the last winter 2010/2011, the Bulgarian Society for the Protection of Birds and the Wildfowl and Wetlands Trust have started a new study to continue for the next two years focused on the movements of the species within the area. Though the limited success, the last winter data helped to reveal the truthfulness of some previous speculations and showed how the species is using the region. This information would not be only useful for habitat selection studies but, in view of the fast and unplanned development of tourist infrastructure and renewable energy facilities, would benefit decision-making process.

THE LAKES OF SHABLA AND DURANKULAK AS KEY SITES FOR THE RED-BREASTED GOOSE AND FIRST RESULTS OF LOCAL MOVEMENTS STUDIES USING GPS RADIO TAGS

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The Red-breasted Goose (*Branta ruficollis*) shifted its wintering grounds in the second half of 20th century to the western Black Sea coast, principally in the Dobrudga region of Romania and Bulgaria. Up to 80–90% of the population are concentrated in the two countries during wintering. In recent years, wintering in the Ukraine and even Southern Russia during mild winters has been registered. Nevertheless, still considerable part of the population is found in the wintering grounds in Bulgaria and the largest concentrations are registered at the lakes Durankulak and Shabla. The species is usually mixed with flocks of greater white-fronted geese

Plenary Session III

(18 October 2011, 09:00 – 10:00)

SPREAD OF TROPICAL MALARIA PARASITES IN A CHANGING CLIMATE

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Emerging infectious diseases (EID) are a growing threat to biodiversity, livestock and human health. Because most of the vast number of pathogens are specialists, their distribution ranges are ultimately restricted by the range of their host species and vectors. At present, species ranges are changing at unprecedented rates as a result of habitat alterations, the spread of accidental introduction of invasive species and global warming. Hence, with the range changes of the hosts and vectors follow the range changes of their parasites. This is setting the scene for a large number of novel and evolutionary untested host-parasite-vector interactions. Such first-time interactions may involve cases in which the parasite is already adapted to invade the new host (EF – ecological fitting), whereas the new host population lacks protective immunity. Avian malaria parasites provide an excellent model system to study EF and EID. Because these are vector-borne parasites, wetland birds thriving in mosquito abundant habitats are of primary concern. Globally, avian malaria contains several thousand species of parasites infecting birds of most species. Each year, migratory birds are carrying numerous species of avian malaria parasites from African wintering grounds to Europe and since these are present in the blood of the migrant birds during the summer months, they can potentially be spread to resident species. The present absence of transmission for a majority of these parasites may be lack of competent vectors or, if competent vectors are present, then low ambient summer temperatures prevent the development of the parasite to infective sporozoites. With increasing summer temperatures in Europe as a result of the global warming, many new tropical parasites might overcome this transmission barrier. I will discuss this scenario and illustrate distribution patterns with data from a database containing global screening of malaria parasites and show results from infection experiments testing the infectiousness of tropical malaria parasites in resident European birds.

GENETIC MARKERS FOR ASSESSING AND PRESERVING BIODIVERSITY

José Matos, Carla Borges, Diogo Mendonça, Joana Guimarães, Marta Varandas, Paula Sá-Pereira, Fernanda Simões

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Biodiversity can be defined as the contribution of species diversity, ecosystem diversity and genetic diversity. Managing landscapes and monitoring ecosystems are increasingly multidisciplinary activities, always based on solid ecological studies and routine physiological analysis, but making use of complementary inputs from a wide variety of approaches where molecular genetics has become a most useful set of tools providing relevant data to design adequate strategies for both preserving and restoring wild populations on a well-balanced management. The assessment of genetic diversity is extremely important to analyse the evolutionary adaptation of a given population within an ecosystem and to predict its survival and growth in that environment. High-throughput fragment analysis, Microarrays, DNA chips and pirosequencing allow the simultaneous genotyping of millions of samples and individuals. Also, metagenomics approach allows the identification of species and resolution of complex samples. In the post-genomic era SNPs and microarrays are leading the way to genotyping approaches at a time where sequencing the complete genome information of an organism can be performed on a couple of days. But this is leading us to a time when one must realize the amount of data that will be performed and evaluate whether adequate bioinformatics tools and expertise are available to process these huge piles of sequencing data. Based on previous field work, examples of field monitoring will be described and its usefulness to wetland management will be discussed. Gene expression is mostly important to evaluate plant-microbe interactions, plant resistance to abiotic and biotic stresses and identify the presence of pathogens. Also, genetic markers can be helpful on the evaluation of heterozygosity within a population, providing insights on the recent evolution and adaptation and the level of introgression within different populations. Molecular genetics does not bypass any of the conventional ecological approaches; it rather provides extremely useful data for a comprehensive monitoring for scientists and policy makers.

Thematic Session III. Wetlands biodiversity: populations, communities, interspecific interactions

(18 October 2011, 10:30-12:15)

RANGE EXPANSION OF PADDYFIELD WARBLER (ACROCEPHALUS AGRICOLA) IN WETLANDS ALONG THE BLACK SEA COAST: POPULATION DIFFERENCES IN GENETICS, PARASITE DIVERSITY AND BEHAVIOUR

Mihaela Ilieva¹, Staffan Bensch², Olga Oparina³, Mihail Oparin³, Bengt Hansson², Susanne Åkesson²,
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The Paddyfield Warbler, *Acrocephalus agricola*, has gradually extended its breeding range from Central Asia to the western Black Sea coast. The recently expanded populations offer a unique chance to test the effect of breeding range expansion on population genetics, diversity of blood parasites and migratory directions. We studied paddyfield warblers from westernmost part of the species range, breeding in two lakes at the northern Bulgarian Black Sea coast, as well as birds from steppe wetlands in Saratov Region, Russia, and southern Kazakhstan. We analysed mitochondrial DNA and microsatellites to investigate the population genetic structure and *cyt b* to determine the haemosporidian parasite lineages. Orientation experiments with Emlen funnels were performed to test if the Bulgarian paddyfield warblers migrate along the historical expansion pathway circumventing Black Sea in autumn or choose direct route across the sea towards their wintering grounds in Hindustan. Analyses of mtDNA showed that there was no divergence between Bulgarian and Russian populations, whereas those in Kazakhstan differed significantly from the European breeding populations. The degree of differentiation between populations at nuclear markers was weaker than for mtDNA, which suggests a recent postglacial expansion of the species. The overall prevalence of haemosporidian parasites in all populations studied was 33.3%. The composition of parasites varied geographically, with six

genetic lineages recorded in Russia, five lineages in Bulgaria and two lineages in Kazakhstan. Two lineages were described for the first time. Orientation of the birds from the westernmost population of the Paddyfield Warbler in Europe showed that they still follow the historical breeding range expansion, circumventing the Black Sea from north. Preservation of small and geographically isolated populations, which may contain individuals with unique adaptive traits, such as the studied Bulgarian population of paddyfield warbler, is valuable for the long-term conservation of expanding migratory bird species.

CONNECTIVITY OF BULGARIAN WETLANDS: OUTCOMES FROM BIRD MALARIA RESEARCH AND HIGH TECHNOLOGY IN BIRD MIGRATION STUDIES

Pavel Zehndjiev¹, Steffen Hahn², Valentin Amrhein³, Mihaela Ilieva¹, Dimitar Dimitrov¹,
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Almost one third of the European breeding birds, about 2.1 billion individuals, migrate to sub-Saharan Africa. Different selection pressures act on migratory compared to sedentary birds because migrants live temporarily in various and distant ecosystems during subsequent periods of the annual cycle. Despite huge effort in breeding biology research during the last hundred years, we have little knowledge about the locations of non-breeding sites in Africa, and the factors influencing choice of and fidelity to non-breeding sites as well as ecological factors influencing life performance of migrating birds. During a large-scale tracking of nightingales (*Luscinia megarhynchos*), a small passerine long-distance migrant, a new technology for bird tracking and molecular biology approach were combined. The diversity of bird malaria has been studied in 3 populations of nightingales: French, Italian and Bulgarian. The discovered cytochrom b lineages were identified in MalAvi database (<http://mbio-serv4.mbioekol.lu.se/avianmalaria>). The regions of transmission of bird malaria parasites of nightingales are defined. Geographically specific lineages of *Plasmodium* revealed in this study indicate connectivity of many wetland bird species populations infected by the same parasites to the same wintering regions of Africa and thus can be used as natural markers for these populations. Twice lower survival rate of infected nightingales point at the selective role of the parasites and the large geographic frame of related to the climate change ecological interactions, which have to be considered when planning management and monitoring of wetland territories in temperate zone of Europe, including Bulgaria.

BIRD MALARIA AND RELATED HAEMOSPORIDIAN PARASITES AT KALIMOK WETLAND AREA

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We used a nested PCR protocol to examine the genetic diversity of cytochrome *b* (cyt *b*) lineages from blood parasites of the genera *Plasmodium*, *Haemoproteus* and *Leucocytozoon* in birds at Kalimok Wetland Area situated along the Danube River (Kalimok-Brushlen Protected Area). In total, 473 birds of 36 species and 15 families (mostly passerines) were examined for the presence of haemosporidian infections. Of them, 301 were recognised as infected with parasites. Mixed infections were recorded in 43 individuals (14%). Besides them, 142 individuals (47%) were positive for *Haemoproteus* spp., 116 (38%) for *Plasmodium* spp. and 9 (3%) for *Leucocytozoon* spp. We identified 51 genetic lineages of haemosporidian parasites: 35 of *Haemoproteus*, 15 of *Plasmodium* and 7 of *Leucocytozoon*. Fifteen new cytochrome *b* lineages of *Haemoproteus* (8) and *Leucocytozoon* (7) were recorded. The most common lineage was SGS1 (*Plasmodium relictum*), which had a total prevalence of 19% (57 individuals) and occurred in 7 host species belonging to 5 families. The presence of *Plasmodium relictum* (lineages SGS1 and GRW11) and *Plasmodium elongatum* (lineage GRW06) in first-year birds indicates local transmission of the parasites at Kalimok region. Both are cosmopolitan avian malaria parasites, which cause lethal diseases in naturally and experimentally infected birds. This might be important in conservation management. Three of the cyt *b* lineages of the genus *Haemoproteus* (DURB1, DURB2 and SYNIS2) showed more than 5% divergence from all described morphologically lineages. These lineages probably represent at least two distinct morphospecies, which remain to be identified.

EMERGING INFECTIOUS DISEASES AND WETLAND CONSERVATION: THE KEY TO A CAN OF WORMS?

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Wetlands have long been associated to vector-borne diseases. Drainage of wetlands was therefore undertaken

in many parts of the world and this successfully reduced (and in some cases eradicated) vector-borne diseases. Since then, the loss of biodiversity associated with the reduction and disappearance of wetlands has become a cause of concern to conservationists. Today, new emerging and older re-emerging diseases are becoming an increasing cause of concern to public health authorities. This should also become a major cause of concern to conservationists as most emerging and re-emerging diseases are vector-borne diseases. Plans aiming to eradicate vectors and reservoirs have already been proposed and in some cases initiated in practice. Such actions shall further reduce biodiversity with yet improperly modeled side effects. Blind or short-sighted management plans based on speculative models are more likely to be deleterious rather than beneficial. It is therefore critically important to thoroughly investigate and precisely describe the exact relations and interactions existing between the various elements of the ecosystems at risk. Indeed, only actual field data are suitable to parameterise exploratory models. The hypotheses derived from such models must then be tested experimentally before any large-scale action is undertaken. To be efficient, such studies must involve both field ecologists and epidemiologists.

