Wetlands – indicators of the changing environment

Abstracts of the SWS European Chapter Meeting

Bled (Slovenia), 10\textsuperscript{th} to 13\textsuperscript{th} of May 2015
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For many of us, water simply flows from a faucet, and we think little about it beyond this point of contact. We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports.

S. Postel (1997)
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About SWS

The Society of Wetland Scientists is a non-profit organization founded in 1980 to promote wetland science and the exchange of information related to wetlands. SWS is focused on understanding and advancing wetland science, as well as assuring that decision-making processes affecting wetlands are based on an understanding of wetland science. The members are informed about both the underlying science and the kinds of considerations that affect decision-making, many of which are specific to Europe and in particular the European Union.

The objectives of the Society are:

- to operate solely and exclusively as a charitable and educational organization to foster conservation and understanding of wetlands,
- to advance public education and enlightenment concerning wetland resources,
- to provide an independent forum for an interchange of ideas and data developed within wetland science,
- to develop and encourage wetland science as a distinct discipline by supporting student education, curriculum development, and research,
- to encourage and evaluate the educational, scientific, and technological development and advancement of all branches of wetland science and practice, and
- to encourage the knowledgeable management of wetland resources.
Welcome to Bled

We are glad to welcome you to the SWS European Chapter Meeting *Wetlands – indicators of the changing environment* that will be held from 10\textsuperscript{th} to 13\textsuperscript{th} of May 2015 in Bled (Slovenia).

Bled belongs to the oldest touristic towns in Slovenia. It is located in a glacial landscape in the transition area between the Radovljica depression and the eastern foothills of the Julian Alps. The islet in the middle of the lake has attracted people since prehistoric times. In the early 20\textsuperscript{th} century it became a fine health resort.

The aim of this SWS European Chapter Meeting is to enhance the European wetland research domain, by summarising the outcomes and presenting the achievements related to wetland research as well as to strengthen collaborative interactions across disciplines, connecting different institutions and countries, not only in Europe but also world-wide.

We wish you a productive and enjoyable meeting!

Dr. Keith Raymond Edwards  
Secretary of SWS Europe

Dr. Alenka Gaberščik  
Dr. Mateja Germ  
Local Organisers
Plenary lectures
Wetlands in darkness

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In 1990’s the Ramsar Convention included subterranean hydrological systems as a wetland type. Main groups of subterranean habitats are interstitial water and caves; seemingly terrestrial habitats underground are wet also. First specialised subterranean animals (troglobionts) were scientifically described from Slovenia, i.e. from Dinaric karst. The most eminent troglobiont in Europe is the first discovered cave amphibian *Proteus anguinus*; most numerous species in waters are representatives of Crustacea, while outside water representatives of Coleoptera. In Europe, approximately 8% of aquatic species are troglobionts, but they mainly exhibit very small distribution areas. From W Balkans, close to 800 terrestrial and more than 500 aquatic troglobionts (or stygobionts) are known. Two caves with richest troglobiotic faunas - ca 100 species in each - are in Slovenia and in Hercegovina. Very showy terrestrial and aquatic bacterial assemblages were analysed recently. Evidently adaptive morphological characters (called troglomorphies) of subterranean animals are elongation of the trunk and appendages and reduction of some useless structures, like eyes and protective pigmentation. Physiological characteristics are the reduction of metabolism intensity and slowdown of most life processes, consecutively prolongation of the life span. All these mean economisation in the environment with permanent darkness, low food availability, and very low temperature fluctuations (daily and annually). The subterranean biome may react to modern disturbances peculiarly. E.g., moderate organic pollution may be for fauna dangerous in some circumstances, but even beneficent in some others; surface animals may supplant troglobionts if they are supported by slight organic pollution. Selfpurification of organically polluted water break up at the level of nitrates, etc. Troglobionts are prone to extinction for their small distribution areas.

References


Processes approach to ecosystem services of wetland plants

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The concept of ecosystem goods and services has received publicity since the appearance of the World Resources (2000–2001) report and of its part dealing with wetlands and water (Millennium Ecosystem Assessment 2005). The concept of ecosystem services is by definition anthropocentric. For its incorporation into ecological science the crucial role belongs to the scientific assessment of processes determining each ecosystem service. This presentation gives examples of plant physiological processes, both metabolic ones and those controlling the formation of anatomical or morphological plant structures responsible for various services we obtain from wetlands. Of these wetland ecosystem services, attention is paid especially to the water retention in wetlands, their role in buffering hydrological extremities, improvement of water quality, climate amelioration by water-saturated wetlands, production of useful plant materials ranging from human food or animal feed to technological or energy-yielding raw materials, trapping of water, nutrients, pollutants and carbon in wetland soils, erosion control and shore protection, not forgetting about the contribution to the maintenance of regional and global biodiversity. Out of the controlling ecophysiological processes attention is paid especially to water relations of wetland plants, their photosynthesis, respiration, phloem transport and assimilate partitioning, storage and mobilization of reserve substances, mineral nutrition and morphogenesis. The importance of the control of the timing and rates of these processes by various environmental factors is stressed. An attempt is made to summarize the importance of the sustainable functioning of ecophysiological processes in both individual-plants and plant stands or communities for the sustainability of wetland ecosystem services to human well-being. See also Westlake et al. (1998) and appropriate chapters in other books on wetlands and shallow water bodies and their plant life.

References


Acknowledgements

My interest in the assessment of ecosystem goods and services was stimulated by my colleagues Ivan Rynda (Prague), David Pithart (Lutová), Jan Pokorný (Třeboň), Hana Čížková (České Budějovice) and Josef Seják (Ústí nad Labem). All of them deserve my sincere thanks.
Session 1
Wetland structure and function
Nutrient retention by fishponds in agriculture landscape - principles, case studies, capacities

Pokorný, Jan¹, Potužák, Jan², Pechar, Libor¹, Duras, Jindřich³, Baxa, Marek¹, Kropfelová, Lenka¹, Šulcová, Jana¹, Benedová, Zdeňka¹, Chmelová, Iva¹

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Nutrient losses from agriculture fields reach several hundred kg/ha per year. In order to reduce water eutrophication in agriculture catchments coagulants are applied to runoff waters (Florida) and phosphorus is trapped in wetlands. Fishponds in Czech Republic form the hydrological skeleton of landscape since the Middle Ages. Due to high nutrient loadings the natural fish production increased ten times in Czechia during the second half of 20th century. The study brings data on amount of nutrients retained in water, plankton, littoral vegetation, sediments and fish biomass. Nutrient inputs in form of fodder and fertilizers as well as water fowl are dealt with. Principles of nutrient dynamics in hypertrophic fishponds are explained in terms of “phosphorus trap/source relation” with respect to anoxic and oxic conditions of sediments. Case studies briefly show (i) an effect of sediment removal on P retention (ii) dynamic of inorganic nitrogen in heavily loaded fishpond receiving communal sewage water. Results of a mass balance monitoring (total phosphorus/TP, total nitrogen/TN, suspended solids/SS) of nine large fishponds (60 – 449 ha) performed in 2010 – 2013 showed high nitrate retention (c. 80%) and both negative (source) and positive (trap) retention of SS and TP. Conditions for nutrient retention in fishponds are discussed in terms of hydrology (retention time, water depth, bottom/surface water outflow), sediment quality (oxic, anoxic), management measures (fertilizing, feeding, fish stock), fish harvest (how to prevent transport of suspended solids). Practical recommendation aimed at nutrient retention in fishponds in agriculture landscape and rough quantitative estimation of retention capacity are summarised. Nutrient recycling in fishponds belongs to their important ecological functions and we also attempted a monetary valuation of such services.

