

EULAKES MEETING AND SCIENCE DAY

PROGRAMME and BOOK of ABSTRACTS



Vienna, November 28th – 30th, 2011

University of Natural Resources and Life Sciences, Vienna

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EuLakes- PARTNERS



**AUSTRIAN INSTITUTE
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EuLakes Results

Internal Scientific Session

Tuesday Nov. 29th, 2011

PROGRAMME

Tuesday Nov. 29th, 2011

13.30 – 13.50 h: **M. Milan** and **M. Tolotti**: Paleolimnology of Lake Garda

13.50 – 14.10 h: **S. Shams**, **L. Cerasino** and **N. Salmaso**: Diversity and seasonality of cyanotoxins in Lake Garda

14.10 – 14.30 h: : **J. Padisák**, **V. Üveges**, **K. Tapolczai**, **G. B. Selmeczy**, **N. Salmaso**, **P. Casper**, and **L. Krienitz**: Unexpected cyanobacterial dominances in a deep oligo-mesotrophic lake

14.30 – 15.00 Coffee break

15.00 – 15.20 h **F. Tóth**, **K. Hubai**, and **V. Üveges**: Evaluation of the shorezone of Lake Balaton using Shorezone Functionality Index

15.20 – 15.40 h: **Á. Ferincz**, **G. Paulovits**, **A. Ács**, and **N. Kováts**: Ecological risk assessment of non-indigenous fish species in Lake Balaton – a conceptual framework

15.40 – 16.00 h: **N. Kováts**, **Á. Ferincz**, **A. Ács**, and **G. Paulovits**: Assessing the ecological status of the Kis-Balaton – Balaton reservoir–lake system, based on selected metrics



ABSTRACTS

Tuesday Nov. 29th, 2011

Paleolimnology of Lake Garda

Manuela Milan and Monica Tolotti

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Lake Garda is the largest Italian lake. The deep basin is relatively little impacted by human activities and is suitable for environmental reconstructions, including effects of climate change. In contrast, the shallow basin (81 m) is strongly affected by human activities and is for this reason more suitable for studying eutrophication. Beside being a study site of Eulakes Project, it is also investigated in my PhD. The main aim of the study is reconstruct the long-term ecological lake conditions in relation to human impact and climate change based on sedimentary diatom and cladocera remains, and sediment geochemistry. The reconstructions will be validated through combination of monitoring data and paleolimnological data recorded during the last two decades.

Additional investigation will regard the X-ray fluorescence (XRF) analyses for trace metal concentrations and the Fourier transform infrared spectroscopy (FTIRS) for biogeochemical sediment properties.

Determining the historical status of the lake, in particular before severe human impact during the 20th century, is also of crucial importance for future lake management. Furthermore, the paleolimnological data will also build the basis to evaluate the vulnerability of Lake Garda in the context of climate change and increasing human impact (e.g., hydroelectrical exploitation).

Objective, methods and preliminary results will be presented.

Diversity and seasonality of cyanotoxins in Lake Garda

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The presence of toxic cyanobacteria is a matter of concern in many freshwater ecosystems because some genera can produce toxic secondary metabolites: hepatotoxins (microcystins, nodularins), neurotoxins (saxitoxins, anatoxins, BMAA), cytotoxins (cylindrospermopsins). Cyanotoxins have also the potential to accumulate in aquatic organisms at different trophic levels. In this project, we are studying the temporal dynamics of microcystins production in Lake Garda. Moreover, we have planned to perform a set of lab experiments for elucidating the fate and distribution of microcystins along the food web. *Planktothrix rubescens* and *Anabaena lemmermannii* are the most frequent potential toxic species in this water basin. The first species produces essentially microcystins while the second species produce anatoxins and microcystins. Since April 2010, Lake Garda was regularly investigated by monthly sampling and molecular diversity of toxins also analyzed by using LC/MS techniques. The desmethylated microcystin-RR was always the most abundant microcystin (more than 90% of the total). This variant is ca. 4 times less toxic than the most toxic microcystin (MC-LR). The highest concentrations of MCs were found in the summer months, coinciding with the metalimnetic development of *Planktothrix* populations. Results obtained from this study will help us to determine the degree of transferring of different microcystins through food webs.