BRINE SHRIMPS, WATER BIRDS AND AVIAN CESTODES: ECOLOGICAL CONSEQUENCES OF PARASITISM IN HYPERHALINE WETLANDS DURING AN ONGOING BIOLOGICAL INVASION

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Twelve cestode species of the families Hymenolepididae, Dilepididae and Progynotaeniidae parasitic as adults in intestines of water birds use brine shrimps of the genus *Artemia* as intermediate host in their life cycles in the hyperhaline wetlands in the Western Mediterranean. These are specific parasitic in grebes, gulls, flamingos, waders and common shelducks. We studied the prevalence and abundance of cestode larvae in the native species *Artemia salina* and *A. parthenogenetica* and in the invasive species *A. franciscana*. Our studies revealed that the cestode parasitism is associated with altered appearance, modified behaviour and reduced reproductive capabilities of the native *A. parthenogenetica*. Our results throughout the annual cycle of brine shrimps demonstrate lower levels of infection of the alien species compared to those in the two native species. In view of this and the negative impact of the parasites on the populations of the native species, we suppose favourisation of the invader in its interactions with the local competitors, which is induced by the cestode parasitism. Further directions of studies include comparison of the infection in *A. franciscana* in its native and invasive range.

A MIGRATORY CORRIDOR FOR WETLAND BIRDS REQUIRES INTERNATIONALLY COHERENT POLICIES: THE ROLE OF GREECE IN THE ADRIATIC-IONIAN FLYWAY

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Global and local loss of biodiversity challenges policies and governance for action. In Europe, the diversity of political regimes (EU member states, candidate countries, non EU) engenders complexity in conservation and management issues. This is particularly felt for migratory animals, such as wetland birds, which cross political and governance borders. The enlargement of the EU with a politically heterogeneous set of neighbouring countries, mandates the need for analysis of the differences in governance structures and processes e.g. in old, new and non EU member states with the perspective of contributing to the implementation of the EU conservation policy. What is happening with the legal conservation tools in the case of migration corridors? How is put into action a 'no borders policy' in a world made up of units with political and governance borders? We take as a case study country Greece. Greece is geographically positioned in the Balkan Peninsula and a European Union member state. The Balkan coastal wetlands are very important ecosystems, vital as stop-over sites for migratory birds. But is Greece as an EU 'representative' a good model of environmental policy and practice for the countries of the western Balkans as a part of this migratory continuity? We used as a case study the Amvrakikos Gulf, western Greece, an important stopover complex for migratory birds, with an excellent legal protection status. We did a literature review, a compilation and analysis of Greek legislation, interviews with privileged witnesses in an exploratory fashion, and a ground truth survey (April 2007, April 2011). Over the years, the political will for conservation has increased but has not yet resulted in structures and mechanisms that assure the protection of Greek biotopes as a part of the migratory continuity. Moreover, sustaining political will in Greece will need citizens as contributors embracing policy changes.

Thematic Session IV. Coastal marine zones: functioning and restoration

(18 October 2011, 14:00-15:15)

CYTOSEIRA SP. MACROALGAL COMMUNITIES IN SW BLACK SEA (BURGAS BAY, BULGARIA): DISTRIBUTION, COMMUNITY STRUCTURE, AND POSSIBLE LONG-TERM IMPACT OF EUTROPHICATION

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Cystoseira barbata and *C. crinita* (Phaeophyceae, Fucales) form the dominant macroalgal communities in the upper in-frallittoral along the Bulgarian Black Sea coast. The two species dominate the photic zone in clean waters and form unique habitats with high biodiversity and importance in the functioning of coastal ecosystems. The *Cystoseira* communities are sensitive to human-induced pollution and were severely affected by the period of elevated eutrophication in coastal waters in the Black Sea in the 1980s. The current study aims to investigate the distribution and state of *Cystoseira* communities in the Burgas Bay and the possible mechanisms of eutrophication impact on them. Seasonal sampling in *Cystoseira* communities in the study region was conducted between July 2009 and September 2010. Sampling stations were selected along a gradient of increasing eutrophication effects where monthly monitoring of physical and chemical parameters was also carried out. A modified version of the photo-frame developed by Preskitt et al. (2004) was adapted for the purposes of this study. Destructive samples were also collected along the studied transects. In total, over 138 quadrant samples were collected as well as 34 photo-transects were completed, consisting of 630 photos, covering approximately 500 m² of the benthos. Photos were analysed with the CPCEe 3.6 software. Biological data was analysed using PRIMER 6 statistical package.

In total 63 species were identified: Rhodophyta (34), Ochrophyta (14), Chlorophyta (15). *Ceramium rubrum*, *Polysiphonia subulifera*, *Corynophlaea umbellata*, *Stilophora tenella*, *Sphacelaria cirrhosa*, *Chaetomorpha linum*, *Cladophora albida*, *C. sericea*, *Ulva rigida*, *U. linza* and *Bryopsis plumosa* were found as common species in the *Cystoseira barbata* communities and *Ceramium elegans*, *C. diaphanum*, *C. rubrum*, *Cladophora albida*, *C. sericea*, *Ulva rigida* and *Bryopsis plumosa* were common species in the communities of *C. crinita*. The results indicate a gradual decreasing in the depth distribution of *C. barbata* and *C. crinita* with increasing levels of eutrophication in the Burgas Bay, decrease in the presence of brown and red macroalgae, and an increase in the presence of opportunistic green algal species. Macroalgal communities in the less eutrophicated areas were grouped in three significantly different depth categories: 1-3 m (dominated by *C. crinita*,

Cladophora sp. and *P. subulifera*), 4–5 m (dominated by *C. barbata*, *U. rigida* and *Cladophora* sp.) and 7–11 m (dominated by *U. rigida*, *Ceramium* sp., *Gelidium* sp., *Acrochaetium* sp.) with corresponding typical levels of percentage of surface PAR. The applied *DistLM* statistical model reviewed that the impact of physical parameters of the environment, such as exposure of the coast to wave-impact, average percentage of surface PAR reaching the depth of occurrence, seasonal average temperature and bottom inclination, are important driving factors for the structure of the studied *Cystoseira* communities, as well as the concentration of nutrients, chlorophyll a and seston.

Although the Principal Components Analysis reviewed a significantly higher levels of eutrophication in the area in the 1980s (elevated NH_4 and PO_4 concentrations), species composition in 2009–2010 and in the early 1980s was very similar. We noted 64.1% similarity with Sozopol samples from 2009–2010, 62.5% with those from the referent zone Cape Maslen Nos, and only 34.8% with the highly eutrophicated area Kraimorie. The composition of the shallow-water macroalgal communities in the Sozopol area were either unaffected by the period of elevated eutrophication in the 1980s, or the communities managed to recover to their state from before the mid 1980s. The impact of the elevated eutrophication levels in the 1980s was instead in the change of the depth structure of the communities – the severe decrease in the depth of penetration of the habitat-forming *Cystoseira* species and shrinking of the extend of the photic zone.

SEAGRASS MEADOWS IN A EUTROPHIC GRADIENT: PRELIMINARY STUDY OF INFAUNA AND PLANT BIOMASS FROM BURGAS BAY TO ROPOTAMO RIVER MOUTH

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Seagrass meadows provide habitat, protection and nursery functions for economically valuable fishery species, serve as indicators of and modify local water quality conditions, and protect the shoreline from erosion by attenuating wave and current energy. Over the last 50 years, seagrass populations have declined globally. This is due to the combination of natural phenomena (hurricanes, grazers and diseases) and anthropogenic disturbances, both direct and indirect. These disturbances include decreased light availability due to deteriorating water quality conditions and increased sedimentation due to coastal development. Although seagrass conservation and restoration efforts have increased in response to these global losses, populations continue to decline. Three seagrass species are present along the Bulgarian Black sea coast: *Zostera marina*, *Zostera noltii* and *Ruppia maritima*. They form specific habitats on soft sediments such as sand or silt. In this study, we focused on the investigation of biomass, shoot density and epiphytes of *Z. marina* and *Z. noltii* as well as on associated infaunal diversity and abundance as indicators of anthropogenic impact. Sampling was conducted at six stations distributed along an eutrophication gradient from the southern part of the Burgas Bay to the Ropotamo River mouth. Destructive samples were taken both for plant biomass and

for infauna using SCUBA. At each station, 3 samples were taken using corers with surface 0.0779 m² and 0.00196 m² for plants and infauna, respectively. To indicate the level of eutrophication, nutrients (PO_4 , NH_4 , N_{total}), chlorophyll a, suspended matter and Secchi depth were measured.

The results show an increase of the shoot density for both *Z. marina* and *Z. noltii*, with lowering levels of nutrients and suspended matter in the water column and higher water transparency. The biomass did not show a clear pattern along the gradient. A total of about 40 macroinvertebrate taxa were found. A general decrease in species richness with increasing levels of eutrophication was observed. The infaunal communities at the stations with the highest levels of eutrophication were dominated by tolerant and opportunistic taxa (e.g. capitellid polychaetes, oligochaetes). These preliminary results seem to confirm that seagrass beds and the associated invertebrate communities from Burgas Bay are susceptible to human influences. Further in-depth research is needed in order to achieve better understanding of the functioning of seagrass ecosystems in this area.

FIRST RESULTS ON ABUNDANCE AND POPULATION STRUCTURE OF TWO DEPOSIT FEEDERS IN A MAN-MADE POIKILOHALINE LAGOON ON THE BLACK SEA COAST, ATANASOVSKO LAKE (BULGARIA)

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High rates of decomposition are critical to the sustained functioning of the lagoon ecosystems. The release of nutrients and dissolved organic matter (DOM) from sediments supports phytoplankton and bacterial production in overlying waters. The benthic and epibenthic biota are crucial for decomposition and nutrient recycling. Deposit feeders consume surface deposits and are primary food items for bottom feeding fish and birds. The dead organic material of sediments, which mainly consists of structural carbohydrates and other poorly decomposable materials, is mainly utilised indirectly through microbial decomposers. The living microorganisms attached to mineral and detrital particles constitute the main food source of deposit feeders. Through their feeding and burrowing activities, deposit feeders stimulate mineralization processes in the adjacent sediment. In addition to mixing nutrient-rich pore waters with overlying waters, the deposit feeders increase the percolation of water and oxygen levels, remove organic material from the water column and excrete demineralised nutrients in form of pseudofeces and through direct excretion. The sediment enrichment with biodeposits provides in turn a nutrient source for other biotic components. A follow-up of the deposit feeder populations is needed in order to obtain a quantitative measure of their role in the benthic-pelagic coupling in the Atanasovsko ecosystem.