Acknowledgements
Research was supported by TACR TE 02000077- Smart Regions - Buildings and Settlements Information Modelling, Technology and Infrastructure for Sustainable Development and TA04020123-Technological process of recycling nutrients from the fishpond sediments using suction dredger, integrated station for flocculant dosing and geotextile bags for local application in micro-catchment.
Both nutrient and water levels influence belowground production in two wet grasslands

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Belowground plant structures can represent a significant portion of total plant biomass and can greatly affect ecosystem processes. There have been few studies conducted in wet grasslands on the effect of nutrient additions in the production of belowground plant structures, with most such studies being of short duration (1 year or less). The effect of prolonged (7 years) nutrient additions on net belowground production (NBPP) was determined in two wet grasslands, growing on either organic or mineral soil, using in-growth core bags. It was expected that fertilization would reduce belowground production, but that the structures would have higher N and P contents, and that changes would be more pronounced in the organic soil wet grassland. Mesh bags (7 cm diameter, 15 cm depth) were placed in selected plots at the beginning of the 2007, 2008, 2010 and 2012 growing seasons, representing years 2, 3, 5 and 7, respectively, after the start of fertilization. The bags were removed at the end of each respective growing season and NBPP and nutrient contents of the in-grown roots were determined. Changes in NBPP and nutrient contents over time were analyzed by repeated measures ANOVA, while two-way ANOVAs were run to determine between-site differences. Nutrient effects were analyzed by one-way ANOVAs within each site, while linear regressions were run to determine the relation of water level to the measured parameters. NBPP decreased over time in both sites with these changes being more connected to changing hydrologic conditions than nutrient additions. However, there were significant nutrient effects on NBPP in several years, especially in the wet grassland on organic soil. Nutrient contents and stoichiometric ratios of the belowground plant structures also differed over time and between the two grasslands, with water level being a better predictor of these changes than nutrient additions. Thus, hydrologic conditions overshadowed nutrient effects in these grasslands.
Evapotranspiration dynamics in pristine and managed Fennoscandian peatlands

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Boreal peatlands are sensitive to the effects of rising temperatures, changing hydrology and the temporal patterns in the solar radiation. However, besides the more frequently addressed carbon balance, these external forces are also linked with the energy balance of peatland ecosystems. We address the problem of the Fennoscandian peatland energy balance by examination of eight sites, which had been subjected to a varying degree of anthropogenic impact through forestry activities and agricultural management. Natural peatlands (Siikaneva-1 and -2, Degerö Stormyr and Fäjemyr), agricultural peatland sites (Linnansuo and Jokioinen), and treed peatlands (Alkkia and Kalevansuo) are represented. A synthesis of such a range of datasets on boreal peatland energy budgets has never been attempted before. Various parameters, including the Bowen ratio, surface conductance, decoupling coefficient and the other evapotranspiration characterizers varied between the site groups, while still exhibiting a wide range within the groups. The managed peatlands were, on average, drier and more resistant to evapotranspiration than the pristine mires. In all analyses, the managed sites showed an immediate reaction to weather changes (e.g. draughts and hot spells), while the pristine mires were notably more resilient.

Figure 1. Locations of the study sites (Alkkia, Kalevansuo, Jokioinen, Linnansuo, Siikaneva-1, Siikaneva-2, Degerö Stormyr, Fäjemyr).

Acknowledgements
We gratefully acknowledge: Academy of Finland Center of Excellence Program (project No. 272041), Finnish National Doctoral Programme in Atmospheric Sciences (ATM-DP), Nordic Centre of Excellence DEFROST, projects ICOS and GHG-Europe. This study is part of DEFROST Work Package 1.
Planktonic algae abundance and diversity in urban stormwater ponds and natural shallow lakes

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Impermeable surfaces of urban areas and highways accumulate pollutants, which are moved with the runoff into downstream natural ecosystems. Stormwater ponds are often used to treat urban runoff and mitigate adverse effects on the environment. At a superficial level, these systems have many similarities to natural shallow ponds. However, closer examination shows that stormwater ponds and natural ponds can be considerably different. Stormwater ponds, for example, receive and retain large amounts of contaminants and they experience a hydraulic regime quite different from natural ponds (Wium-Andersen et al. 2013). The delivered pollutants undergo various processes, such as chemical or biological degradation, and they can settle and accumulate in sediments (e.g., PAHs, heavy metals). This movement to sediments can increase their toxicity and adversely affect flora and fauna (Hvitved-Jacobsen et al. 2010). Therefore, it becomes a topic of importance to investigate which organisms are able to inhabit and survive in such systems. Here we examined planktonic algae, which are one group of important primary producers in small pond ecosystems. Our primary objective was to examine the abundance and diversity of planktonic algae in constructed stormwater ponds and compare it with phytoplankton communities found in natural shallow lakes. Water samples were collected approximately 20 cm below the water surface from 3 ponds in Denmark, 3 ponds in Canada and 3 natural shallow lakes in Denmark. Each water body was sampled at 5 spots distributed along its perimeter. A mixed water sample representing each pond or lake was preserved with Lugol’s solution for later examination. Sampling was completed monthly from May till September, 2014. This study will help to better understand which planktonic algae communities can be found in stormwater ponds compared with natural shallow lakes. It will also shed light on what changes they experience over time due to varying loads of pollutants into stormwater systems, and it will yield knowledge on other environmental conditions such as, for example, the geographic location of ponds.

References
Thirteen karst ponds in Alpine region of Slovenia were sampled in the summer of 2014. Mesohabitats and types of substrata were estimated, respectively. Macroinvertebrates were sampled according to standard method. The number of habitats and land-use in the catchment area were also recorded. Some chemical and physical characteristics of water were measured in the field, while others were measured in the laboratory. The results of correlation analyses showed that the abundance of Odonata is positively correlated to Secchi depth or water transparency, while it was negatively correlated to intensity with which the banks had been trampled, total phosphorous, nitrates and ammonium. Number of dragonfly taxa is positively correlated to the depth and surface of the pond, while negative correlations were calculated in case of distance to the closest road and the contents of nitrates, inorganic nitrogen and total dissolved solids. The composition of dragonfly community and distribution of specific taxa is most influenced by the number of habitats in the catchment, turbidity of the water and abundance of submerged macrophytes. Despite the fact that karst ponds were made to supply the water for cattle, they become an important habitat for dragonflies, therefore too intensive and frequent use of these waterbodies by the cattle negatively influences the abundance and species richness of dragonflies.
Role of plants in the greenhouse gas budget of a sedge fen

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Wetlands play an important role in the global carbon cycle. These ecosystems release methane and fix or release carbon dioxide depending on the site conditions, especially temperature, soil moisture, and performance of the vegetation cover. In 2012 and 2014, we studied the effect of plants on the gas emissions from “The Wet Meadows” model wetland near Třeboň (Czech Republic). We compared CO\textsubscript{2} and CH\textsubscript{4} fluxes from vegetated and unvegetated plots (measured in manual emission chambers). Simultaneously, we measured the seasonal course of aboveground biomass and production on these plots. The results confirm the close relationship between methane fluxes and water level. The wetter sites had generally higher methane emissions than the drier sites. In comparative measurements, methane fluxes were generally higher from vegetated plots than from the paired plots with bare soil. This difference was significant in the wetter year 2012, when the water level was frequently above the soil surface, but not in the drier year 2014. The methane emissions from vegetated plots were presumably facilitated by diffusion of methane from deep soil layers to the atmosphere via internal ventilating systems inside roots. The CO\textsubscript{2} fluxes were several times higher from the vegetated plots than from those on bare soil. This difference was highly statistically significant in both years and was ascribed to the respiratory efflux of CO\textsubscript{2} by live plant parts and microbial communities of the hummocks.