Unexpected cyanobacterial dominance in a deep oligo-mesotrophic lake, Lake Stechlin, Germany: *Aphanizomenon flos-aquae*, an ecosystem engineer

Judit PADISÁK⁽¹⁾, Viktória ÜVEGES⁽²⁾, Kálmán TAPOLCZAI⁽³⁾, Géza Balázs SELMECZY⁽⁴⁾, Nico SALMASO⁽⁵⁾, Peter CASPER⁽⁶⁾, Lothar KRIENITZ⁽⁷⁾

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Probably the most coherent observation, almost without latitudinal limitations, in phytoplankton ecology is the proliferation of heterocytic cyanoprokaryotes as a response to increasing P load of lakes and the withdrawal of this group after successful eutrophication management. However, an ongoing expansion of cyanobacteria in European lakes with moderate trophic states has been observed recently without parallel increase in trophic state indicators. An unexpected and perennial *Aphanizomenon flos-aquae* bloom in Lake Stechlin, Germany in 2009-2010 represents such a case since no increase in P load was detected prior to the bloom.

Lake Stechlin is a deep (z_{\max} : 69.5 m) glacial lake that used to be considered oligotrophic in the recent past of its history. Its oligotrophic status was supported by all commonly used measures (TP, chlorophyll-a) and also by phytoplankton assemblage structure and seasonal development. Cyanoprokaryotes, however, were well represented by seasonally developing upper hypolimnetic maxima of *Cyanobium* or occasionally *Planktothrix rubescens*. In late summers, various species of coccoid green algae were typical, and the only planktonic heterocytic cyanoprokaryote, *Anabaena lemmermannii* provided summer peaks no higher than 100 $\mu\text{g L}^{-1}$.

The first filament of *Aphanizomenon flos-aquae* appeared in the lake in 2000 and then it developed a minor peak by every late summers. In 2009, however, an intensive growth started reaching a maximum (310 $\mu\text{g L}^{-1}$) in August. After a decline in August a winter population started to develop with a maximum around 920 $\mu\text{g L}^{-1}$ in December-February that persisted almost as monoculture under thick ice and snow. This winter population provided net photosynthesis in the euphotic layer at 2 °C. The ice-break was followed by a short peak of *Stephanodiscus neoastraea* and by June (normally the clear-water phase in the lake) another *Aphanizomenon* bloom developed reaching a maximum of 2380 $\mu\text{g L}^{-1}$.

These repeated blooms had a cascade of consequences including spatial and temporal patterns of the phytoplankton community and zooplankton development.

Evaluation of the shorezone of Lake Balaton using Shorezone Functionality Index

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Shoreline is a transition zone between the surrounding territory and lake, and has important ecological functions. It regulates nutrient inputs, protects the lake from non-point source pollution, guarantees the execution of ecological processes, serves food and habitat for biota, protects the shoreline from erosion, etc. The Shorezone Functionality Index (SFI) was developed to assess, how much the shorezone is likely to support the above processes. Development of tourism and use of shorezones for recreational purposes often conflicts with integrity of ecological processes. A lake shorezone management based on the concepts of functionality allows reconciling the environment protection with the human use of the lake, and helping an eco-sustainable city planning and watershed management. A further advantage of the SFI is that its simplicity allows understanding of basic processes by non-specialists since it uses five categories that can be visualized by different coloration on graphical displays. Data for calculating the SFI for lake Balaton were recorded between 7-9 September, 2010. We identified 155 homogeneous stretches. The data collected in the field were entered into the Shorezone Functionality Software, which then calculates a functionality value for each homogeneous stretch. According to the SFI index, the shorezone of Lake Balaton spans all different categories of functionality, ranging from Excellent to Poor.

More than 70% of the northern shorezone of Lake Balaton is in the excellent and very good categories, and only less than 5% belongs to the very bad category. On the southern part of the lake 25% of the shorezone is in the excellent and very good category, but very long sections of the shorezone belong to the bad and very bad categories (~25%). It can be established, that according to the SFI, the western basin of the lake is in better condition than the eastern, particularly the south-eastern regions of Lake Balaton. The touristic areas, the presence of roads and railways and the lack of shorezone vegetation greatly impair the qualification.

This project is implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors, 2CE243P3)

Ecological risk assessment of non-indigenous fish species in Lake Balaton – a conceptual framework

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Although invasive and non-native species are recognized as one of the main ecological problem in the 21st century, in numerous cases we could not even determine the exact status of an alien species in a given locality.

Ecological Risk Assessment is a useful tool to estimate the likelihood, that a given stressor cause negative impacts on a recipient. In this case non-indigenous species could be described as stressor and the recipient is the whole environment. In our study the qualitative risk assessment of non-indigenous fish species living in the ecosystem of Lake Balaton is presented, based on the ISEIA (Invasive Species Environmental Impact Assessment) methodology. This framework has been developed for both impact assessment and screening purposes in the British Isles, and was found to be able to give an up-to-date view of risk priority of alien species. The systematic review of all available literature has been carried out and 15 recent non-indigenous species were assessed. Two species: Gibel carp (*Carassius gibelio*) and Amur sleeper (*Perccottus glenii*) have been highlighted with high risk priority, from which *C. gibelio* has been chosen as model species for further examinations.