The present study is part of a research project on the trophic relationships between macroinvertebrates and water birds carried out within the frame of the WETLANET project (EC FP7). The Atanasovsko Lake is a shallow coastal

poikilohaline lagoon of 7 200 ha surrounded by freshwater marshes on the Black Sea coast of Bulgaria near Burgas. Since 1906, the lagoon is used for salt production. For this purpose, it has been successively transformed in a complex of evaporation and crystallization ponds for salt-extraction. Seawater is lead consecutively from pond to pond, thus the water has enough time to increase salinity until reaching salinity from which salt crystallize. Deposit feeders and bioturbators are the only present functional macroinvertebrate groups in the lagoon. Does the water interchange used for salt production affect the recruitment of epibenthic and endobenthic deposit feeders? We plan to take three replicate samples monthly from May 2011 to January 2012, at a total of 6 sites, using a 13 cm inner diameter cylindrical coring tube containing a 20 cm thick substrate layer. The sediment cores are rinsed in a 300 µm gauze hand-net. Four sampling campaigns have been carried out on the lagoon and data from three campaigns are available, e.g. May, June and August 2011. We present the abundance and size-frequency distribution of *Ecrobia ventrosa* (Gastropoda) and *Abra segmentum* (Bivalvia) in Atanasovsko Lake, which harbours a conspicuous population of migrating and wintering waterbirds.

ESTIMATION OF PRIMARY PRODUCTION OF A WIDE POLYGON IN THE MARINE COASTAL ZONE

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Measurement of primary production of the phytoplankton using the ¹⁴C method in more than one point a day encounters many difficulties due to lack of personnel, technical and laboratory facilities. In large region, satellite methods can give satisfactory results (Melin and Hoepffner, 2004, Global Marine Primary Production: A Satellite View. Joint Research Centre, EU, EUR21084, 210 pp.) but in smaller coastal areas this approach is hardly possible and economically not reasonable. In 2000-2001 and 2004-2005, the primary production was measured in the Sozopol Bay (SW coastal zone of the Black Sea). In the first period, the area covered was about 7 km² and in the second period the area was larger, about 10 km². The monitoring programme included monthly estimation of some physical factors (wind, wave, cloudiness, Secchi depth), nutrient concentrations (NH₄⁺, NO₃⁻, NO₂⁻, PO₄³⁺) and basic biological parameters of the plankton community (chlorophyll a concentration, seston, primary production). In the present report, the approach and the results from the 2004-2005 study are given. The primary production (Pp) of phytoplankton was measured using the ¹⁴C method according to the modification by Dybert *et al.* (1976). Three light and one dark bottles (118 ml), after inoculation with NaH¹⁴CO₃ (total activity of the sample from 5 to 10 mCi), were incubated *in situ*. After filtering on membrane filters and additional processing the samples activity was measured in a Rack Beta 1217 (LKB) scintillation counter. A full water profile was measured in a referent point. In other four points direct Pp measurements of the 5 m samples were made. Calculation of Pp in a random point of the polygon is based on the general hypotheses (Koblenc-Mishke, Wopzniak, 1989, In: Proceedings of the Twenty-first European

Marine Biology Symposium, Gdansk, 14-19 September 1986, Ed. R. Klekowski, p.329-338):

$$Pp = C \cdot PAR \cdot Chl \quad (1)$$

where: C – coefficient; PAR – photosynthetic active radiation; Chl – chlorophyll concentration.

Such a relation is reasonable only in the water layers where photoinhibition is not available. In such cases, Pp is proportional to Chl-a concentration in the surface samples. Around the assumed maximum of the photosynthesis (5 m depth), Pp is measured directly and, in all deeper horizons, a modification to the relation (1) is used:

$$Pp(Z) = Pp(Z)(referent) \cdot Chl(Z)/Chl(referent) \cdot PAR/PAR(referent) \quad (2)$$

The ratio PAR/PAR (referent) is calculated from a local relation between Secchi depth and Kd, where PAR(Z) = PAR(surface) · exp[-Kd·Z], Z – horizon depth.

The model estimations of Pp was applied on five sample stations in the Sozopol Bay monthly for the period June 2004 – November 2005. The results reveal substantial variation in the Pp values for the water column on different stations as well as for different stations/horizons mainly due to the distinct chlorophyll concentration.

INTEGRATED ANALYSIS AND ENVIRONMENTAL STATUS EVALUATION OF MARINE ECOSYSTEM PERTURBED BY REGIME SHIFTS: THE BLACK SEA

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In recent times, many marine ecosystems have experienced large-scale human-driven disturbances such as collapses of fish stocks, eutrophication and invasions by alien species. Ecosystem regime shifts are characterized by sudden, irreversible switches caused by transformations of ecological structure and function. Based on the example from a large marine ecosystem – the Black Sea – I attempt to discriminate between effects attributable to the environment, to fisheries and to other anthropogenic factors. Using an integrated approach combining time-series & multivariate statistical methods I analyse regularities on different scales in time and space, explore linkages between physical, biological and anthropogenic indices, and assess the ecosystem status over a 40 years period. Overfishing in combination with fluctuating climate is recognized as a main cause of fisheries collapses, and a deteriorating environment and alien introductions exacerbated the problem. Overfishing and alien intrusion at high trophic levels drove trophic cascades and switched dominance from valuable fisheries resources to an excess of jellyfish and microalgae. Interaction between environmental, biological and anthropogenic factors generated feedbacks resulting in harmful plankton blooms, hypoxia and the production of hydrogen sulphide, adversely affecting the ecosystem as a whole and fish stocks in particular. The complex nature of ecosystem responses to human activities calls for more elaborate management approaches than currently provided by traditional environmental and fisheries assessments and regulations. This implies challenging the existing paradigms and delivering better explanatory models that can reconcile fishing with nature conservation and ecosystem management.

Thematic Session IV. Wetland monitoring, management, restoration and sustainable use

(18 October 2011, 16:00-17:15)

STRESS RESPONSE OF *CHLORELLA* SPECIES FROM CONTRASTING HABITATS

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We hypothesize that algal species isolated from habitats with extreme environmental conditions would have more efficient cellular defence mechanisms to various types of stress. The aim of this study was to compare stress response of *Chlorella* species isolated from contrasting habitats to oxidative stress. Three *Chlorella* species were used: *Chlorella* sp. (Antarctic), *Chlorella vulgaris* 8/1 (thermophilic) and *Chlorella kessleri* (mesophilic). *Chlorella* species were cultivated on TAP medium under standard conditions in a growth camera Phytotron GC 40. Cell suspensions at the end of the exponential phase or the beginning of the stationary phase were used. Two inducers of oxidative stress were used, i.e. UV-B and temperature induced stress. Cell response of *Chlorella* species was examined on the basis of various endpoints: spot-test, micro-colonies assay and growth rate after UV-B. Cells were irradiated in BLX-254 (Life Technology, UV crosslinker) as a source of UV-B irradiation ($\lambda = 312$ nm). To determine cell response of *Chlorella* species to temperature stress clonogenic assay and Western blotting were applied. Cells were treated with three temperature regimes: 39°C/30 min., 42°C/5 min, 45°C/5 min and recovery time of 2 and 4 hours was given. Interspecies variability was obtained with respect to cell sensitivity, constitutive and induced levels of HSP70B. *Chlorella* species were found to differ in their capacity to overcome harmful effect of UV-B measured as growth rate, cell survival and sector of photo-reactivation. *Chlorella* sp. could be described as the most resistant to UV-B induced stress. In spite of the fact that all experimental data and differences among species sensitivity were statistically significant, only $t=45^\circ\text{C}$ applied for 5 min was revealed as being more stressful for *Chlorella* species. At this temperature regime, SF values of species were as followed: *Chlorella kessleri* SF = 0.70, *Chlorella vulgaris* 8/1 SF = 0.76 and *Chlorella* sp. SF = 0.83. HSP70B were presented in control cells of all three species. About 30% higher levels of constitutive HSP70B were measured for Antarctic *Chlorella* sp. compared to *Chlorella vulgaris* 8/1 and *Chlorella kessleri*. About 60% higher content of HSP70B was measured for *Chlorella kessleri* after the treatment with 39°C/30 min and 42°C/5 min. No changes were obtained after the treatment at 45°C. The only

temperature that can induce heat stress in *Chlorella* sp. and *Chlorella vulgaris* 8/1 was 45°C.

The present study revealed that HSP70B could be used as a marker of thermal stress in these organisms. Higher constitutive content and overproduction of HSP70B could be considered among of the factors that allow *Chlorella* sp. to survive in the extreme Antarctic environment.

This study was partly funded by project WETLANET (EU FP7, GA 229802) and the bi-lateral academic agreement project between Russian Academy of Sciences and Bulgarian Academy of Sciences "Molecular mechanisms of plant induced resistance to oxidative stress".

NEW DEVELOPED FUNCTIONAL INDICES BASED ON MACROINVERTEBRATE COMMUNITIES – ADAPTATION AND ESTABLISHMENT ON BULGARIAN RIVER ECOSYSTEMS

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The purpose of this study is to make a review of the trophic structure of macroinvertebrate communities, to compare the assessment value of three trophic indices and to examine the links between the contents of organic matter in bottom sediments and physical and chemical parameters of the environment, from one side, and the results of the saprobic and structural indices from the other side. The studies were carried out in two hydrological regimes during summer of 2009 (low waters) and spring of 2011 (high waters). The Multi-Habitat Method (adapted to Bulgarian conditions) was used for macroinvertebrate sampling. Samples were taken from three Bulgarian rivers (Mesta River, Tundja River and Vit River) belonging to two catchment basins, Mediterranean and Danubian. On each river, benthic samples were taken from three river sections (mountain, foothill and plain area). On the basis of the physical and chemical parameters for the second studied period, the quality of waters varied between Category I (drinking waters) and Category II (natural waters) as defined by the national legislation. Content of organic components in the sediments for 2011 showed a gradual increase in organic concentration downstream due mostly to the flow and the transport of organic matter. Possibly, there is also a role of the increased anthropogenic influence in the middle reaches of rivers compared to the alpine reference sites. One exception was registered for Tundja River, where the peak of organic matter in sediments was found in the second point (caused by a local pollution). The result on the macroinvertebrate fauna showed that the percentage ratio of Functional Feeding Groups (FFG) differed between studied stations. Sites situated in the upper parts of the river systems followed the natural course according to the principles of the river continuum concept. Trophic structure of the macroinvertebrates at the downstream sites was affected by the anthropogenic impacts.

The ratio of deposit feeders (DF) correlated with saprobic indices that characterised quantity of the decomposition of the biodegradable organic matter. A variation of the percentage of the FFG at the same point during the years of the study (2009 and 2011) was detected. Cenotic (evaluated community structure) and saprobic (described water quality) indices varied between oligo- and alpha-mezosaprobity. Trophic indices (Integrated Index, Index of Trophic Completeness and RETI/PETI), characterising functioning of the benthic communities, graduated and corresponded to the ecological state as revealed by biotic and saprobic indices.