References

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The authors gratefully acknowledge the financial support provided by project No. P504/11/1151 of the Grant Agency of the Czech Republic and project No. 063/2013/Z of the Grant Agency of the University of South Bohemia.
Habitat effects on morphology and physiology of *Phragmites australis*

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The morphological and physiological characteristics of *Phragmites australis* (/Cav./Trin. ex. Steudel) and its abiotic environmental conditions were investigated at Lake Fertő/Neusiedler See (47 42’ N, 16 46’ E), which is a reed dominated wetland ecosystem characterised by highly variable habitat conditions and where the enhanced detritus accumulation often leads to anoxia in the rhizosphere of *P. australis*, having a negative impact on its growth and metabolism. The total above and belowground biomass, the traits connected with the reed growth, the free amino-acid content and electron transport system activity of the basal culm internodes and the physical and chemical characteristics of the water and sediment interstitial water were determined in a vigorous and die-back reed stand of the Hungarian part of the lake. The aboveground and living belowground biomass, the shoot length, the basal culm diameter and the number of the living leaves were lower, while the shoot density and the decaying belowground biomass were higher at die-back site than at vigorous site. The ETS-activity was lower and the γ-amino-butyric acid content of the basal culm internodes was higher at die-back site. The relationship of the physiological parameters with the redox potential and S\(^2\) concentration of the surface and sediment interstitial water indicated the response of *P. australis* to the environmental stress factors like oxygen deprivation.
How different types of waterbodies contribute to diversity of macrophytes? A case study from Slovakia

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We compared local (α), among-site (β) and regional (ϒ) diversity of 100 localities (25 localities for 4 basic types of aquatic habitats: ponds, rivers, streams and ditches) in the Váh river valley. The valley is about 400 kilometres long, with altitudinal range from 106 to 664 m, and connects two distinct bioregions (Pannonian and West Carpathian). Totally, 84 taxa (including bryophytes, stoneworts and vascular plants) were found. All waterbody types supported unique species. Numbers of species unique for rivers, streams, ditches and ponds were 14, 4, 8, 17, respectively. The order of habitats based on increasing mean α diversity was: streams (2.56) < rivers (3.24) < ponds (3.44) < ditches (4.04). Nevertheless, there were no significant differences when comparing α and ϒ diversity among waterbody types. Ponds supported both the greatest number of unique species and total number of species, and β diversity was the highest. Our study showed that ponds and ditches are important aquatic habitats for preserving macrophyte diversity.

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This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0059-11.
Macrophyte composition and richness on environmental background of small ponds in Slovakia

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Small ponds are very frequent aquatic habitats in Slovakia and they play an important role in conservation of macrophyte diversity. We conducted a large-scale study covering whole area of Slovakia and studied the effects of environmental variables on macrophyte composition and richness in 93 ponds. Totally, 133 taxa were found; 9% belong to bryophytes and stoneworts and 91% to vascular plants. *Typha latifolia* was the most frequently occurred species (48% of ponds), followed by *Lemna minor* (37%), *Phragmites australis* (27%), *Myriophyllum spicatum* and *Sparganium erectum* (both 23%). More than 30% of the recorded macrophyte species are endangered in Slovakia. Generalized linear model relating macrophyte diversity to environmental conditions explained about 40% of variability in species richness. Number of species significantly increased with pond area and annual air temperature, while decreased with both average water depth and catchment slope. Species composition responded significantly to chemical properties of ponds, mainly to amount of nutrients, pH and electric conductivity. Beside those, proportion of sand substrate, climate, water depth and hydrological connectivity emerged as significant predictors of macrophyte community composition. The multivariate model explained about 14% of the variability in community data set.

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This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0059-11.
Effects of ecological conditions of Danube oxbows with different connection on the developing of epiphytic invertebrate assemblages

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The spatio-temporally diverse and hydro-ecologically variable conditions of riverine floodplains determine the living conditions and hereby the dynamic changes of the organism assemblages. The phytophilous macroinvertebrates were investigated in two different oxbows of Béda-Karapancsa district (Danube-Drava National Park, Hungary): in the Mocskos-Danube side arm (3.5 km length, 60 m wide), situated in the active floodplain and in the Riha oxbow (4.5 km length, 80 m wide) on the protected side and has no connection with the main channel. The Mocskos-Danube has a surface lateral connection with the main channel above the medium water level of the Danube, 550 cm at the gauge Mohács, rkm 1447. The water level fluctuation in the main channel is maximum 9 meter. Along these two oxbows there are two very dense macrophyte stands (the Mocskos-Danube is characterized by *Trapa natans* and *Ceratophyllum demersum* stands, and the Riha-oxbow only by the *Ceratophyllum demersum* stands). The collecting of the epiphytic macroinvertebrates was carried out in different density of both macrophyte stands, furthermore in the edge and the centre of the macrophyte patches. The 17 000 specimens sorted so far belonged to 2 families (*Ceratopogonidae*, *Chironomidae*), 6 orders (*Ephemeroptera*, *Odonata*, *Heteroptera*, *Coleoptera*, *Trichoptera*, *Diptera*), 1 subclass (*Hirudinea*) and 2 classes (*Bivalvia*, *Gastropoda*). The caddishfly characteristically preferred the edge and the rare patches of the macrophyte stands with two architectural complexities. The chironomids appeared at the edges only in the *Ceratophyllum demersum* stands but with approximately four times greater abundance (per unit weight). The snails and mayflies, as grinders and scrapers also preferred the *Ceratophyllum demersum* stands.
Zooplankton diversity in different water bodies of Lake Fertő/Neusiedler See

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Lake Fertő/Neusiedler See (47 42' N, 16 46' E) situated on the Hungarian-Austrian border with a surface area of 309 km² is an extremely shallow lake; 85 % of the Hungarian part (75 km²) is covered by reed. Within the reed belt, there are numerous reedless water areas (inner ponds) of variable size. The reedbelt is enmeshed with canals, which connect the inner ponds with the open water areas. This specific fragmentation of the lake insures high habitat and species diversity. The aim of our study was to investigate the spatial differences in zooplankton assemblages and the influence of the chemical characteristics of the water on the habitat diversity at Lake Fertő/Neusiedler See. 37 zooplankton taxa (15 Rotatoria, 12 Cladocera, 3 Ostracoda, 7 Copepoda) were recorded from the different habitats of the lake. Most of the species were representatives of the eutrophic, shallow lakes with expanded reed belt areas. The cluster analysis based on the Crustacea data showed a high coincidence with the cluster analysis based on the chemical parameters and three habitat groups were separated: open water, inner ponds and reed-belt sites. The composition and the density of the Rotatoria and the Crustacean assemblages showed significant spatial differences. Our results support the concept of high instability of Lake Fertő/Neusiedler See and the remarkable variability and changeability of the microcrustacean and Rotatoria assemblages of the different habitats.
Beyond mass loss: FTIR-spectroscopy as a tool to study litter decomposition

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The process of litter preservation and decomposition is undeniably critical for maintaining fertility and productivity of wetlands. The litterbag technique is a common method to study litter decomposition in wetlands and litter mass loss is the principal parameter of this method. However, litter decomposition is influenced by litter quality as well as by physical, chemical and biological wetland characteristics. Consequently, mass loss data alone might be misleading in some experimental setups as the molecular process of decomposition might differ substantially what might not be apparent from the resulting mass loss. Different analytical methods are commonly applied to the litter in order to gain further insights into the molecular composition and transformations. One of those, Fourier Transform Infra Red Spectroscopy (FTIR) is a technique based on the interactions between IR radiation and the organic molecules in the plant litter or organic material. The most abundant biopolymers in plant litter show very specific signals in the resulting IR spectra and the intensity of the signals show a linear relationship to the concentration of the specific biopolymer. FTIR is therefore a cheap, fast and comparably easy to learn method to gain an overview over the abundance of the major biopolymers present and their dynamics over time. The poster will give a methodological overview for the application of FTIR to litter decomposition studies. Standard and more advanced FTIR interpretation schemes will be introduced using FTIR data from a Phragmites australis decomposition study in different fens.
The greenhouse gas (GHG) balance is currently considered to be one of the main causes of global climate change. Wetlands may act as GHG sinks in some periods and as sources in others, depending on management, hydrological and meteorological conditions. GHG according to concept of IPCC affect positively radiative forcing which increased of 1 – 3 W.m\(^2\) since 1750. Effect of wetlands on climate via GHG balance can be called indirect. Wetlands also affect climate directly via the distribution of solar energy. There are three essential processes that control the distribution of energy in biosphere:

- water evaporation and condensation,
- dissolution and precipitation of salts,
- disintegration and recombination of the water molecule (photosynthesis, respiration).