This project is implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors, 2CE243P3).

Assessing the ecological status of the Kis-Balaton – Balaton reservoir–lake system, based on selected metrics

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The first multimetric, fish-based index was developed by Karr in 1981 and has been widely used for characterising the ecological quality of diverse aquatic habitat types. The index uses ecosystem attributes for status assessment, which in turn are characterised by metrics. One important attribute, community structure involves a very important metric, presence and abundance of non-indigenous species. In our study, spatial analysis was done to assess the ecological status of three different, but geographically connected water bodies: two reservoirs of the Kis-Balaton Water Protection System (KBWPS) and the western basin of Lake Balaton. The KBWPS was designed to function as a natural filter zone and to protect the water quality of Lake Balaton. The main aim of our study was to lay out the framework for assessing the ecological status of the Kis-Balaton Water Protection System and Lake Balaton and to present preliminary results how non-indigenous species contribute to the ecological quality assessment.

This project has been implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors, 2CE243P3).

Sustainable Lake Management and Climate Change

International Symposium

Wednesday Nov. 30th, 2011

PROGRAMME

Wednesday Nov. 30th, 2011

8.30 – 9.00 h: *Registration*

Session 1 – Sustainable lake management under climate change conditions as a European challenge

9.00 – 9.10 h: Opening

9.10 – 9.25 h: **J. Lubor**: The Central Europe Programme

9.25 – 9.55 h: **N. Gallinaro**: EULAKES project presentation - EuLakes: European Lakes Under Environmental Stressors (Supporting lake governance to mitigate the impact of climate change)

9.55 – 10.35 h: Guest lecture –**M. Dokulil**: Successful Restoration of the Shallow Lake Alte Donau (Vienna): A Case Study Based on Bistable Theory

10.35 – 10.55 h: *Coffee break*

10.55 – 11.30 h: **T. Harum** and **C. Holman**: SILMAS project presentation - Sustainable Instruments for Lakes Management in the Alpine Space – SILMAS

11.30 – 12.05 h: **R. Jandl**, **H. Züger**, and **E. Gebetsroither**: MANFRED project presentation - Management strategies to adapt Alpine Space forests to climate change risks (Interreg MANFRED)

12.05 – 12.35 h: **G. Kubu** and **W. Loiskandl**: GENESEE project presentation - Geodetic Survey of the Lake Neusiedl – Hanság Channel System

12.35 – 13.30 h: *Lunch break*

Session 2 – Lake monitoring and lake management options

- 13.30 – 13.50 h: **M. Bresciani, C. Giardino, and E. Matta**: Water quality of the CE lakes by remote sensing technique
- 13.50 – 14.10 h: **M. Siligardi and B. Zennaro**: Shorezone Functionality Index, methodology and results
- 14.10 – 14.30 h: **M. Tolotti and M. Milan**: Palaeolimnological studies and reference conditions of CE lakes
- 14.30 – 14.50 h: **B. Nowicka and A. Nadolna**: Anthropopression markers in bottom sediments of Lake Charzykowskie - state of researches
- 14.50 – 15.10 h *Coffee break*
- 15.10 – 15.30 h: **G. Soja, B. Kitzler and A.-M. Soja**: Greenhouse gas emissions from a shallow steppe lake: case study Lake Neusiedl
- 15.30 – 15.50 h: **Üveges V., L. Krienitz, J. Padisák**: Photosynthetic characteristics and physiological plasticity of winter blooming *Aphanizomenon flos-aquae* in a deep oligo-mesotrophic lake
- 15.50 – 16.10 h: **N. Salmaso and L. Cerasino**: Impact of eutrophication and climate change on the development of cyanobacteria in a deep southern subalpine lake (Lake Garda)
- 16.10 – 16.30 h: **L. Cerasino and N. Salmaso**: Impact of cyanotoxins: implications for management and water utilisation with particular reference to Lake Garda
- 16.30 – 16.50 h: **G. Molnar and N. Gallinaro**: Environmental issues and local governance in EULAKES project
- 16.50 – 17.00 h: Summary and closure of the symposium



ABSTRACTS

Wednesday Nov. 30th, 2011

EuLakes: European Lakes Under Environmental Stressors

Supporting lake governance to mitigate the impact of climate change

Nicola Gallinaro

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EULAKES is a cooperation project, financed by the European Union throughout Central Europe Programme. It comes out from the need to find a match point between the recent scientific discoveries about the effect of climate change on lakes water quality and quantity and the territorial management of them.