CATALOGUE OF MEASURES TO INCREASE CARBON DEPOSITION IN WETLANDS

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Carbon fixation of wetlands in the Czech Republic has relatively low importance due to their small total area. The profit from the both carbon fixing mechanisms (utilization of plant production as a source of recent instead of fossil carbon and carbon storage to the soil) is directly related to the area where they take place. Part of carbon sequestration, materializing through biomass production, increases other ecosystem services, as a nutrient retention and recycling or climate regulation at local level. While searching the appropriate management, it is necessary to consider the carbon accumulation function in the context of other ecosystem functions. The increase of carbon sequestration can be most efficiently achieved by the combination of two following measures: (i) optimization of harvest regime; gathering of the grown biomass supports the recycling of recent carbon instead of usage of fossil sources and (ii) support of long-term carbon accumulation in soil by means of the maintaining or increase of groundwater level; storage of organic matter in flooded un-aerated soil is the main mechanism of organic matter accumulation in wetlands. In the Catalogue of measures there are discussed particular interventions and measures applied to certain categories of wetlands and grasslands from the viewpoint of carbon balance. The following part describes in detail the proposed measures in individual wetland categories. The last part consists of the decision key of proposed measures, considered some general factors that are crucial for the suitable management leading to increased carbon sequestration on mires (peat bogs), wet grasslands and reed beds.

ENHANCING EMISSION CHARACTERISTICS OF HEAT EXCHANGERS USED IN DESALINATION OF SEA WATER

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Desalination is the process to convert sea water to fresh water for human consumption or irrigation. The process can sometimes be used to produce table salt as a by-product. It is mainly used on ships and submarines but in recent applications of desalination researchers are focused on developing cost-effective ways of providing fresh water for human use in regions where the availability of fresh water is limited. Such installations are Tampa Bay Desalination Plant, Florida in the United States, Jebel Ali Desalination Plant (Phase 2) in the United Arab Emirates and the Minjur Desalination Plant near Chennai in India. In desalination processes, it is important to ensure that the pure water does not contain any acidic components. Formation of acids such as carbonic and nitric acid must be considered after the process of direct-contact evaporation of seawater. In typical indirect-contact thermal evaporation of seawater, the seawater evaporates usually on the outer pipe surface. The water vapour rises, because of its lower density, relative to the air, and is received from the top of the evaporator while the highly concentrated brine is received from the bottom. The inner section of the pipe holds the heat source, usually the high-temperature combustion products. In this type of indirect contact arrangement, the net rate of heat transfer from the combustion gases into the seawater relies on the transmitting material (pipe) and fouling that occurs on this transmitting material surface. On the other hand, in direct-contact heat-transfer processes, such a transmitting medium does not exist; the overall heat-transfer coefficient is dependent on the heat-transfer coefficients of the continuous phase (combustion products) and the dispersed phase (seawater). The resistance of one of the phases, e.g., seawater, is ignored and the results are given based solely on the heat-transfer coefficient of the chosen phase (primarily the continuous phase). In the present study, the possible nitric acid formation in seawater desalination process was investigated. Based on chemical reaction processes and graphs of the chemical equilibrium constant versus temperature, the products side of the fuel and hydrogen combustion equations is determined for both hydrocarbon and hydrogen fuels. The global chemical equilibrium composition approach is used to analyse nitric acid formation risk in the products.

A QUALITATIVE REASONING APPROACH TO MODELLING FISH MORTALITY DUE TO ALGAL BLOOMS IN WETLANDS NEARBY URBAN AREAS

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This paper presents a Qualitative Reasoning Model of urbanization and its effects on fish mortality due to algal blooms in wetlands surrounding cities. One of the environmental problems, which are caused by the migration of people from rural to urban areas, is the increase of the sewage production in the cities. The resulting nutrients accumulate in wetlands nearby the urban area. As a result, the growth of algal community increases and their biomass reaches critical values. Such algal blooms affect the fish populations in two ways. Firstly, the toxins emitted by algae directly influence the fish. Secondly, the algal bloom causes oxygen deprivation, which kills the fish. The issues discussed above are represented in a Qualitative Reasoning (QR) model. QR is an area of Artificial Intelligence (AI) engaged in describing the causal relations that govern the behaviour of biological systems. QR is a useful alternative to numerical modelling methods, as it allows hypotheses to be tested when numerical data are unavailable. Within the ecological modelling community, there is a growing trend of using QR to model dynamic systems. The model discussed in this paper was built using established best practices in QR modelling and is implemented in the DynaLearn modelling and simulation workbench (www.DynaLearn.eu). DynaLearn allows systems to be represented on varying levels of complexity (called learning spaces), depending on what is needed for the knowledge that has to be represented. The model was built in the fifth learning space (of total 6), which allows conditional knowledge to be represented. The model represents the main processes in the system: urbanization, sewage production, algae growth and fish mortality due to algal bloom. The model also has two conditional expressions: (1) If the biomass of the algae community is above the critical level, the biomass will have positive indirect effect on fish mortality due to algal blooms. (2) If the biomass is equal or below the critical level, then the mortality of the fish community will be zero and stable. The model about fish mortality due to urbanization aims at answering the following question: How do urbanization and the consequential increase in sewage production affect fish mortality in wetlands surrounding the city? The model shows that if the process of urbanization increases, then the size of urban population increases. This leads to an increase of sewage production and nutrients. These organic compounds are food for the algal community. The algal biomass increases, which leads to algal blooms. As a result, the fish mortality rate due to algal bloom increases. This work is co-funded by the EC within FP7, Project no. 231526 (www.DynaLearn.eu).

POSTER PRESENTATIONS

Poster Session I

(17 October 2011, 15:30-16:00)

P01

MICROBIAL NUMBERS IN THE PERIPHERAL LITTORAL AND ADJACENT SHORE OF THE SREBARNA LAKE

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The fate of organic matter is a key problem in wetlands, which are environmentally diverse ecosystems. The presence and numbers of certain trophic microbial groups could serve as a marker for the scale and direction of *in situ* production, external input, destruction and mineralization of organic substances, as well as of the mineral biogens transformation.

The depth of the Srebarna Lake is quite variable in time, being immediately dependent on the water level of the Danube and the rains. As a result of the flood-pulse, considerable area of the littoral and adjacent shore is subjected to consecutive floods and dries up, so it consecutively switches functions of bottom and shore. This is associated by dramatic changes in the physical and chemical environment of the microorganisms, making the water-soil ecotonal zone elastic and variable.

The aim of the study was to describe the flood-pulse by microbiological characteristics of water and sediment/soil solids along the water to soil gradient in the Srebarna Lake. Three transects across the littoral-shore ecotone of different slope were investigated – at Todoranka's Fountain (average slope 0.75°), at the Quay (average slope 6°), and at the Southern Lock (average slope 11°). The observations were accomplished in two characteristic hydrological moments in 2010: on May 17, at the normal hydrological conditions for the season, and on July 26, after a profound flood kept almost the whole studied area under water for more than 2 months. Three pairs of bacterial trophic groups were assessed: carbophilic organotrophs and ammonifiers (characterizing the total and final mineralization of organics), ammonium oxidizers and nitrate reducers (reflecting major transformations of mineral nitrogen), and soil autochthons and oligotrophs (generally connected to the humus complex). All samples were subjected also to conventional chemical analyses.

The three transects differed clearly in their chemical and microbiological characteristics in May. The richest in organotrophic microorganisms were the samples from Todoranka's Fountain. The other two transects were of

notably lower and fairly equal average numbers of organotrophs. The autochthons prevailed in all the soil samples at the Quay. The numbers of ammonifiers varied in concordance with the ammonium content. The only autotrophs of the microbial groups studied, the ammonium oxidizing bacteria, were in their lowest numbers at the Southern Key, and were of comparable higher values at the other two sites. This trophic group was in quite complex connection with the nitrate, nitrite and ammonium in the water, sediment and soil. The spatial dynamics of the studied microbial trophic groups however, was very similar at all the three sites in May. Microbial numbers displayed the tendency to increase smoothly, and oligotrophy decreased in direction from water to shore along the transects.

The pattern changed noticeably in July, after the sites were submerged for the previous two months. The differences among the three transects were smoothed, and all microbial numbers in almost all samples were reduced, as compared to May. The common tendency in the spatial distribution of microbiological and chemical parameters observed in May was disturbed and blurred. Yet, the three transects reacted differently to the flood. The steepest site at the Southern Key underwent the greatest changes, and the flattest, at Todoranka's Fountain, was the most stagnant. The observed variations revealed the role of each of the trophic groups in the dynamics of the organic matter transformations in concordance with the flood-pulse concept.

P02

GENOTOXIC AND MUTAGENIC ACTIVITY OF POLLUTED SOIL SAMPLES IN A TEST-SYSTEM *CHLAMYDOMONAS REINHARDTII*

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Recently it was shown by us that test-system *Chlamydomonas reinhardtii* could be successfully used as a good model system for genotoxic, mutagenic and oxidative stress assessments. Here we present our data concerning evaluation of genotoxic and mutagenic activity of environmentally polluted soil samples collected during the summer and autumn of 2004 using as a test system wild strain 137C. Samples from two different areas nearby Kremikovtzi Corp. – Yana and Lokorsko villages (Sofia region) were analyzed. Parallel between three bio-tests with different resolution was performed ("clonal" assay) for genotoxic assessment, induced "visible" mutants, for mutagenicity assessment and biomarkers for oxidative stress – MDA, H₂O₂ and photosynthetic pigments. The genotoxic and mutagenic potential of the samples were compared with the effect of the standard mutagen MNNG.

It was shown that soil samples collected from Lokorsko and Yana possess strong toxic and genotoxic effect.

Survival fractions (SF) were measured to be 0.001 and 0.30 for both Lokorsko soil samples (summer and autumn). SF values for Yana soil samples (summer and autumn) were 0.15 and 0.004 respectively. Standard mutagen MNNG treatment with concentration 1x10⁻⁴M resulted in SF=0.13. A strong mutagenic effect was revealed after the treatment with Lokorsko summer samples – MI =14.5. Summer samples collected from Yana plot had a weaker mutagenic potential (MI = 4). According RIEW data heavy metal concentrations in these areas are below or slightly above maximum acceptable concentrations (MAC) in this period. However, higher concentrations of pesticides were detected in the Lokorsko plot sample than that in Yana plot sample. Strongest mutagenic effect was observed after the treatment of algae cells with autumn Yana samples (MI = 30). Data provided by RIEW about Yana plot contamination showed higher levels of Pb and As in autumn than that sample in summer. The concentration of Pb and As in this area exceeded MAC 4-fold and 3-fold respectively. Similarly to genotoxic potential mutagenic potential of autumn Lokorsko samples shown seasonal decrease – MI in this case is 3 (compared to 14.5 for the summer sample).

Changes in the oxidative stress biomarkers obtained after the treatment with both summer and autumn samples are indicative for the presence of pollutants inducing oxidative stress in the algal cells. Pollutants presented in soil samples analyzed by us had the capacity to induce oxidative stress, as well as these samples possess genotoxic and mutagenic activity depending on the season. Our results are in agreement with the requirement of National Health Organization that bio-tests with different resolution must be used for obtaining valuable evaluation of natural samples.