Plants well supplied with water reduce gradients of heats and air pressure through evapotranspiration (ET) which can be considered as one of the most powerful air-conditioning process. ET responds immediately to incoming solar radiation and reaches value of several hundreds Wm\(^2\). Data of several years monitoring of incident solar radiation, air and soil temperature, air relative humidity in different ecosystems of the culture landscape were evaluated. Evapotranspiration, sensible heat and ground heat fluxes were calculated, generalized and presented in diagrams showing differences among wetlands, farmland etc. Double air-conditioning effect of wetlands is shown: ET cools places of solar energy surplus with intensity of several hundred Wm\(^2\), latent heat of water vapour is then released when due point is reached on could places. Pictures taken with thermal imaging camera from an airship showed both differences in surface temperature among ecosystems of culture landscape and their daily dynamics. The role of wetlands in reducing of heat gradients which drive winds and cause weather extremes is shown.

References
Session 2
Threats to wetlands
Global environmental change impact on the local scale: the case of Dehtář fishpond (South Bohemia, Czech Republic)

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Global environmental changes represent serious threat for wetland ecosystems. Little is known about the synergy effects of various changes such as climate, land use, or trophy change. We analysed vegetation and management changes on the fishpond Dehtář used for carp production. We detected three main groups of factors influencing vegetation of the fishpond: 1) Frequent strong winds and wave action are natural factors related to the size of the fishpond (246 ha) and its position in the flat, forest-free basin. These factors have eliminated development of shallow-water reed beds (e.g. of *Typha* spp.) and of hydrophytes; 2) Intensification of fish-farming and agricultural use of surrounding landscape during 20th century has led to eutrophication of Dehtář. Full pond summer drainage, traditional way to increase fish production, started to by practiced only as fishpond margin exposure for a part of the year after fish harvesting. As a consequence, semi-aquatic plants of nutrient poor sands (e.g. *Juncus tenageia*) and species with longer life cycle (e.g. *Gnaphalium luteo-album*) declined. However, the overall species composition did not change significantly since 1930ies. Disturbances by wave action partly eliminate expansion of competitively strong nitrophilous herbs, and thus enable survival of threatened *Montia arvensis*, considered to be extinct since 1970ies (Lepší et al. 2013). Valuable vegetation of exposed muddy substrata has been maintained, including threatened species *Coleanthus subtilis*; 3) Recently, flood events on one side and strong droughts on the other side limit the possibility of water level regulation of Dehtář. It may have consequences for the survival of a range of annual plant species. Large weather fluctuations increase probability of damage of seedlings and exhaustion of soil seed bank. We conclude that frequent extreme climate events may lead to abandonment of fish farming and loss of many fishponds.

References

Acknowledgement
The research was funded by grants nrs LD14045 (Czech Ministry of Education; part of the COST action 1201 NETLAKE) and 14-36079G (Centre of excellence PLADIAS, Czech Science Foundation). We greatly appreciate the co-operation with our colleague Jan Potužák and Hluboká nad Vltavou CZ s. r. o. fish farm.
Selenium (Se) is a naturally occurring trace element which is toxic at high concentrations, but it is also an essential element for many organisms. Large amount of pollutants is released daily into the environment, including widespread discharge of soluble Se from industrial and agricultural sources, such as the addition of Se to feedstuff and soil fertilizers. Therefore monitoring of Se in selected Slovenian streams was performed (Mechora et al. 2012 and 2014). Sampling of water and macrophytes in three successive years in streams from Notranjska and Central region of Slovenia was done. It was found that aquatic moss *Fontinalis antipyretica* would be suitable for monitoring of Se in Slovenian streams, since Se content varied between sampling sites. The effect of Se on macrophytes is poorly investigated, even less is known about Se metabolism in macrophytes. To evaluate the effect of Se on macrophytes, the measurements of physiological and biochemical parameters was performed on various species, i.e. *Myriophyllum spicatum*, *Ceratophyllum demersum*, *Potamogeton perfoliatus* and *Lemna minor* (Mechora et al. 2011, 2013, 2015). Among selected macrophytes, the most affected was *P. perfoliatus*. The ability of macrophytes for Se uptake was also investigated and later on its transformation in plant’s body. All selected macrophytes were able to uptake large amount of Se. Based on the studies selenite form was found to be more toxic for selected macrophytes than selenate form. Results also indicated that the more toxic selenite was transformed into Se organic compounds (Mechora et al. 2013), while selenate accumulated in the same form (Mechora et al. 2011).

**References**


Selenium compounds in macrophyte Veronica anagallis-aquatica

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Growing human population and human activities have resulted in higher emission of various pollutants into the environment. Research of pollutants in different aquatic systems is one of the major activities in environmental sciences. Se is a naturally occurring trace element with increased concern in recent years due to increased mobilization and concentration of Se in aquatic systems, mainly because of anthropogenic activities like agriculture, mining, petrochemical industry etc. (Lemly 2004, Kaur et. al. 2014). There is a lack of data in terms of naturally present Se concentrations in macrophytes. The main aim of this study was to research Se compounds in aquatic macrophyte Veronica anagallis-aquatica L., which is widely spread in Slovenia. This plant was sampled in three streams in the region of Central Slovenia and in Notranjska region. The sampling was done in three successive years (2009-2011) and in year 2013. Concentrations of Se in years 2009 to 2011 varied from 186 to 1535 ng g⁻¹ dry weight. It is known that Se is usually bound to proteins, so investigation of Se compounds in Veronica anagallis-aquatica with enzymatic extraction using non-specific enzyme protease XIV was done. The amount of extractable Se in whole plant samples varied from 19.4 – 28.1 %. We identified only Se (VI) and Se (IV). Concentration of Se (VI) ranged from 1.4 - 2.6 ng Se g⁻¹ and Se (IV) from 2.7 – 21.1 ng Se g⁻¹ of sample. Identification of Se species in different plant parts, sampled in 2013, was also done. In leaves 25 – 480 ng Se g⁻¹, in stems 19 – 529 ng Se g⁻¹ and in roots 302 – 727 ng Se g⁻¹, all on dry weight basis were determined. Extractable Se in plant parts varied from 10.5 % in roots to 29.6 % in leaves. Identification of Se(IV) and Se(VI) was achieved but no Se-amino acids were detected even at highest concentrations.

References

Acknowledgement
The authors are grateful to Urška Remic who performed the analyses of Se in 2013. This research was financed by Ministry of Higher Education, Science and Technology, the Republic of Slovenia, through the program “Young researcher” PR-01678, project PR-5524 and program P1-0212.