The synergy between researchers, local authorities and territorial management bodies is the base of this project and it is also its key element. To this aspect is associated the need to deal with the rising problems within an European comparison in order to give an international value to the scientific results and to the best practices apply to the lake Governance.

European lakes in fact cope with several common problems like pollution and subsidence of water levels, sustainable management of the coasts and of the territorial planning of the activities related to lakes. This european project regroup four important lakes for the first time: Lake Garda (IT), Lake Balaton (H), Lake Neusiedl (A), Lake Charzykowskie (PL) and nine partners from the four different countries.

The main actions are:

- to evaluate the health of the lakes involved in this project, starting from a study of the monitoring systems already existing and developing new approaches for the monitoring of waters' quality and quantity;
- to improve the knowledge about the environmental weaknesses of the lakes and about the short-term and long-term risks connected to it;
- to activate in the four lakes some surveys on nuisance species (e.g. cyanobacteria) and new risks in water use, on climate change impacts on grassland and agriculture, on climate change and new invasive species, on climate change effects on sludge permeable and heavy metals;
- to enhance the role of local Governance about lakes, involving local communities within a for a transnational approach

Total budget: 2.910.799 € Duration: April 2010 – March 2013

Website of the project: www.eulakes.eu Email: info@eulakes.eu

Partnership:

| | |
|---|--|
| Lake Garda Community – Lead partner | www.lagodigarda.it |
| APPA The environment protection agency of Trento | www.appa.provincia.tn.it |
| Edmund Mach foundation | www.iasma.it |
| Austrian Institute of Technology | www.ait.ac.at |
| Naturschutzbund Burgenland | www.naturschutzbund-burgenland.at |
| University of Pannonia | www.uni-pannon.hu |
| Lake Balaton Development Coordination Agency | www.balatonregion.hu |
| Institute of Meteorology and Water Management (IMGW) | www.imgw.pl |
| National Research Council - Institute for the Electromagnetic sensing of the Environment (IREA) | milano.irea.cnr.it/water/water.htm |

GUEST LECTURE

Successful Restoration of the Shallow Lake Alte Donau (Vienna): A Case Study Based on Bistable Theory

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Lake eutrophication is a worldwide environmental problem. The process of eutrophication and (re)-oligotrophication has manifold aspects including many moderate and continuous disturbances originating in the lake, its watershed, or its airshed. Eutrophication of shallow lakes provides an excellent example of alternative stable states. Clear water, macrophyte-dominated stages can alternate with turbid conditions characterized by high algal concentrations. Stable states can switch from one to the other domination through alterations of natural factors such as changes in water level and reduction in throughflow. Forward switches are often associated with anthropogenic pressure. In such cases, backward shift to the original, macrophyte-dominated stage may be difficult. Return times are often prolonged due to hysteresis as a result of resilience. The theory is exemplified with results from a shallow, urban, seepage lake 'Alte Donau,' which is within the city limits of Vienna. Causes and consequences of switches between stable states including resilience and hysteresis are discussed. The remediation measures are explained and the success of the restoration is explained in detail.

Sustainable Instruments for Lakes Management in the Alpine Space – SILMAS

Till Harum and Cecile Holman

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Natural and artificial lakes are a main characteristic of the Alpine Space and belong, with their catchment areas, to the European heritage. During last decades, authorities in charge of lakes management worked to preserve and restore this heritage and its natural resources. They now have to anticipate climate change impacts. SILMAS, by exchanging good practices and testing new methods, will supply its 15 partners with efficient tools for reaching goals of the frame directives (Water and Natura 2000) and the Alpine Convention:

- creation of a virtual laboratory, to define current ecological state of the lakes and anticipate changes due to climatic and biological dynamics,
- assessment of existing governance tools dealing with regulation of land/resources and conflicts solving, then testing decision-making instruments in different lakes sites,
- production of information and education tools for sustainable lakes management and uses, dedicated to decision makers, stakeholders and the young public.

Alpine lakes are fragile environments and are affected by the impacts of climate change. To measure them, Austrian and German partners have already started collecting and analysing samples. The workgroup on conflict-solving governance have selected pilot sites to monitor experience. With regards to education tools, partners have worked on formation session programmes, and on the requirements for the interactive game. SILMAS now has its own logo, and progress is being made with the website. Furthermore, SILMAS is in close contact with the other Alpine Space climate change projects, and will participate in the climate change cluster in the future.