P03

RESEARCH OF FILTRATION THROUGH SORTED CRUSHED ROCK

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The paper presents the experimental results of fluid flow through homogeneous permeable media – sorted crushed rock with four different diameters: 22.5 mm, 10.0 mm, 5.4 mm and 3.9 mm. Experiments for hydraulic gradients corresponding to Darcy's law up to 7.5 (post Darcy's movement) has been undertaken. Using a capillary tube model of filtration, parameters of the movement has been determined: porosity, pores diameter, tortuosity, Forchheimer type quadratic relationship of hydraulic gradient, the dynamic and static specific area and friction factor law in function of pore diameter Reynolds number. Post Darcy's filtration has many technical applications in: hydraulic of permeable bed rivers, medicine, flows within permeable hydraulic structures, movement over permeable walls, fluid raw material extraction, dispersing polluting substances within built areas, oxygen and carbon dioxide exchanges in vegetation zones, forest fires propagation, in the drains and wells filters, etc.

P04

| CZECH GLOBE: GLOBAL CHANGE RESEARCH CENTRE AS CR, V.V.I.

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P05

PAH DETERMINATION IN ENVIRONMENTAL SAMPLES USING GC ANALYSIS TECHNIQUE: A CASE STUDY ON BLACK SEA WATER AND SEDIMENTS

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The monitoring of polycyclic aromatic hydrocarbons (PAHs) has become an important problem because of their well-known mutagenic and carcinogenic effects. These substances can be found in a number of different kinds of samples, both biological and environmental. PAHs are typical non-polar compounds and have excellent retention

on a reversed-phase adsorbent such as C18 bonded silica. Although their solubility in water is very low, concentrations in the $\mu\text{g l}^{-1}$ level are commonly encountered in the environment. Since these compounds are considered toxic at this level, their presence needs to be monitored.

The Water Framework Directive imposes on the EU Member States the obligation of monitoring natural water quality, including the marine coastal waters. Coastal seawater is a very specific matrix, quite different from inland waters, due to salinity and high particulate matter content. Near shore waters are often under strong anthropogenic stress, which results amongst others in eutrophication, intensifying their turbidity in comparison with the open sea or ocean waters. Determination of PAHs in marine coastal waters and sediments has to be carried out with great care to avoid serious losses occurring during the sampling and storage stage. This is due to the hydrophobicity of these compounds, and their tendency to be adsorbed to surfaces they are in contact with, including suspended particulate matter. The best technique to separate PAHs is gas chromatography with mass spectrometer. However of low concentration levels to be quantified in water samples; an enrichment step is needed before chromatographic analysis.

The main objective of this work is to adapt and implement relatively simple and rapid method for gas chromatographic determination of individual PAHs in samples of coastal waters and sediments, taking into account impact of such key factor as pH, salinity and preliminary pretreatment.

This research was funded by project: "WETLANET- Enhancing research potential by strengthening a local network of laboratories for studying wetland ecosystems functioning, restoration and management" (FP7 EC, CSA – SUPPORT ACTION, REGPOT-2008-1).

P06

A COMPUTATIONAL APPROACH FOR CONTAMINANT REMOVAL PROCEDURES IN HORIZONTAL SUBSURFACE FLOW CONSTRUCTED WETLANDS

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The paper presents a numerical investigation of groundwater flow and contaminant transport and removal in porous media. Emphasis is given to horizontal subsurface flow constructed wetlands (Kadlec, R.H. & Wallace, S. (2009) *Treatment Wetlands*, 2nd Edition, CRC Press, Boca Raton, FL, USA) under Mediterranean conditions. First the mathematical modelling of the problem is formulated. Next, for the numerical simulation, the Visual MODFLOW computer family code is used. Further, the numerical procedure is applied for the simulation of pilot-scale units of horizontal subsurface

flow wetlands. These units were constructed and operated in the Laboratory of Ecological Engineering and Technology, Department of Environmental Engineering, Democritus University of Thrace (DUTH), in Xanthi, Greece. Finally, the optimal values for the BOD removal coefficient are obtained (Liolios, K. (2008) *Simulation of flow and performance factors for contaminant removal in horizontal subsurface flow constructed wetlands*, Master Thesis (in Greek), Departments of Civil and Environmental Engineering, Democritus University of Thrace, Xanthi, Greece; Liolios, K., Tsihrintzis, V., Moutsopoulos, K., Georgiev, I. & Georgiev K. (in press) *A Computational Approach for Remediation Procedures in Horizontal Subsurface Flow Constructed Wetlands*. In: Margenov, S. et al (eds), *Large-Scale Scientific Computing, LSSC 2011*, Springer Verlag, Lecture Notes in Computer Sciences) by using an Inverse Problem methodology.

P07

MACROZOOBENTHOS OF COASTAL AREAS ALONG THE BULGARIAN DANUBE STRETCH WITHIN SEVEN SITES OF THE EUROPEAN NETWORK NATURA 2000

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A study of the macrozoobenthos species distribution along the coastal area of Bulgarian Danube stretch has been carried out in autumn of 2010 at 9 sampling points during a low-water period. The sampling points Zagradjen – Danube River (ZAGD), Belene – Danube River (BELD), Vardim Island (VARI), Vardim – Danube River (VARD), Batin – Danube River (BATD), Ryahovo – Danube River (RYHD), Babovo – Danube River (BABD), Popina – Danube River (POPD) and Pojarevo – Danube River (POJD) are located into the European ecological network NATURA'2000 sites Karaboaz, Persina, Vardim, Batin, Marten-Ryahovo, Kalimok-Brushlen and Pojarevo-Garvan. The samples were taken with a triangular dredge with size 30 × 30 × 30 cm. Members of 23 families belonging to 10 higher taxonomic groups were found: phylum Nematoda, class Oligochaeta, class Gastropoda, class Bivalvia, class Malacostraca, order Odonata, order Trichoptera, suborder Heteroptera and order Diptera. The most abundant were members of Gastropoda, followed by Malacostraca, Oligochaeta and Bivalvia. Single specimens were found of Nematoda, Odonata, Trichoptera and Heteroptera. One specimen of a species, included in the Habitat directive, i.e. *Theodoxus transversalis* (C. Pfeiffer, 1828) was found for the first time in Vardim (the sampling point VARI). Other macrozoobenthos species listed in the Habitat Directive were not found. A cluster analysis showed a similarity between the sampling points with respect to the distribution of the species and the substrate. This survey is a pilot study, which does not exclude the possibility of further records of species listed in the Habitat Directive. The results of the species distribution can be used as a starting point to continue the investigations on the macrozoobenthic populations along the Bulgarian Danube stretch.

P08

CURRENT ECOLOGICAL STATE OF THE BOTTOM INVERTEBRATE COMMUNITIES IN TUNDJA RIVER, SOUTH-EAST BULGARIA

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This paper is summing up data of the assessment of the current state of both species composition and the structure of the bottom invertebrate communities along the Tundja River (SE Bulgaria). The survey was conducted in July-August 2009 at 6 sampling sites: Panicite, Nikolaevo, Gavrailovo, Samuilovo, Pavel Banya and Srem. All sampling sites belong to the National Biomonitoring Network of water bodies. European norms and international standards (EN 27828:1994, EN ISO 5667-1:2006/AC:2007, EN ISO 5667-3:2003/AC:2007, EN 28265:1994) corresponding with the multihabitat sampling techniques (adapted version) of the EC projects AQEM/STAR have been used. The methods were applied in accordance with the type-specific conditions of the rivers in Bulgaria. Cenic indices characterized the structure of the macroinvertebrate community. The saprobiological assessment was carried out following two classical methods – SPUB of Pantle & Buck (1955) and SROT of Rotschein (1962). During this study, in total 94 invertebrate taxa were found along the Tundja River. The dominant groups were presented by the same percentage. These were Trichoptera (14%), Ephemeroptera (14%), Oligochaeta (14%) and various Diptera (14%). According to the saprobiological assessment, 3 of 6 sites along the Tundja River were found to be in a very good state (Pavel Banya, Gavrailovo and Panicite), while the sites Nikolaevo and Srem were in a good state. Water quality of the site Samuilovo showed value between good and moderate. According to the values of Shannon's Diversity Index (HIND), 5 of 6 sites were found to belong to the 1st category. The unfavourable value of this index was determined at the Samuilovo site. With regard to the Pielou's (EVNS) and Simpson's (DOMN) indices, 5 sites belonged to the 1st category and one was in an intermediate state between the 2nd and 3rd category. According to BgBI, the ecological state assessment of the water bodies at 3 sites are described as very good (BI=4-4.5), two as good (BI=3.5) and one was described as moderate (BI=3). In conclusion, during the studied period, water quality of the Tundja River was characterized in favourable saprobiological status. This indicates that in spite of local sources of pollution and because of the powerful potential of the current river to maintain clean water, the river ecosystem reached its climax. The ecological state assessment at different sites was described as very good and good. Furthermore, there were observations of the positive recovering process of the macrozoobenthos communities, which have been intensely influenced by water pollution in the previous years.

P09

CONTENTS OF SEVERAL METALS IN THE SEDIMENTS OF THE LAKE IN THE SREBARNA BIOSPHERE RESERVE

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The sediments from the lake in the Srebarna Biosphere Reserve could be divided into several typical layers: (1) upper layer of semi-fluid slime of recent origin as a result of ongoing biological processes since the past 10-20 years; (2) medium layer, containing information about older contamination from the 1950's; (3) lower layer (crescent-shaped suite) where the studied metals are of geological origin. The present study on the contents of metals in the sediments from the Srebarna Lake demonstrates a stable tendency of decrease in the content of copper, lead and manganese. In contrast, a slight increase within the permissible concentration has been observed for zinc and iron. No contamination with cadmium has been proved for the studied period (1999–2006). The results from the samples of the one-meter sediment layer for the period 1999-2006 confirm our previous observations on the contents of several heavy metals in sediments. Therefore, we conclude that there are no significant changes in terms of heavy metals contaminations of the sediments of the Srebarna Lake.

P10

BACTERIOPLANKTON AND ITS INTERACTIONS WITH ENVIRONMENTAL FACTORS IN THE WETLANDS ON BELENE ISLAND (LOWER DANUBE, BULGARIA)

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Bacterioplankton abundance, mean cell volumes (MCV), biomass, morphology and size structure were determined in three marshes, Murtvoto Blato, Peschina and Dulyova Bara, situated on Belene Island (Lower Danube) in summer and autumn of 2009-2010. The influence of abiotic factors, phytoplankton and zooplankton on the dynamics of bacterioplankton was tested by several statistical analyses on the basis of the dataset for 2009. Bac-

terioplankton abundance and MCV were higher in autumn than in summer and the highest values were found in Murtvoto Blato ("The Dead Marsh") and in the samples taken for comparison from the branch of Danube River near the town Belene, where bacteria were with various cell sizes and with largest rods, both free-living and attached to detritus particles. The share of bacterioplankton carbon biomass was 0.3-2.1% in total plankton biomass, while phytoplankton share was above 90% in summer, most probably as better competitors for nutrients than bacteria. Strong correlations were found between MCV and pH ($R_{sp} = -0.83$), MCV and $PO_4\text{-P}$ ($R_{sp} = 0.84$), and between detritus particles with attached bacteria and $NO_3\text{-N}$ ($R_{sp} = 0.88$).