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Wetlands – indicators of the changing environment

The response of common duckweed (*Lemna minor* L.) to the pollutants in the water samples of the Peklenščica stream

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Peklenščica stream is a small karst stream that runs through the area with intensive agriculture and uncontrolled sewage system. The purpose of this survey was to determine the water quality of the Peklenščica stream and suitability of the duckweed growth inhibition test for testing water, polluted by agriculture and municipal water. The analysis of nitrate, nitrite and total phosphorus concentration and measurement of the pH and a toxicity test using common duckweed (*Lemna minor*) were performed in water samples collected at five measurement locations between November 2013 and August 2014. The highest concentrations of nutrients were detected in the spring sampling, which took place after heavy rains and the fertilization on the Ponikva plateau. The lowest values were detected in the winter sampling time with absence of both fertilization and rainfall on the plateau. The response of common duckweed to pollutants in water samples was evaluated according to the standard ISO 20079:2005. The established method of the counting of fronds, where subjective errors could occur, was upgraded by computer vision, which measured the surface of the fronds. Differences arising from the fact, that the counting of fronds with the naked eye included also fronds, which are hardly visible and are considered the same as those who have fully developed (Eberius 2001). A reduction in the growth rate of the common duckweed is one of the indicators of the toxicity of water samples. *Lemna* is tolerant to very high concentration of nutrients (Lasfar et al. 2007), while results showed that the pH of the media is a limiting factor for its growth, what can be seen also from other researches (Landesman et al. 2005). Less favourable pH was present in the situation of higher concentration of nutrients, when it was expected that also other toxic substances could be present in the media (e.g. residuals of pesticides). In order to determine the influence of other potential pollutants in the water on the growth of the common duckweed, the maintenance of permanent pH conditions in water samples would be necessary during the *Lemna* test.

References

Hydrological impact of intensive rice cultivation in the inland valley of Tossahou in Benin

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Inland valleys are often characterized by high soil fertility and assured water availability which makes them suitable for rice production. Nevertheless, unsustainable intensive agricultural production bears the risk of soil degradation and may impact downstream water availability and water quality. The current study investigates water dynamics, water quality, and rice production in the Tossahou inland valley located in the north-western part of Benin which is used for rice production. Climate and hydrology (dynamics of soil moisture, groundwater, and discharge) were monitored over two rainy seasons and the dry season in between. Management practices were surveyed, prevailing agricultural land use as well as soil physico-chemical properties have been mapped, and rice yield was measured. One of our specific objectives was the assessment of the suitability of the inland valley for four different rice-based cropping systems: rainfed upland (RU), rainfed bunded (RB), cultivation under natural floods (NF) and irrigated cultivation (IC). The climatic as well as the landscape and soil requirements were evaluated for each cropping system based on the parameter method developed by Sys et al. (1991, 1993) and the FAO Guidelines for Land Evaluation (FAO 1976). Results show that 79.8% of the analyzed area is suitable for RU, 52.1% for IC, 17.8% for NF and 1.2 for RB. Maximum rice yield of 6t/ha was observed in the inland valley in spite of the low rate of fertilizer application. These high yields are caused by the natural soil fertility and low fertilizer inputs account for low nitrate concentration in the discharge. The analysis of the seasonal and spatial variations of the shallow groundwater table revealed a highly fluctuating water table with the lowest level occurring during the dry season. Contrary to expectations, groundwater in the dry season was only accessible at the upstream part in the valley bottom with a depth to the water table of about 1m.

References

Acknowledgement
The study is carried out in cooperation between the University of Bonn, Germany and the Africa Rice Center in Cotonou, Benin as part of the project ‘Sawah, Market Access and Rice Technologies for Inland Valleys’ (SMART-IV). We are grateful to all the field assistants for their contribution at different levels in the data collection process.
Session 3
Wetland management and conservation
Mire conservation and management in Latvia

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Diverse wetlands are distinguished in Latvia, including the peat forming mire types. The importance of their conservation is determined by the fact that half of Latvian mires covering 4.9% are influenced by various human activities. In Latvia the characteristic examples of wetlands are protected in especially protected nature areas, like Slitere, Kemeru and Gauja National Parks, Teici Mire and about 140 nature reserves. From 2014 “Wetlands” LIFE project “Conservation and management of priority wetland habitats in Latvia” is carried out. The aim of the project is to introduce protection and management measures to secure the most favourable conservation status for wetland habitats of European and Latvian importance. The project includes 4 sites Slitere and Gauja National Parks, Ziemelu Mires Nature Reserve (Ramsar site) and Raunas Staburags Nature Reserve. The LIFE project sites include wetland habitats that are habitats of EU importance – active raised bogs, transition mires and quaking bogs, mineral rich springs and spring fens, petrifying springs with tufa formation. For raised bogs, the management will include rising of the groundwater level in the degraded areas, for fens – cutting of trees and shrubs, but for springs – elimination of an invasive species *Heracleum sosnowskii*. Prior to the implementation of wetland management actions, Management plans are being elaborated for the project sites that include various studies – species, habitat, hydrological and geological studies. In the project sites, 160 habitat monitoring relevés are established to follow the vegetation change after the implementation of management actions. Good results of wetland management were reached also within other LIFE projects in Latvia, like „Restoration of Raised bog habitats in the especially protected nature areas of Latvia” where restoration actions were carried out in 4 sites – Melnais Lake Mire, Aklais Mire, Rozu Mire and Aizkraukle Mire and forests”, for example, in Melnais Lake Mire where in January/February 2012 raised bog restoration by building of peat dams on the drainage ditches was carried out. Six month after rising of water level positive vegetation changes were observed in habitat monitoring plots. Rising of groundwater level was observed in 13 monitoring wells.
Quantifying nitrogen removal effects of restored wetlands in Denmark since 1990 utilizing a new national N-model

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A new national nitrogen (N) model has been developed in Denmark that enables simulations of N-sources (diffuse and point), transport processes in soils and removal processes in groundwater and surface waters (streams, rivers, wetlands and lakes). The model operates on a 500 x 500 m grid and the output is aggregated for approximately 3,300 hydrological units with a topographic area of 1500 ha. A sub-model for inclusion of N retention in restored wetlands was developed and implemented in the overall model. Sixteen years of monthly mass-balance data from an intensively studied experimentally restored wetland of 0.8 ha was used for development of a model for total N retention in the wetland that was fed with tile drainage water from a catchment area of 24 ha. A significant (P<0.05) empirical model for total (T) N retention was developed with hydraulic load (mm) and season (summer/winter) as explanatory variables ($R^2_{\text{summer}} = 0.77$; $R^2_{\text{winter}} = 0.36$). The empirical model was based on the 16 years record of monthly N mass-balances. The model was recalibrated using monthly stream flow instead of drainage flow. Mass-balance results from national monitoring of larger restored riparian wetlands (Hoffmann and Baastrup-Pedersen 2006) were used in the new wetland model to calibrate the sub-model to give a long-term average annual TN retention rate of 120 kg N ha$^{-1}$ for wetlands in dominantly sandy regions and 190 kg N ha$^{-1}$ in dominantly loamy regions. The final model was run for the period 1998-2010 during which wetland restoration has been applied as a national mitigation option to reduce diffuse N pollution as part of different Governmental Action Plans against environmental nutrient pollution (Hoffmann et al. 2011, Windolf et al. 2012). The national wetland restoration program has restored a total of 137 wetlands since 1998 that covers a total area of 9457 ha. The total N retention in restored wetlands increases during the period 1998-2010 and the N retention amounts to a total 1,100 tonnes N in 2010.

References


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Implementing practical restoration measures in English chalk streams – does it work, and is there a sound scientific evidence base?