The programme covers 18 lakes in Germany, Slovenia, France, Austria and Italy. The lakes vary widely: the largest of them, Lake Constance in Germany, has a surface area of 536 sq. km, whereas the smallest, Lake Bohinj in Slovenia, measures 3.3 sq. km! Despite their diversity, the lakes are all part of the Alpine arc and, as such, face similar issues. The purpose of this project is to facilitate dialogue between the different institutions involved in managing Alpine lakes. Over a three-year period, scientists, academics and technicians from the public authorities in charge of managing the lakes will pool their knowledge, with a particular focus on three main areas:

- 1. The effects of climate change on the Alpine lakes
- 2. Resolving conflicts between the different uses of the lakes
- 3. Educating the public in sustainable development as it relates to the Alpine lakes

Management strategies to adapt Alpine Space forests to climate change risks (Interreg MANFRED)

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INTRODUCTION

Climate change imposes considerable challenges for forest management in mountain areas. The aim of the MANFRED project is the development of management strategies based on an intensive stakeholder participation process and on an analysis of the factors that are identified to shape forest growth in the future. The project is organized around three transnational case studies where similar challenges are addressed by somewhat deviating national traditions.

MATERIALS AND METHODS

Climate envelopes have been developed for the main tree species. A climate envelope displays the presence/absence of tree species at current climate conditions.

Climate scenarios derived from the model chain ECHAM5/COSMO-CLM have been further regionalized. We used the IPCC scenarios A1B and B1.

The pressure from bark beetles and other pest infestations are addressed in several simulation models that are based on data of previous mass outbreaks that have substantially affected the forest ecosystems and have led to the necessity of an increased management intensity.

Forest growth was simulated and different management scenarios were assumed. We used the forest simulator Caldis, which is based on the generic model PrognAus.

RESULTS

The climate scenarios show a general temperature increase up to more than 4.5°C as a mean for the whole alpine area. Although the yearly precipitation sum in the future will be nearly the same, the annual distribution may change significantly, resulting in more precipitation during winter and spring and a major decrease during the summer months. In addition the length of drought periods and heat waves may increase resulting in additional risks like ozone or fire. But as there is a clear division between north and south the Alps, the regional situation at each case study region may be quite different.

The pressure from insect infestations is expected to rise substantially. The challenge is especially high in regions where the pressure has been rather low so far. The immediate output of the Manfred project is the development of a transnational monitoring and alerting system. Outbreaks of insect infestations are georeferenced and loaded into an online database. The collaboration between national monitoring projects in Slovenia, Switzerland, Bavaria, France, and Austria ensures an early alerting so that forest managers have time to make the required preparations.

The simulation runs show that the growth rate of forests in the Austrian test region in the Ossiacher Tauern will benefit from climate change. Expert judgment however shows that the disposition for bark beetles will be greatly increased.

CONCLUSIONS

The outcome of the Manfred project will be presented in a book that combines the experiences from the test areas. The book is considered to be a seed for a collection of best-practice case studies and should be used by forest management practitioners.

Geodetic Survey of the Lake Neusiedl – Hanság Channel System

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INTRODUCTION

Lake Neusiedl is a shallow lake at the Austrian-Hungarian Border. The lake has a positive influence on the regional climate and is relevant for tourism, water sports, recreation, shipping and fishery. Further a considerable area of the lake is part of an Austrian – Hungarian National Park. The EU funded project “Geodetic Survey of the Lake Neusiedl – Hanság Channel System” was launched 2011. A digital elevation model of the lake and the Hanság Channel with detailed information on the actual sludge volume and distribution will be important information for a sustainable water management of the lake.

MATERIALS AND METHODS

The area of the open water surface will be surveyed by a hydro-acoustic method from a boat to detect the lake ground-surface and sludge thickness. Profiles will have a distance of 100 m. The reed belt can only be measured by single point measurements following profiles with much bigger distances. Former geodetic surveys in the reed belt were carried out with a special surveyor’s rod, consisting of an additional plate to detect the sludge surface. Now this method will be complemented by penetrometer and hydraprobe measurements to improve measurement accuracy and receive information on the sludge consistence. To extend the lake model to its near surrounding airborne laser scan will be used. All survey methods, hydro acoustic measurements, point measurements and airborne laser scan will use satellite positioning systems.

RESULTS

The result will be a digital elevation model of the lake basin, it’s surrounding and the outlet system Hanság Channel. The project results will be available in the Austrian, Hungarian and future European Coordinate- and elevation systems. They will be used for research, water management (weir operation rules) as well as reed- and sludge management planning.

CONCLUSIONS

Interdisciplinary, multinational research can provide the knowledge base for sustainable water management of European Lakes. In case of the Lake Neusiedl – Hanság Channel System at the Austrian – Hungarian border region the financial support of the European Union was crucial for realization.