Very low oxygen conditions and higher $NH_4\text{-N}$ concentrations (especially in autumn) were probable reasons of low fish presence in summer and the lack of fish populations and high zooplankton development in autumn. Therefore, in such ecosystems the grazer food chain was without top predators and the role of microbial loop was important. Higher presence of large bacterivorous *Daphnia* spp. was found, but due to the very low phytoplankton biomass in autumn, Cladocera were main suppliers of DOC and showed strong positive correlations with bacterial biomass ($r = 0.89$) and with the numbers of largest bacteria above 2.5 μm ($r = 0.80$) and bacteria $<0.5 \mu\text{m}$, as small and non-preferable food in microbial food web ($r = 0.83$).

The study was funded by Bulgarian Science Fund within the project DO-02-352/08 and will last until the end of 2011, when more detailed results about these marshes are expected after recently made connection between them and the river by canals, aiming their restoration as important wetlands for biodiversity.

P11

CHANGES IN THE WATER QUALITY ALONG AN EUTROPHICATION GRADIENT SOUTH FROM BURGAS CITY

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Two year monitoring program (2009–2011) of the water quality parameters was carried out along an eutrophication gradient in the coastal zone south from the city of Burgas (Bulgarian Black Sea coast). The first monitoring point was in the bottom of the Burgas Bay, an area under heavy anthropogenic impact since 1980, and the most southern monitoring point was the referent point of the Bulgarian coastal zone, Cape Maslen Nos. The sampling was carried out monthly in the 500 m coastal zone and covered the water column down to 9 m depth. The monitoring program included some physical factors (wind, wave, cloudiness, transparency as Secchi depth, underwater solar radiance - PAR), nutrient concentrations (NH_4^+ , NO_3^- , NO_2^- , N tot, PO_4^{3+}) and basic biological parameters of the plankton community (chlorophyll A concentration and seston).

The aim of the investigation was to find relations between the water column characteristics and the ecosystem status according to the macroalgae community structure.

In 2009–2010, the station under strongest impact (Kraimorie) differs substantially from the Maslen Nos station, especially in winter time. The Sozopol station is also affected by the impact. The second period 2010–2011 shows more similarity between Kraimorie and Sozopol; the area from Sozopol to Cape Maslen Nos reflects the influence of the open sea water. As general conclusion, the studied area had two distinct zones: from station Kraimorie to station Sozopol (a zone under anthropogenic impact) and from Sozopol to the Cape Maslen Nos (an area with more natural conditions).

The gradient of the water quality parameters were compared with the structure of the macroalgae communities surrounding the areas of the monitoring points. The improvement in water quality from the inside of the Burgas Bay towards Cape Maslen Nos is paralleled by gradual improvement in the status of the studied macrophytobenthos, i.e. an increase in the biodiversity and in the depth of distribution. Even though when comparing data from 2009–2011 to data from 1982–1986, significant differences in the concentrations of nutrients were detected (elevated NH_4^+ and PO_4^{3-}), no significant differences in biodiversity of macroalgae were detected in the two periods for the area of Sozopol. The difference between these two periods was in the decreasing of the depth of distribution of the dominant habitat-forming macroalgae in the area, *Cystoseira* spp.

Further investigations will focus on sharing some experience (the user's point of view) for converting data using SDN tools as well.

This study was carried out in the framework of the Bulgarian National Science Fund Project (No 218/2008) and partly supported by the grants BS SCENE-Upgrade of the 7FP and WETLANET- FP7 CSA – SUPPORT ACTION, GA 229802.

P12

DO UNICELLULAR GREEN ALGAE MODULATE GENOTOXIC EFFECT OF CuSO_4 IN PLANTS AND HUMAN LYMPHOCYTES?

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The significance of ecological problems and environment protection has a global importance. CuSO_4 is one of the main environmental pollutants which could accumulate in high quantity in organisms and can induce various injuries. One of the increasingly favoured waste removal methods is the use of living organisms to treat contaminants. In addition to various plant species, unicellular algae can be successfully applied in remediation procedures.

The aims of the present study are: (i) to evaluate *Chlamydomonas reinhardtii* ability to modulate cytotoxic and genotoxic potential of CuSO_4 ; (ii) to clarify whether metabolised products released in the nutrition medium as a result of algal normal living activity can modulate harmful effect of CuSO_4 in *Hordeum vulgare* and human lymphocytes *in vitro*.

Hordeum vulgare and human lymphocytes *in vitro* were used as test-systems. Various types of algal fractions were prepared. Two experimental designs were used: 1. Cell free medium/lymphocytes assay and algal cell extract/lymphocytes assay (algal cell extract from disintegrated cells previously treated with CuSO_4). 2. Cell free medium/*Hordeum vulgare* assay and *Chlamydomonas reinhardtii* / *Hordeum vulgare* co-incubation (resuspended algae cells previously treated with CuSO_4). Cytotoxic potential was evaluated on the basis of the mitotic index (MI). Genotoxic potential was analysed on the basis of chromatid aberrations (CA). The results were analyzed statistically by the χ^2 method and Fisher exact-test.

CuSO_4 enhanced the yield of chromosome aberrations ($p < 0.001$) in a dose dependent manner in both test systems compared to the negative control. Both cell free medium (SN) and algal cell extract (CE) from *Chlamydomonas reinhardtii* previously treated with 0.2 mg/l, 2mg/l and 20mg/l of CuSO_4 can modify the cytotoxicity and genotoxicity induced by copper in human lymphocytes *in vitro*.

In *Hordeum vulgare*, only cell free medium (SN) and resuspended algal cells (CR) from *Chlamydomonas reinhardtii* previously treated with the higher concentrations 20 mg/l and 30mg/l of CuSO_4 can decrease the cytotoxic and genotoxic effect of this heavy metal.

Algal fractions from *Chlamydomonas reinhardtii* previously treated with CuSO_4 enhanced the mitotic activity and decreased the formation of CA probably by accumulation and metabolising of copper. More pronounced effect was obtained for lymphocyte culture.

The present results demonstrate that the effectiveness of action depends on the concentrations, type of fractions and the co-incubation system used. The results have a direct practical significance for risk assessment in organisms exposed to heavy metals. The study is also of importance for practical applications in some remediation procedures.

This study was funded by the National Science Fund, Ministry of Education, Youth and Science, Bulgaria (Grant B-1306 "Metabolic action of *Chlamydomonas* as modulator of heavy metals in plants") and the project WETLANET (EU FP7 CSA – SUPPORT ACTION, GA 229802).

Poster Session 2

(18 October 2011, 15:30-16:00)

P13

ECTOPARASITIC NEMATODES OF FAMILY LONGIDORIDAE (DORYLAIMIDA) FROM BLACK SEA COASTAL SAND DUNES

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Coastal sand dunes represent unique type of ecosystem in terms of some environmental factors such as temperature desiccation, low moisture retention, soil erosion, sand accretion, soil salinity, salt spray, changes in organic matter and pH involved in formation of a variety of micro-environments there. The coastal communities dominated by the pioneer species Marram grass (*Ammophila arenaria* L.) play an important role in sand dune stabilization and formation and coast protection and has received much attention during the last years. Plant nematodes including ectoparasites as longidorids, tylenchorinchs and criconematids are substantial part of the pathogen complex affecting Marram grass establishment.

Several samples from sand dunes at the Bulgarian Black Sea coast vicinities of Krapetz village, Shabla Lake, Kraimorie and Pomoriisko Lake have been collected. They were processed by decanting and sieving techniques; nematodes were fixed in 4% formalin and mounted on permanent slides in dehydrous glycerine. Here we present new data about the species composition and distribution of longidorid species in *A. arenaria* communities. *Longidorus* and *Paralongidorus* genera were represented by one species each, both of them unknown so far; two *Xiphinema americanum* group species were identified - *X. taylori* and *X. pachticum*.

Longidorus sp. is very similar to *L. dunensis* described from the coastal sand dune region of the Netherlands and *L. balticus* originating from sand dunes in northeast Poland but differs from them by having different amphidial fovea shape. Additionally, it has somewhat more plump body and abundant males compared to *L. dunensis*; from *L. balticus* it differs by its narrower lip region, more posterior position of guide ring and differently shaped and longer tail. *Paralongidorus* sp. is a member of a group of 4 species characterised by stirrup amphids with very large aperture, presence of cephalic lobes, high and rounded labial region separated from the rest of the body by constriction, (*P. maximus*, *P. paramaximus*, *P. litoralis* and *P. rex*) however, differs from them either by morphology or morphometrics. *Paralongidorus* sp. is the most widespread species occurring along the Bulgarian Black Sea coast, associated not only with Marram grass but also with wide range of plants species growing on sand dunes. The other longidorid species have been recovered from a single locality.

The present study was supported by the project WETLANET (EU FP7 CSA – SUPPORT ACTION, GA 229802) and the National Science Fund, Ministry of Education, Youth and Science, Bulgaria (grant No DO 02-101/2008).

P14

LONGIDORUS SP. (NEMATODA: DORYLAIMIDA) FROM RIPARIAN VEGETATION IN RILA MOUNTAIN

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The riparian habitats support a high diversity of plant parasitic nematodes with the river flow having an important role for their dispersal. In the course of several studies carried out on Bulgarian nematode fauna ninety four samples from various riparian habitats (grasslands and forests on river banks and floodplains) all over the country were collected. About 40% of investigated samples contained nematodes of the genus *Longidorus*. Nine species belonging to this genus have been recovered from riparian zones. A new bisexual species inhabiting the rhizosphere of *Prunus cerasus* (L.) Mill. trees along tributary of Mesta River in Rila Mountain was found, at an altitude 1032 m a.s.l. The species is characterised by a body length of 6.1-8.1 mm; 106-129 µm long odontostyle; flatly rounded lip region continuous with the body profile, short stirrup-shaped amphidial pouches, 21.5-24 µm wide; normal arrangement of pharyngeal glands, and bluntly rounded to hemispherical tail. Four juvenile stages were indentified. Males with 2-4 adanal pairs and a row of 11 - 13 single ventromedian supplements, spicules 96-120 µm long. Morphometrically the new species is most similar to *Longidorus poessneckensis*, *L. caespiticola*, *L. raskii*, *L. pauli*, *L. helveticus*, *L. vinearum* *L. pius* and *L. kheirii*. Two ribosomal regions, D2-D3 expansion domains of the 28S rRNA and the ITS, were used as genetic markers. The D2-D3 and the ITS regions yielded a single fragments of 800 bp and 1384 bp, respectively. The ITS1 and ITS2 sizes were 579 bp and 338 bp, respectively and were the shortest ITS regions recorded for *Longidorus* species so far. The NCBI BLAST analysis for D2-D3 domains sequence showed 80-93% degree of similarity to other *Longidorus* spp. suggesting that the new species can be easily differentiated from other species by using this ribosomal region. The closest species were *L. poessneckensis* (93% similarity), *L. caespiticola*, *L. macrosoma* and *L. helveticus* (92% similarity). Phylogenetic analyses based on Maximum Likelihood and Bayesian Inference methods for D2-D3 domains were used to characterize the phylogenetic relationships of *Longidorus* sp. with other *Longidorus* sequences recovered from GenBank database. Our study proved that this species possess a unique combination of both morphological and molecular characteristics. The present study was supported by the National Science Fund, Ministry of Education, Youth and Science, Bulgaria (grant No DO 02-101/2008) and the project WETLANET (EU FP7 CSA – SUPPORT ACTION, GA 229802).