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Chalk streams have been widely recognized for their unique species-rich habitats. They are home to *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, as described in the EU’s Habitat Directive. Good quality chalk streams also boast game fish such as Atlantic salmon *Salmo salar*, Brown trout *Salmo trutta* and Grayling *Thymallus thymallus*. Like most European rivers, chalk streams have been highly regulated in the past; dredging, channelization and disconnection have had a large negative impact on the ecology and biodiversity. At present, aquatic invertebrate communities and fish assemblages are often failing the targets set through EU Water Framework Directive (WFD) legislation. In the UK, hundreds of professionals from statutory agencies and charitable organisations are working in partnerships to improve the ecological quality of chalk streams and other rivers, by delivering a large number of restoration projects. The majority of this restoration work focusses on increasing habitat quality and habitat heterogeneity. A wide range of techniques is available in the River Restoration Centre’s manual (2013) for practitioners to use, including introduction of dead and living wood, increasing variation in flow, bed raising and remeandering. The manual however, is based on case-studies and does not include any scientific evidence base. Studies into the effectiveness of these techniques often struggle to find a positive effect, for instance on aquatic macrofauna diversity (Palmer et al. 2010). This automatically leads to the question – are we spending millions and millions of pounds of public and private money for naught? During the next cycle of River Basin Management Plans we might get the answer to this. The ecological conditions will be reassessed on a catchment scale and we will find out whether we have met the targets of the WFD or, at least are moving towards Good Ecological Status. If not, we have to completely rethink our way of chalk stream restoration.

References


Acknowledgement
Wiltshire Wildlife Trust hosts the Wessex Chalk Streams Partnership aiming to improve the ecological condition of the Avon by supporting restoration projects, educating the public and influencing policy. We are grateful for funding received from the Environment Agency, Natural England and Wessex Water.
Documenting success stories regarding management of diffuse nutrient emissions at catchment scale by restoring wetlands: An example from the Pilot River Odense, Denmark

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Monitoring data from a gauging station in the pilot river Odense in Denmark shows that annual flow weighted total nitrogen (N) and total phosphorus (P) concentrations have decreased significantly (57% and 40%) during the last 20 year period (1995-2014). The reductions obtained in flow weighted N and P concentrations in the river have been achieved due to implementation of general and more targeted catchment management plans for combating diffuse nitrogen and phosphorus pollution. One important implemented management option in the river Odense basin originates from the 2nd Danish Action Plan on the Environment from 1998 that included reestablishment of wetlands (Hoffmann et al. 2011). As part of this programme and later Govermental wetland programmes more than 20 km of the main river channels and some major tributaries has been re-meandered and former wet meadows with temporary inundations and wetlands have been recreated (Hoffmann et al. 2011, Poulsen et al. 2014). The intention behind the national wetlands restoration programme from 1998 and the following wetland programmes in Denmark has been to remove nitrate (denitrification) and store some of the sediment bound nutrients (especially particulate phosphorus) that are emitted to the river from diffuse sources before the nutrients ultimately discharges into the highly eutrophicated Odense Estuary. Modelled and *in situ* measurements of the nitrate removal and storage of particulate phosphorus in the restored wetland have been conducted utilizing a new national Danish N-model and experimental data from a 6 km re-meandered part of the main river Odense channel studied during the period 2003-2013. A comparison of the monitored downward trend in N and P concentrations and loads at the main gauging station at the outlet from the catchment with information from GIS mapping of re-meandered river channels and total areas of restored wetlands is expected to reveal if the additional downward trends observed for N and P flow-weighted concentration in the River Odense as compared to other Danish river basins can be attributed to the effects of the intensive wetlands restoration programme.

References

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Do changes in plant species composition alter the methane emissions in degraded inundated peatlands?

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Rewetting of long-term drained fens often results in the formation of eutrophic shallow lakes with an average water depth of less than 1 m. This is accompanied by a fast vegetation shift from cultivated grasses via submerged hydrophytes to helophytes. As a result of rapid plant dying and decomposition, these systems are highly-dynamic wetlands characterised by a high mobilisation of nutrients and elevated emissions of CO₂ and CH₄. However, the impact of specific plant species on these phenomena is not clear. Therefore we investigated the CO₂ and CH₄ production due to the subaqueous decomposition of shoot biomass of five selected plant species which represent different rewetting stages (Phalaris arundinacea, Ceratophyllum demersum, Typha latifolia, Phragmites australis, and Carex riparia) during a 154 day mesocosm study. Beside continuous gas flux measurements, we performed bulk chemical analysis of plant tissue, including carbon, nitrogen, phosphorus, and plant polymer dynamics. Plant specific mass losses after 154 days ranged from 25% (P. australis) to 64% (C. demersum). Substantial differences were found for the CH₄ production with highest values from decomposing C. demersum (0.4 g CH₄/kg dry mass day) that were about 70 times higher than CH₄ production from C. riparia (Zak et al. 2014). Thus, we found a strong divergence between mass loss of the litter and methane production during decomposition. If C. demersum as a hydrophyte is included in the statistical analysis solely nutrient contents (nitrogen and phosphorus) explain varying GHG production of the different plant species while lignin and polyphenols demonstrate no significant impact at all. Taking data of annual biomass production as important carbon source for methanogens into account, high CH₄ emissions can be expected to last several decades as long as inundated and nutrient-rich conditions prevail. Different restoration measures like water level control, biomass extraction and top soil removal are discussed in the context of mitigation of CH₄ emissions from rewetted fens.

References
Hydro-chemical response to restoration in a rich fen

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Globally, it is estimated that fens cover 26% of all wetlands and 42% of all peatlands. In the UK fens are rare, contributing to just 1% of all British peatlands. Therefore many fens are disproportionately small to the catchment area; however, these wetlands make an important contribution to drinking water quality. In spite of their rarity and importance, many UK fens are degraded, which is principally due to abandonment. In the absence of management, succession leads to an increased abundance of competitive graminoids, which results in biomass accumulation. Standing biomass and litter pose a threat to the oligotrophic conditions, due to internal eutrophication. Senescing and decomposing vegetation contribute to dissolved organic carbon (DOC) and macronutrient release in the water. Increased nutrients are deleterious to biodiversity and DOC exports to reservoirs can compromise water treatment processing. Restoration using a single mowing event took place in 3 wetlands in north-west Wales (U.K). In an attempt to rehabilitate the degraded condition of the fen and improve water quality we examined the hydro-chemical response. Major nutrients nitrate and phosphate were observed as were cations calcium and magnesium. Biomass removal was expected to reduce nutrients and DOC concentration in the pore water, although an initial pulse in DOC was expected following intervention. Pore water chemistry was studied monthly prior to and for 2½ years after management. The basin fen community, Cladio-molinietum (CM) was monitored using a paired plot design which was replicated within and between three sites (n=9). Results show an unexpected increase in electrical conductivity (EC) immediately following treatment which was sustained for 6 months. This was correlated with increased calcium, which supports rich fen minerotrophic hydrology and fen species colonisation. It is proposed that the weight of the mower applied undue pressure to the peat surface causing groundwater mixing. This was unanticipated, given the low pressure specification of the harvester. Also, 4 months after mowing, commencing in August; DOC concentration also increased and remained higher than the control for 4 consecutive months. Conversely, macronutrients did not show a reduction as expected, following biomass removal over the duration of this study.

References

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Nature-Friendly Fishpond Management in the Czech Republic
(Dedicated to the memory of Štěpán Husák, 31 December 1939 – 25 October 2014)

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Problems caused by the attitude of the Czech fishpond managers to the natural values of fishponds were studied in a grant project funded by the Czech Ministry of Environment in 2000-2003. The results of this project together with the experience from earlier studies can be summarised as follows:
- In the Czech Republic (CR), as a landlocked country, fishponds represent not only economically important fish-producing units, but also important landscape-forming elements serving as substitute biotopes and refuges for numerous endangered plant and animal species.
- In the CR, there are about 22,000 fishponds occupying about 52,000 hectares. They contribute to an equilibrated water balance of the surrounding agricultural or forested land and protect large areas from inundation; as, e.g., during the catastrophic flood of 2002. When not frozen, the fishponds’ evaporation and heat capacity damp temperature extremes.
- Fishponds are reserve pools also of other exploitable natural resources than fish (e.g., peat, medical plants, game, etc.) and contain a gene pool of both plant and animal species potentially suitable for human use.
- The value of fishponds’ biodiversity is irreplaceable as they comprise ecologically highly valuable biotopes hosting numerous rare plant and animal species. In most fishpond-rich areas, certain fishponds or fishpond systems comprising valuable biotopes have therefore been selected to be managed with respect to their natural values, and potential or actual conservation status.
- Fishponds suitable for recreation (swimming, sailing, angling, etc.) have to be managed in a specific way according to their purpose, the size and species composition of their fish stocks have to be adjusted accordingly as well.