Water Quality of the CE Lakes by Remote Sensing Technique

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The EULAKES (*European Lakes Under Environmental Stressors*) project, which is funded by the Central Europe Programme 2010-2013, aims at monitoring four major European lakes: Garda (Italy), Charzykowskie (Poland), Neusiedl (Austria) e Balaton (Hungary) and this work has developed under its framework with the specific objective of assessing lake water quality using remote sensing techniques.

Remote sensing is an important source of data for deriving qualitative and quantitative information of the Earth surface. In particular, these techniques become often the unique source of data for environmental monitoring over large areas and long time periods. The major applications in the framework of lake water monitoring relate to the assessment of parameters describing the quality of the upper stratum (euphotic zone).

We used satellite images for deriving optically active parameters (spatially distributed maps) for the period 2004 to 2011 of the water of the four lakes included in the project. These maps will be used for analysing the impact of both climate change and of increasing human pressure on the lake ecosystems.

We also used time series of the MODIS 11A product over the period 2004 to 2011 for deriving and analyzing the lake surface temperature. Results depict the temporal trends of this important parameters as well as its spatial variability within each lake. Moreover, we highlighted significant difference among the lakes.

The optically active parameters (Chlorophyll-a, Total Suspended Solids, Yellow Substances) have been derived by processing 235 images acquired by the MERIS sensor. Images were selected and acquired based on the monitoring strategy defined the Water Framework Directive. Reflectance measures from MERIS images were validated by comparison with field data and different algorithms were used for estimating the water quality parameters.

Results, which were validated by comparison with field limnological data, highlight the trophic conditions of the lakes: eutrophic for lake Garda, meso-trophic for lakes Balaton and Charzykowskie and highly turbid for lake Neusiedl. We found a significant difference between lake Garda and the other lakes both in terms of values and of seasonality of the estimated indicators of water quality. In lake Garda, the maximum values of chlorophyll-a concentration during the study period were found in the winter-spring period whereas in the other lakes maxima occurred in summer. Moreover, all lakes were affected by cyanobacteria blooms during the study period which alter the quality of the waters; we observed increasing frequency of the blooms and levels of concentration with respect to the past.

The spatially distributed analyses based on remotely sensed data pointed out a great spatial variability of the quality of the waters within each lake: the poorest ecological conditions are often in correspondence with the occurrence of both a higher human pressure and less favorable climatic conditions (e.g. high winds).

The temporal analysis did not highlight a significant trend in water quality parameters (no significant change over time).

The remote sensing techniques were also used to evaluate for recent changes in common reed patterns have been evaluated based on multi-temporal Landsat images in Lake Neusiedl. The analysis also indicates the health status of common reed, that has been estimated with radiometric indexes (i.e., NDVI) and for change-detection analyses of land use land cover has been performed in Lake Charzykowskie by using multi-temporal Landsat images.

Moreover, for the lake Garda, remote sensing techniques we used for maps of macrophyte distribution using airborne Multispectral Infrared and Visible Imaging Spectrometer (MIVIS) images.

MIVIS works in 102 spectral channels, spanned from 0.43 μm to 12.68 μm , where four different spectrometers detect electromagnetic radiation. In particular, for applications related to water quality the first spectrometer, with 20 spectral channels from 0.43 μm to 0.83 μm .

Twelve images, with a spatial resolution of 5 m were acquired on 27 June.

Image data were first geocoded and then corrected for both atmospheric and skylight reflection effects at the water surface using the radiative transfer code actor 4. The images were corrected for sunglint effects and the images were inverted using a bio-optical model (BOMBER), which was parameterised with the inherent optical properties of the lake. The field data used for parametrization included both measures of the archive of the National Research Council, both synchronous measurements made on June 27. The measurements were carried out in collaboration with the Environment Agency for the Environment.

The maps is validated and show the distribution of macrophyte in lake Garda in the region of seven bottom depth.

Shorezone Functionality Index: methodology and results

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INTRODUCTION

While most of earlier indices were characterized by a particular analysis, for example to the water itself (chemical analyses) or the biotic environment (biological indices), the Lake Shorezone Functionality index looks at the overall status of the lacustral environments. Both biotic and abiotic factors are used to evaluate the buffering capacity of riparian vegetation, the complexity and artificiality of the shoreline, the anthropogenic use of the surrounding territory, and the way the inputs from the watershed enter the water body.

These factors are used to assign a different functionality level, for each homogeneous stretch, ranging from excellent to poor (divided into 5 categories as suggested from the WFD 2000/60/CE).