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HETERODORUS ARCUATUS (NEMATODA: DORYLAIMIDA) FROM DISKO ISLAND, GREENLAND, A NEW GEOGRAPHICAL RECORD

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Several samples from moss growing in hot springs and temporary brooks were collected by Dr M. Ilieva (IBER-BAS) in July 2011 on Disko Island, situated west of central mainland Greenland. The nematodes were isolated from moss by Baermann funnel method. They yielded several specimens of *Heterodorus arcuatus* (Thorne, 1939) Andr ssy, 2009. Data on its morphology are provided. The materials from hot springs and the bed of temporary brooks correspond well to the original description. The genus *Heterodorus* Altherr, 1952 (Nordiidae, Pungentinae) encompasses 26 species spread mostly in the Northern hemisphere; only three new species have been described from Peru and Papua New Guinea. *Heterodorus arcuatus* appeared as the most widespread species of this genus (over 20 records), distributed in Holarctic and Oriental biogeographic zones. It has been recorded from different ecosystems (forests, grasslands, tundra). Recently the species have been found in nival desert associated with mosses and higher plants. This is first record of *H. arcuatus* from Greenland. The study is a part of PhD thesis of M. Elshishka and was supported by the project WETLANET (EU FP7 CSA – SUPPORT ACTION, GA 229802).

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ASSOCIATION OF VECTORS AND BIRD MALARIA IN WETLAND TERRITORIES OF BULGARIA: PRELIMINARY RESULTS

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Avian malaria parasites include approximately 40 morphologically distinct species of the genus *Plasmodium*. For reasons of similarities in general biology and a close evolutionary co-ancestry, we also include the genera *Haemoproteus* and *Leucocytozoon* (130 and 35 morphological species, respectively) in the same group of malarial parasites of birds. All these parasites multiply as haploid clones in avian hosts and undergo a sexual phase in vectors, which for avian *Plasmodium* spp. are true mosquitoes (e.g. *Culex*, *Aedes*, *Anopheles*), for *Haemoproteus* spp. primarily biting midges (*Culicoides*) and hippoboscids flies, and for *Leucocytozoon* blackflies (Simuliidae). Although these parasites are more species diverse in the tropics, many have active transmission in temperate regions as far north as the Arctic polar circle. Each year, migratory birds are carrying numerous species of avian malaria parasites from African wintering grounds to North European latitudes. Although being transmitted only in Africa, some species of these parasites are present in the blood of the migrant birds during the summer months and can thus potentially be spread to resident species. In this sense, the malaria parasites and other blood parasites of southern origin constitute a potential source for new parasitic diseases. Despite of the long research tradition of avian malaria parasites and the strong interest in this group also from other research fields apart from systematics and taxonomy, the association of parasite haemosporidian parasite species and insect vector species remains scarce.

This study is a PhD project related to the identification and experimental investigation of bird malarial parasites and their lifecycle in the vectors. The subject is the specificity of avian malaria parasites (Haemosporida) to the vectors. Our main aims are: (i) identification of blood sucking insects related to the avian malaria transmission in Bulgaria; (ii) identification of parasite species and genetic lineages found in the vectors by molecular markers; (iii) prevalence of the parasites in the natural populations of biting midges.

First year of our investigations we tested all lab protocols and designed specific primers in collaboration with Lund University. We got samples collected in 6 different regions in Bulgaria. Up to this moment we have screened around 1200 biting midges collected by Bulgarian Veterinary Service in South-East, South-West and North-West regions of the country. The collections include 4 species *Culicoides obsoletus*, *C. newsteadi*, *C. pulicaris*, *C. punctatus*. The bloodmeal of all collected insect has been scanned for bird DNA. We also organized collection of samples in Bulgarian wetlands along lower part of Danube River (Tutrakan district) and North Bulgarian Black Sea coast (Durankulak and Shabla). The preliminary results do not allow identification of ornithophilous culicoids in Bulgarian fauna for the moment. The collected insects will be scanned by molecular markers for haemosporidian parasites in order to find prevalence of the haemosporidian infections in natural populations of collected insect species. By now we have investigated salivary glands of *Culex pipiens*, a mosquito species suspected for transmission mainly of *Plasmodium* in birds. Surprisingly we have found 2 *Plasmodium* and 4 *Haemoproteus* lineages out of 36 salivary glands investigated. These results promise valuable information in respect to vector specificity of haemosporidian parasites in Bulgaria. A number of control experiments with biting midges and mosquitoes for studying the interactions between parasites and vectors are planned in the next year of our study.

CYTOGENETICAL ALTERATIONS AND THE ROLE OF TRANSPOSABLE ELEMENTS IN THE GENOME OF *CHIRONOMUS RIPARIUS* MG. (DIPTERA, CHIRONOMIDAE) FROM HEAVY METAL POLLUTED RIVER IN BULGARIA

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Chironomus riparius is widely distributed and abundant species in fresh water ecosystems. Its karyotype is characterized by chromosome set $2n = 8$ and chromosome arm combinations AB, CD, EF and G ("thummi" cytochrome), with three Balbiani rings (BRs) and one Nucleolar Organizer (NOR) in chromosome G.

The genome alterations of the species, collected from trace metal polluted river (Chaya River, near Asenovgrad) were studied. The higher concentrations of some trace metals (Cr, Cu, Pb, and Cd) were corroborated with a high spectrum of somatic chromosome aberrations (heterozygous para and pericentric inversions, amplifications, deficiency and deletions) and decreasing the normal activity of key structures (BRs, NOR). In order to check if the somatic rearrangements were randomly distributed or not, *in situ* hybridization with three transposable elements (TEs) NLRCh1, CTR1 and TFB were performed. The copies of the TEs were localized in all chromosomes, cells and individuals of *C. riparius*. The signals appeared either as fixed or variable. Fixed insertion sites of all TEs were found in centromere regions of AB, CD and EF chromosomes. Different number of variable signals were observed along the chromosome arms (for instance, in chromosome AB: NLRCh1 insertions are A1a, A1e, A1g, A1j, A2h, A3b, A3d, A4a, A4c, A4e, A4h, B1d, B1e, B1g, B1k, B1l, B2b, B2d, B2h, B3h, B3j, B4b, B4d, B4h, B4f, C1c, C1e, C2e, C2h, C2l, C3d, C4a, C4c, D1d, D1e, D3d, D3e, E1a, E1b, E1d, E1f, E2b, E2l, E3a, E3e, E3n, F1b, F1d, F2a, F2e, F3b, F3f, F4a, F4g, G1a, G1e, G1g, G2a, G2ke, G3b, G3f, G3n, G3o, G3p; CTR1 insertions - A1a, A2g, A4a, A4e, B1g, B3dfhj, B4bdfh, C2e, C4a, C4c, D1d, D2d, D2l, D3d, E1f, F4eg, G1e, G1g, G2r, G3d, G3j, G3p and TFB insertions - A1ab, A3e, A4h, B4h, C2f, C2i, C2j, C3d, C4a, C4c, D1d, D3b, D3h, E1b, E1d, E1f, E2d, E2l, E3a, E3e, E3m, E3n, F3b, F3h, F4g, G1a, G1c, G1g, G1l, G2k, G2l, G3f, G3mn, G3op). Coincidence between localization of common breakpoints of aberrations and sites of TEs was found. Nearly sixty two percentages of breakpoints were detected at the same sites of TEs.

The present results support the hypothesis that chromosome aberrations appeared not randomly in the genome and they were localized mainly in sites occupied from different TEs. These sites seem to be very sensitive regions of chromosomes - called "hot spots".

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BIRD BEHAVIOUR AND MALARIA: HYPOTHESES, PRELIMINARY RESULTS AND POSSIBLE CONSEQUENCES FOR WETLAND BIODIVERSITY

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Haemosporidian blood parasites of birds include morphologically distinct species of the genera *Plasmodium*, *Haemoproteus* and *Leucocytozoon*. These three genera are often considered as a group of bird malarian parasites because of similarities in their biology and a close evolutionary co-ancestry. Most haemosporidian parasites infect different bird species and therefore are not strictly host specialists. Also migratory birds carry various avian malaria parasite species from their African wintering grounds to European latitudes, which can thus potentially be spread to resident species during the summer months. Changes of the host's range, possibly driven by man-made processes, as well as climate change, can have as consequence the colonization of new host species, with possible dramatic effects on new host's populations. The investigation of host-parasite dynamics and of the consequences of infection on such highly mobile organisms as birds has therefore exceptionally important scientific and practical aspects including wetland management. A wide range of protozoan and metazoan parasites manipulate the phenotype (e.g. behaviour, morphology and/or physiology) of their hosts in a way that favours their own transmission. Recent studies on animal personality revealed consistent differences in reaction to environmental stimuli, identifying reactive and proactive individuals. These behavioural differences are consistent and stable across time and contexts and can be compared with the main dimensions in personality models known from psychology. Our main questions are to what extent parasites affect the bird's behaviour and if the distribution of parasites depends on personality traits. In order to answer these questions, we have started a PhD project aiming at: 1) changes of individual behavioural traits during the development of experimental infections in birds of known personality; 2) assessment of correlations between personality and parasite infections of wild-caught passerine birds. We hypothesize that the birds' coping strategies during the acute phase of the infection might depend on personality. Moreover, an individual's personality might also influence infection probability. Recent studies showed that infected birds were more likely to respond to startle stimuli. Earlier investigations reported similar lower response latencies in proactive (fast, bold) individuals. We assume that blood parasites might increase reaction speed in proactive individuals and slow it down in reactive ones. Based on this hypothesis, we propose that blood parasites play an important role in differentiating personality types by selecting divergent anti-predator defence strategies during the acute phase of the infection. In conclusion, our working hypothesis is that malarian parasites performed the role of limiting factor contributing to the selection of extreme behavioural phenotypes in the host populations. In order to demonstrate this hypothesis we have tested up to now Spanish Sparrows (*Passer hispaniolensis*) and Nightingales (*Luscinia megarhynchos*). This poster presents mainly original methodological approaches and some preliminary results of the study.

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NEW DATA ON CYTOGENETICS AND DISTRIBUTION OF BALKAN AQUATIC AND SEMIAQUATIC BUGS (HETEROPTERA)

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Cytogenetic data for six species of four families of aquatic and semiaquatic bugs are presented. The application of these data as solution for taxonomic problems is discussed. Data on the distribution of the largest Bulgarian aquatic insect (*Lethocerus patruelis*, Belostomatidae) are updated and summarized. Reasons for the migration and expansion of its range to the North, and the possibility for reproduction in Bulgaria are discussed. The family Mesoveliidae is reported for the Northern Aegean Islands for the first time. The study was partly supported by the National Science Fund, Ministry of Education, Youth and Science, Bulgaria (grant DO-02-259) and the WETLANET project (FP7 CSA – SUPPORT ACTION, GA 229802).