After the end of the above project, the effort has continued up to now to define ways of managing the fishponds sustainably. This can be achieved only by optimizing (not maximizing!) their fish production along with their natural ecosystem processes.

Acknowledgement
The authors are grateful for fruitful co-operation to their colleagues L. Adamec, H. Čížková, L. Pechar and J. Pokorný, and acknowledge the support from the grant no. VaV/640/8/00 funded by the Ministry of Environment of the Czech Republic.
**Littorella uniflora** (L.) Asch. - A rescue programme in the Czech Republic

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*Littorella uniflora* is a critically endangered amphibious water plant in the Czech Republic (Decree 395/92). Recent population of the species can be found only at eight localities, two drinking water reservoirs and six extensively managed fishponds. Most of them are located in the southern part of the Czech Republic (Chytrý 2011). To protect recent populations a rescue programme supported by the Nature Conservation Agency of the Czech Republic is prepared. Within this programme the size of the recent *L. uniflora* population will be monitored and the experiments with the seed germination capability will be carried out. Other important aspect of this programme is the mapping of the species historical occurrence in the Czech Republic and finally a selection of suitable sites for the establishment of the new population of *L. uniflora*. Presented poster shows several results of the running programme, especially the seed bank experiments.

**References**

Decree 395/92 Ministry of the Environment of the Czech Republic


**Acknowledgement**

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Session 4
Constructed wetlands
Economic Valuation of Wetlands for Water Quality Improvement: An Example from Florida (USA)

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The goal of this study was to calculate the economic value of wetlands in the Saint Johns River watershed for maintaining and enhancing water quality by removing nutrients such as nitrogen (N) and phosphorus (P). Using a combination of geographic information systems (GIS) data, and published data on wetland N and P accumulation in the Saint Johns River (SJR) watershed and nearby areas (northern Everglades, southeastern Georgia), we calculated watershed-wide rates of wetland N and P removal. Wetlands in the SJR remove an estimated 188,000 MT of N each year, half from burial and half from denitrification. The amount of P removed each year is nearly 2400 MT. The economic value of this watershed-wide nutrient removal was determined using the cost (per pound) of N and P removal by wastewater treatment plants and the cost (per pound) of N and P bought and sold in nutrient trading programs in the SJR watershed, Florida and nearby states. Based on wastewater treatment costs to remove N, including denitrification, wetlands of the SJR watershed are valued at nearly 95 to 122 billion dollars each year. Nitrogen removal using nutrient trading program costs values the wetlands at 3.3 to 21.7 billion dollars each year. For P removal, the value of the SJR wetlands is 20 to 490 million dollars/yr based on wastewater treatment costs and 360 million dollars/yr based on nutrient trading programs. It should be noted that uncertainties in nutrient accumulation and nutrient removal costs might lead to over-estimation. However, assuming a N/P cost of only a $1 per pound results in an economic valuation of nutrient removal by SJR wetlands at over 400 million dollars/yr for N and 5.3 million dollars/yr for P. The large economic value of the SJR wetlands underscores their importance in the maintenance and protection of water quality in eastern and northeastern Florida.

Acknowledgement
We gratefully acknowledge the State of Florida, University of North Florida (UNF) and Professor Courtney Hackney (UNF) for supporting our proposal Water Quality Improvement Valuation of the Saint Johns River Wetlands.
Constructed wetlands for removal of pesticides from agricultural runoff

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Pesticides are used in modern agriculture to increase crop yields, but they may pose a serious threat to aquatic ecosystems. Pesticides may enter water bodies through diffuse and point sources, but diffuse sources are probably the most important. Among diffuse pollution, surface runoff and erosion, leaching and drainage represent the major pathways. The most commonly used mitigation techniques to prevent pesticide input into water bodies include edge-of-field and riparian buffer strips, vegetated ditches and constructed wetlands. The first attempts to use wetland macrophytes for pesticide removal were carried out as early as the 1970s, but only in the last decade have constructed wetlands for pesticide mitigation become widespread. The paper summarizes 47 studies from 13 countries in which removal of 87 pesticides, including 35 herbicides, 27 fungicides and 25 insecticides, were monitored. The survey revealed that constructed wetlands with free water surface are the most commonly used type. The literature survey indicated that removal of pesticides is generally effective, but the efficiency varies widely among pesticides and also among systems for a particular pesticide. There are many processes which are responsible for pesticide mitigation such as hydrolysis, photolysis, sedimentation, adsorption, microbial degradation or plant uptake, however, the extent of these processes depends on local conditions, and it is difficult to single out the most important ones. There is strong evidence to suggest the presence of vegetation enhances pesticide retention. The results of the survey revealed that highest pesticide removal was achieved for pesticides of the organochlorine, strobilurin/strobin, organophosphate and pyrethroid groups while the lowest removals were observed for pesticides of the triazinone, aryloxyalkanoic acid and urea groups. The removal of pesticides generally increases with increasing value of $K_{OC}$ but the relationship is not strong.

References

Acknowledgement
The survey was supported by grant No. TA 04020512 from the Technology Agency of the Czech Republic.
Nitrous oxide and methane emissions from peatlands of the globe at various scales, related to soil environment

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The objective of the work is to analyse N$_2$O (nitrous oxide) emissions in terms of peat environmental conditions, such as soil inorganic nitrogen, temperature, and moisture, at fives scales – collar, position, transect, state and global. The data was collected in a single global soil and gas sampling campaign during 2011–2014. During it, gas samples with static chambers from 380 collars organised between 121 positions at 53 transects, groundwater analysis and peat sampling from the collars for further laboratory analysis were conducted in 15 states across the globe. The results reveal a convex power function limits N$_2$O emissions in relation to soil TIN (total inorganic nitrogen). The temperature–N$_2$O boundary appears to be regression curve with its optimum at ~20°. The relationship between N$_2$O and soil moisture has its optimum at 60–70%. Regarding CH$_4$ boundaries, the effect of soil moisture is linear. A power equation describes the CH$_4$ relationship with soil temperature best. The global N$_2$O boundary lines show a striking similarity with southern German N$_2$O boundary lines, as well as with Europe and Queensland. The Levene’s test showed high variance at the local scales, relative to the variance between respective group averages of the global dataset – collar-scale F=9.51; position-scale F=23.3; transect-scale F=76.1 and state-scale F=99.1; all p<0.001. This suggests local rather than global conditions determine land-use based greenhouse gas emissions. Further work will analyse the spatial distribution of the main functional nirS, nirK and nosZ genes regulating the denitrification process in the soil samples currently deep frozen.
A close-up on N$_2$O hotspots in field-edge riparian zones under variable nitrogen load in a moraine plain during the dry year of 2014