MATERIALS AND METHODS

Morphological, structural and biotic parameters are evaluated in the field with an ecological point of view. These semiotic indices are easily surveyed, evaluate the state of the environment, and assist in the identification of the causes of deterioration, zooming out from the waterbody itself to also include all the surrounding territory and watershed topography.

RESULTS

The SFI was carried out on the 4 Central Europe lakes, Lake Garda (IT), Lake Neusiedl (AU), Lake Balaton (HU) and Lake Charzykowskie (PO). A report for each lake has been written, or is under development, by the partners involved into the Eulakes Projects. The reports provide a picture of the status of the shores around the perimeter of the lakes, providing useful information about their level of functionality. This information can be used by managers and stakeholders for a proper management of the shores, to identify restoration sites and foresee restoration success based on different actions, or simply it can be used as a base map that can be compared in the future with further developments.

An “easy-to-read” SFI leaflet provides direct information about the SFI results and can be addressed to a general public.

CONCLUSIONS

The SFI reports give specific indications on what actions are needed to improve the functionality of the water body and can therefore be used to plan, monitor and evaluate restoration efforts. Similarly, different scenarios can be modeled in a specific area to foresee the impacts that public or private work may have on the waterbody. The data can be entered into a GIS system, in order to carry out further spatial analysis and easily display the results in maps. For these reasons, these indices represent an important and powerful tool that can be used for sustainable planning and management.

Today, the Lake Shorezone Functionality Index (created in 2009) is used within the Eulakes and Silmas European projects in Italy, Austria, Slovenia, Poland and Hungary. The index is also applied in the region Araucania in Chile.

Palaeolimnological studies and reference conditions of CE lakes.

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One of the main objective of the EULAKES project consists in the assessment of lake ecological status and future vulnerability of the big European Lakes respect to both large scale (i.e. climate change) and local scale (i.e. land use, tourism) environmental changes. This objective represents an important issue for environmental conservation and natural resource governance. Within this context, the assessment of the evolution of Central European lakes based on palaeoecological studies of lake sediments represents a powerful tool for the reconstruction of lake ecological status at secular scale, in relation to changing climatic conditions and human impacts (e.g. nutrients, heavy metals, pesticides). The Palaeolimnological approach allow to significantly extend the knowledge on lake evolution toward the past, which is of crucial importance for lake management, considering the knowledge gap existing for the majority of the European lakes related to the fact that even the longest limnological studies (i.e. on lakes included within the European Long Term Research network) span over the last few decades. Palaeolimnological reconstruction allows inferring past trophic status and definition of lake reference conditions, which are necessary to fix restoration targets and management policy according to the WFD 60/2000. Methodological approach, and preliminary results are presented for the four Eulakes lakes.

Anthropopression markers in bottom sediments of Lake Charzykowskie - state of research

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INTRODUCTION

The purpose of the investigation is the evaluation of anthropopression influence range on Lake Charzykowskie. It is a big area (22nd in Poland), dimictic, flow lake, supplied by four tributaries. The lake occupies an extensive glacial chute divided on three lake sub-basins. Charzykowskie Lake is included in the transition mesotrophic lakes according to Thienemann classification. The whole catchment (920 km²) is covered by forests in 59% of its area and agricultural crops occupies 35%. The intensity of anthropopression in the lake's shore zone is spatially differentiated. From the other hand the influence of a big town Chojnice starts to increase from the south. Water sewage management of this town affects the lake conditions.

The assumption of the research is that the uneven anthropopression influence in the shore zones and varied water quality of the tributaries are reflected in spatial distribution of biological and chemical markers. The scientific investigations are made on the base of analysis of samples taken from the top layer of the bottom lake deposits and water samples. The distribution of sampling sites represents different parts of the lake and different levels of anthropogenic influence on shore zones.

MATERIALS AND METHODS

The research included a wide spectrum of biological and chemical markers: quantitative and qualitative structures of macrophytes, macroinvertebrates and phytoplankton; heavy metals (arsenic, cadmium, lead, chrome, nickel, copper, zinc, mercury, iron and manganese); Organochlorine pesticides (DDT, DDD, DDE, DMDT, γ -HCH).

The analysis of marker distribution are made on the background of the feature differentiation of contemporary (150 years) limnetic deposits taking into account the simplified chemical composition (organic matter, CaCO₃, dry residue) and nutrients (N_{TOT} i F_{TOT}). Particular attention is paid on the estimation of the hydration level and the insulation abilities of bottom deposits limiting the underground water exchange.