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HABITATS OF EUROPEAN CONSERVATION CONCERN IN THE COASTAL ZONE OF THE SITE “EMINE – IRAKLI” FROM THE ECOLOGICAL NETWORK NATURA 2000

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The Special Area of Conservation (SAC) “Emine – Irakli” comprises the easternmost parts of Stara Planina Mts, including Emine Cape as well as the adjacent areas ranging from Elenite Resort to the south to the southern suburbs of Obzor town to the north. It was established in order to conserve, and restore if necessary, the size and state of the natural habitats and the habitats of some species with conservation value. Altogether 20 habitats from Annex I and 20 species from Annex II of the Habitats Directive (Directive 92/43/EEC) are conserved in the SAC.

This investigation deals with the natural habitats of conservation concern for the EU in the coastal area of the site.

The following habitats have been recorded: 1210 Annual vegetation of drift lines, 1240 Vegetated sea cliffs of the Mediterranean coast with endemic *Limonium* spp., 2110 Embryonic shifting dunes, 2120 Shifting dunes along the shoreline with *Ammophila arenaria* (“white dunes”).

Most common are the “Embryonic shifting dunes”, which represent the first stages of the dune formation. They include the sandy beach adjacent to the water as well as raised sand surfaces of the upper beach. The main species, which constitute a pioneer vegetation, are: *Eryngium maritimum*, *Cakile maritima* subsp. *euxina*, *Salsola ruthenica*, *Leymus racemosus* subsp. *sabulosus*, *Lactuca tatarica*, *Xanthium italicum*, etc. In many places, especially in the region of Cape Emine, the shore is represented by cliffs with halophytic vegetation – habitat 1240 Vegetated sea cliffs with endemic *Limonium* spp. In areas with accumulations of drift material and gravel rich in nitrogenous organic matter it was recorded the habitat 1210 represented by primarily annual vegetation of *Crambe maritima*, *Cakile maritima* subsp. *euxina*, *Eryngium maritimum*, *Salsola ruthenica* etc. Most rare in the site is the habitat 2120 Shifting dunes along the shoreline with *Ammophila arenaria* (“white dunes”). They represent the next (second) stage of the dune formation. The main species are: *Ammophila arenaria* subsp. *arundinacea*, *Leymus racemosus* subsp. *sabulosus*, *Eryngium maritimum*, *Euphorbia paralias*, *Silene thymifolia*, *Stachys maritima* etc. One possible explanation for the rarity of this habitat is the establishment of camping places on the upper sand beach.

Major threats in the site, which cause deterioration of the habitats are: establishment of relatively dense camping sites on the beach; destruction of the cliffs for extension of the beach (e.g. eastwards of Elenite Resort) and covering of these sites with gravel and sand from elsewhere; construction activities, often illegal, on the beach (e.g. eastwards of Elenite Resort).

In order to protect the habitats and species in the site Emine – Irakli it is absolutely necessary to implement the envisaged protection regime of the area which now represents one of the few coastal territories in the country remaining in relatively natural state.

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RENATURATION AND CONSERVATION SOLUTIONS OF WETLANDS FROM MIDDLE SECTOR OF THE RIVER PRUT

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On a natural flow regime of a river, the floodplain is represented by wetlands, with dependent hydric regime and biocoenosis adapted to periodic flooding fluctuations. In Romania, embankment was applied to great lengths, which interrupted the transverse connectivity of the river with its meadow. Major floodplain water surfaces have been anthropogenically altered, reduced by drainage, draining, regulation of run-off from slopes and meadow.

The history of the major meadow in the case study, of the middle sector of the river Prut characterized the floodplain in terms of topographic, in cross section from the river towards the high terrace, by the existence of the shore sand bank, the lowland with abandoned branches within meadow – with slopes from the river to the meadow, then streams upward to sand shore beneath terrace, “the brook under the terrace” or the preterrace channel and the terrace.

The paper proposed a renaturation solution of the preterrace channel inside the embanked enclosure Trifesti Sculeni, located in major floodplain of the river Prut, in the middle sector.

On natural flow regime the preterrace channel was fed from springs, slopes runoffs and from the river during floods. Currently it works as a drainage channel, collecting and transporting flows from springs and runoffs in order to discharge the excess water in river. The channel is represented by a specific wetland habitat.

In order to avoid/reduce the terrestrialization phenomena on the preterrace channel by depositing sediment from the slopes during runoffs caused by floods it is proposed to be de-silted and for ensuring the development of wetland biocenoses - connecting it to the river. It aims to provide a dilution refresh-rate by water supply from the Prut River: in periods of low water by pumping, during the flood the water supply can be done by gravity as needed. The disposal of excess water from the wetland can be achieved through the pumping station of the drainage systems serving the premises, in Rivers Prut and Jijia. Evacuation can be done by gravity, if the river level is low. Thereby are provided conditions for hosting migratory species and for wintering of geese and ducks. On the Prut track can be identified the East Elbic route, one of the most important bird migration routes to and from northern Europe. The rehabilitated wetland can be arranged for aquaculture and recreation.

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| SREBARNA LAKE – A FUNCTIONING OXBOW-LAKE

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The current presentation aims to introduce a project proposed by the Language School “P. Yavorov”, Silistra, together with the Ecological Station of the Institute of Biodiversity and Ecosystem Research at the Srebarna Biosphere Reserve. The project participates in a school competition organised by Pädagogischer Austauschdienst, Deutscher Akademischer Austauschdienst, Auswertiges Amt, Zentralstelle für das Auslandsschulwesen, Goethe Institut and Partnerschulen – DSD-schools abroad. The aim of this project is to propose the plan for restoration of the statute of the Srebarna Lake as a functioning oxbow lake, following two main steps: (1) lowering the level of the lake’s bottom; (2) restoring the two-way connection with the Danube River. The accomplishing of the main

goal of the project passes through several tasks: (1) to organize a meeting for all the institutions and end-users concerned, aiming at preparation for the least harmful possible action plan; (2) to attract financing organizations; (3) to organize restoring activities; (4) to keep track of the condition of the biodiversity in the reserve while carrying out the restoration steps; (5) to give information to the public about fulfilling the action plan.

Successful accomplishment of the project tasks will result into further preservation of the biodiversity of the lake. In addition, this will assure the promotion of the lake’s role as a natural place for reproduction of the Danube fish and will facilitate and accelerate the processes of self-purification of the Danube River. More information could be found at the website of the project (srebarna.nortienaracing.com).

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| LOCAL MANAGEMENT OF AROUND THE FRESHWATER LAKE (HAMUN - SISTAN)

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Hamoun Oasis is a term applied to wetlands in endorheic Sistan Basin on the on the Irano-Afghan border. Hāmūn is generic term which refers to shallow lakes (or lagoons), usually seasonal, that create in deserts of southeast Iran and adjacent areas of Afghanistan and Pakistan as product of snowmelt in nearby mountains in spring. The term Hāmūn Lake (or Lake Hāmūn) is equally applied to Hāmūn-e Helmand (entirely in Iran), as well to shallow lakes Hāmūn-e Sabari and Hāmūn-e Puzak, which extend into territory of present-day Afghanistan with latter being almost entirely inside Afghanistan. In times of flood the larger lake is recreated in modern times. It used to cover an area of about 4,000 km² (1,500 mi²) with dense reed beds and tamarisk thicket fringing on the edges of the upper lakes. Area was thriving with wildlife animals and migratory birds. In the past five millennium people around Hamoun Oasis for the most part lived in harmony with the wetlands and their wildlife. Specific culture formed around the Hamoun with a way of life suited to the desert wetlands. They fashioned long reed boats to navigate the shallow waters and erected squat, red clay houses to withstand the heat of the desert. Their livelihood was based almost entirely on hunting, fishing, and farming. Until the late 20th century, irrigation waxed and waned in the Sistan Basin for over 4000 years without destroying the wetlands, but then population rapidly increased and new more efficient water management technologies were brought to the region. Soon irrigation schemes began to snake their way throughout the basin. An ancient seat of civilization, Sistan lies in a large depression divided between Afghanistan and Iran.

Remarkably, although the river empties in an extremely arid evaporation pan, it sustains a vast and predominantly freshwater wetland complex, the Hamoun. Reaching their greatest extent with spring floods, these wetlands cover an area ranging from 2,000–4,000 km². The wetlands harbour over 100 species of birds and are an extremely important haven for hundreds of thousands of migratory waterfowl, notably ducks, flamingos,

herons, pelicans and shorebirds. More than a third of the Iranian part has been designated as an internationally protected area under the Ramsar Convention on Wetlands.

The Sistan inland delta has a population of some 400,000 people. The economy is strongly dependent on agriculture (irrigated and non-irrigated) and the goods and services provided by the wetlands. The irrigation system of about 120,000 ha has recently been rehabilitated. Three reservoirs (Chahnimeh) have been constructed for public water supply with a fourth reservoir under preparation. The inflowing rivers from Afghanistan support the irrigated agriculture in the Sistan delta but are also the source for the lake system around the delta. Unemployment in the area is high. The Iranian government tries to improve the living conditions of the people. Further development of the irrigated area will mean less water for the hamouns with resulting lower average water coverage of the lakes. This will not only endanger the ecosystem that the hamouns support but also the livelihoods of the people that depend on the goods and services that the lake provides.

To assist the Iranian government in their decision making on how to further develop and manage the area an Integrated Water Resources Management (IWRM) study has been carried out. The objective of the management of the water resources is to support the socio-economic development in the area, while at the same time protecting and restoring the natural environment.

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| RESTORATION ECOLOGY OF ANZALI WETLAND INVADED BY *AZOLLA*

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Among the challenging topics in the study of the wetlands physically connections is the problem of managing the complex interactions between the natural and artificial wetlands. The impacts of artificially structured wetlands on the natural wetlands create many ecological problems and needs to employ subtle ecological considerations enabling effective restoration practices. Formed on the southern coastal area of the Caspian Sea, the Anzali Wetland covers an area of 19,300 hectare in Guilan Province. It was declared as a Ramsar Site in June 1975 showing international importance of it. As an exotic floating water fern, *Azolla filiculoides* was introduced to the region by the local agricultural authorities in 1984 to be used as fodder for livestock and green fertilizer for the rice paddies. The species, however found its way to the Anzali Wetland, where it spread over a wider area at an alarming rate. *Azolla* is estimated to cover an area of about 1,000 hectares, which has resulted in significant changes in the wetlands natural services. In the lack of proper restoration interventions, the fast growth rate of *Azolla* is expected to result in an increased rate of wetland succession leading to ever faster course of degradation. *Azolla* in case of Anzali Wetland should be gathered and used as a fertilizer or a feedstuff for livestock and farmed fish as an emergency action. However, it is not feasible to use all the *Azolla*. Therefore, removal by machine should be considered. It is desirable that at least 30% of *Azolla* be removed for environmental restoration.