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Although field-edge riparian zones are generally recognised as N$_2$O (nitrous oxide) hotspots, knowledge on the finer spatial variation of the emissions is still lacking. We hypothesised, in fertilised arable fields, the footslope, being the first contact zone of the anaerobic soil with the inorganic nitrogen losses, would yield the largest N$_2$O fluxes. We located the footslopes below three arable fields under a fertilisation of 110 kg N ha$^{-1}$ a$^{-1}$ and below three unfertilised fields under various agricultural management practices in the Porijõgi catchment, southern Estonia. Transects were established across the field edges, with a position right at the footslope, 10 m and 20 m towards the riparian zone, and 10m and 20m into the agricultural field. Gas samples were taken from three static chambers per position in six sessions from mid-May until late September 2014. Soil temperature and moisture, and groundwater chemistry and level were measured simultaneously. Plant species cover of all positions was recorded in mid-September and soil properties were analysed in November 2014. The results confirmed our hypothesis at one of the fertilised transects (mean N$_2$O fluxes 175 µg N m$^{-2}$ h$^{-1}$ on average from the goutweed-dominated footslope on a buried organic soil, p<0.05). Furthermore, upslope arable sandy loam under winter barley emitted significant N$_2$O amounts at two fertilised (95 and 56 µg N m$^{-2}$ h$^{-1}$ on average; p<0.05) and an unfertilised transect (50–56 µg N m$^{-2}$ h$^{-1}$; p<0.05). The data feature large variability and we need to extend the sampling through a moister year. Still, the first results show, at fertilised field edges, both the arable sandy loam and the footslope buried organic soil may be the N$_2$O hotspots. At unfertilised field edges with less nitrogen loss, the hotspots are more likely confined within the arable mineral soil.
Herbicide decontamination of surface water as a water purification service in an agricultural basin: a preliminary assessment

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Agricultural herbicides presently represent a serious threat to surface and underground water, especially in intensive cropping areas. In fact, they can be transported by run-off to the minor drainage network and, therefore, to natural or semi-natural aquatic ecosystems. European Union (Directive 128/2009) established "Mitigation Measures" to reduce impacts of pesticides in aquatic ecosystems. Therefore, many in-field (e.g. vegetated filter strips, grassed waterways) and off-site (e.g. riparian and artificial wetlands) mitigation systems are implemented as management practices in crop production (Reichenberger et al. 2007, Otto et al. 2012). Specifically, buffer strips are effective in water purification service, by retaining sediments and surface run-off; however, efficiency depends on the physical-chemical properties of the individual pesticide, soil texture and structure, hydraulic retention time, and wetland vegetation (Vymazal and Brezinová 2015). The aim of this work is to assess the mitigation capacity of buffer strips and grassed waterways in controlling a common herbicide containing two active principles (terbuthylazine and metolachlor). An experimental site has been set up within the Venice drainage systems (Northeast of Italy), within an intensive cropping system using bare and vegetated agricultural canals and ditches. The 10m wide bufferstrip is vegetated with grasses and shrubs such as Phragmites australis, Phalaris arundinacea, Carex riparia, Typha latifolia, Sambucus nigra, Prunus cesarifera, Carpinus betulus and Viburnum opulus. Preliminary results show on one side mitigation effects of the bufferstrip in reducing terbutilazine concentration from 0.669 to 0.374 µg/L, on the other side methaclor concentration reduction was not detected. In general, the mitigative effect was not so relevant due to the early development stages of grasses and shrubs. Ecotoxicological indices show high TER value for both molecules, indicating a no risk situation.

References

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In the context of increasing resource consumption on one side and in the context of resilience in settlements on the other side the application of green infrastructure solutions including treatment wetlands (TW), that mimic natural ecosystems, could become vital. TW have been used in Slovenia for the last 25 years. During this period horizontal (HF), vertical (VF), and hybrid systems were constructed, consisting of two or more interconnected beds. Today there are around 140 systems in operation, mostly horizontal or hybrid TW. Recently 32 novel single stage VF systems for sewage treatment were installed in the size of 1.5 m$^2$ per PE and planted with common reed (*Phragmites australis*), following Danish guidelines design. Their capacity varies from 4 to 15 person equivalents (PE). Because till 2013 most of TW were constructed as a HF systems, more detailed evaluation of vertical system performance was needed. Performance efficiency of VF systems was monitored by means of hydraulic loads, hydraulic retention time, and evaluation of physical and chemical parameters at inlet and outlet, targeted for the removal of BOD and COD only, to meet Slovenian legislation limits for wastewater treatment plants < 50 PE, which are 30 mg/l and 150 mg/l, respectively. The average results ($n = 16$) showed effluent concentration of 41.8 ± 23.4 mg/l for COD and 8.8 ± 7.7 mg/l for BOD5. In next months all systems will be monitored at inlet and outlet for TSS, N and P contents. The results of the performance efficiency will be evaluated and compared with comparable TW, constructed in Denmark according to Danish guidelines. The performance results will be helpful in preparing Slovene guidelines for TW with practical information about operational and legislation requirements, and performance efficiency to meet new legislation for settlements below 2000 inhabitants, which will in Slovenia enter in force in 2015.

References

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Treatment wetlands for sustainable sanitation in Central and Eastern Europe

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Insufficient sanitation in settlements with less than 2000 inhabitants in Central and Eastern Europe represents a significant pollution of surface and groundwater. Namely there is more than 42 Million people living in such settlements in the region and only around 9% of these are so far connected to wastewater treatment plants. There is an increased interest in implementation of low-cost on-site wastewater treatment plants that will have beneficial effect on economic, environmental and social wellbeing of the society. Through different activities Global water partnership (GWP) promotes treatment wetlands as a technology that can meet stated goals and is of special importance in rural areas where they can be integrated in water and nutrient needs in agriculture. The current status of treatment wetlands in the region has been investigated through a questionnaire sent to sustainable sanitation experts in each country. The survey revealed that there are institutional and administrative barriers that hinder broader application of the technology along with low knowledge on treatment wetland performance and construction at municipal level and building sector. In order to enhance the implementation and acceptance of treatment wetlands as a proper technology for sustainable sanitation, GWP published an expert book presenting performance and characteristics of treatment wetlands and similar nature-based technologies. The book is used as a learning tool at the Universities and by other expert communities. The translation of the book’s extended summary from English to other languages of the GWP region will enable awareness rising also at other levels of stakeholders. Moreover, GWP has also prepared workshops for different levels of stakeholders from Ministries to local communities to enable opportunities to establish new national and international networks and exchange of knowledge and good practices regarding treatment wetlands and other nature-based solutions enabling sustainable sanitation and higher settlements resilience.

References

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The authors would like to acknowledge to Global Water Partnership for financial support and to all national experts who contributed the answers to the questionnaire.
The role of semi-natural wetlands and vegetative floating systems in abating nutrients load within an agricultural basin

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The ecological impacts of intensive cropping systems on water bodies is already well documented (MEA, 2005). Nowadays, wetland systems represent an important approach for integrated water management in intensive agro-systems characterized by high agricultural inputs such as fertilization and pesticide treatments. Particularly, wetlands already showed major efficiency in nutrient and sediment retention, so that they can trap and retain 80 to 90% of sediments from runoff and eliminate 70 to 90% of entering nitrogen (Borin et al. 2001; Borin et al. 2007). Such nutrient trapping ability is also well mimed by constructed wetlands which may assume even more importance, at territorial scale, in treating agricultural drainage water by reducing N load and protecting surface and ground water. The aim of this work is to evaluate, at field-scale, the performance of an integrated wetland system set up on 5 phytoremediation sub basins vegetated with some macrophyte species (Phragmites australis, Mentha aquatica, Juncus articulatus and Typha latifolia) and on a three downstream canal floating systems testing different macrophyte species (Iris pseudacorus, Schoenoplectus lacustris, Phalaris arundinacea, Juncus effusus) in abating N and P from agricultural drainage system. Preliminary results confirm relevant reduction in N-NO₃ concentrations, showing a significant decrease within the basins from 0.95 (inlet) to 0.29 ppm (outlet); however, the floating systems located in the downstream canal still did not show significant reduction as species are in early development stages. Total phosphorous concentrations were very low both in sub-basins and canal, ranging from 0.0025 to 0.005 ppm. These agricultural wetlands may also provide several ancillary ecological services such enhancing biodiversity and landscape values.

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SWS
European Chapter Meeting
Wetlands – indicators of the changing environment
Bled, Slovenia, 10 – 13 May 2015