The researches are made in pools themselves and in transects designated across the reservoir in particular pools and riffles. The transect chooses were affected by the zones of increased antropopression (harbours, roads of intensive traffic, discharges of wastewater, buildings). The river outlets are also considered because these are transitional zones between lake and river environments being the habitats for various flora and fauna. Topographic and bathymetric maps, verified in the field, were the base for the designation of ten main and two auxiliary transects. Ield investigations were done during two time measurement series: 11-21.04.2011 and 01.08-03.09.2011. The works in April were focused on surveying measurements documenting research transects and on benthos sampling. Sampling to the physico-chemical analysis and investigations on macrophytes and phytoplankton was done in August. During summer there were also done the additional benthos analysis.

RESULTS

During the fieldwork there were collected: 72 samples of invertebrate fauna (from 448 deposit cores); 105 samples of bottom sediments to analyse heavy metals, basic chemical composition and nutrients (pesticides are marked in chosen 15 samples); 11 water samples from 3 pools (bottom and surface water) and from lake tributaries to analyse heavy metals and nutrients (pesticides are marked in 5 water samples); 43 bottom sediment cores to determine the deposit insulation capacity (to analyze the basic chemical composition and the hydration level, cores were divided into 165 samples). Laboratory and computation works are just in progress. Their degree of advancement is estimated in average on 60%. The most advanced are the investigations on the deposit insulation capacity.

CONCLUSIONS

Modern bottom sediments of Charzykowskie Lake are deposited unevenly. The shape of the bowl and the prevailing wind direction can easily create a mixing of water masses to a considerable depth. Intensive processes of waving cause the removing of the matter from the littoral zone to the sub-lake depressions, where the top layer of organic sediment are built of sapropel deposits. The littoral zone is dominated by sand deposits coming from the denudating shores. Sandy deltas are created in estuaries. Littoral zones are lined with shells of molluscs, which significantly impedes the sampling of the bottom material. There is still open the issue of the collection of samples with intact structure in the aqua environment. This condition is particularly difficult to meet in the semi-liquid sludge to what sapropel deposits are included.

Greenhouse Gas Emissions from a Shallow Steppe Lake: Case Study Lake Neusiedl

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INTRODUCTION

The ongoing increase of greenhouse gas concentrations in the atmosphere requires knowledge about the dominant natural and anthropogenic sources to design appropriate mitigation measures wherever possible. Whereas the terrestrial compartment of natural and artificial ecosystems is well studied concerning the greenhouse gas emission potential of agricultural, forest and permafrost soils, surface waters are less studied but may function as significant emitters. This presentation reports first results of a pilot study on the emissions of CO₂, CH₄ and N₂O from a non-alpine inland lake (Lake Neusiedl, Eastern Austria).

MATERIALS AND METHODS

Emissions of CO₂, CH₄ and N₂O were measured in gas samples that had been recovered from the gas space of floating cuvettes operated as closed chambers. The emission rates were calculated from the linear increase of gas concentrations during 30 minutes, monitored at 4 different times for each sample. Sampling periods covered summer and autumn months. The gas samples were analysed by gas chromatography.

RESULTS

Emissions of the 3 analysed greenhouse gases amounted to 10-20 kg CO₂-e.ha⁻¹.d⁻¹ in mid summer and to 20-30 kg CO₂-e.ha⁻¹.d⁻¹ in late summer. Highest emission rates were observed from water areas adjacent to the reed belt where thick layers of soft sediment cover the lake bottom. The emissions of open waters in larger distances (100-200 m) from the reed belt were 25-35 % lower than the emissions in and near to the reed belt. CO₂ was the dominant contributor to the greenhouse warming potential (75-80 % of CO₂-e) with CH₄ (15-20 %) and N₂O (0-10 %) playing minor roles.

CONCLUSIONS

Based on an analysis of the greenhouse gas warming potential in the summer months, Lake Neusiedl emitted 500-1000 kg CO₂-e.ha⁻¹.month⁻¹ whereas agricultural crops would emit only 25-125 kg CO₂-e.ha⁻¹.month⁻¹. However, the emissions of field crops are dominated by N₂O-emissions whereas Lake Neusiedl emissions are mainly caused by CO₂.

Photosynthetic characteristics and physiological plasticity of winter blooming *Aphanizomenon flos-aquae* in a deep oligo-mesotrophic lake

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The appearance of *Aphanizomenon flos-aquae* at higher latitudes is known and there are sporadic data about its high biomass in winter in temperate eutrophic lakes, sometimes under ice and snow cover. In winter of 2009/2010 *A. flos-aquae* bloomed in the ice and snow covered oligo-mesotrophic Lake Stechlin, Germany. The unusual winter bloom of *A. flos-aquae* monoculture in Lake Stechlin needed research to explore not only its optimum, but also the upper and lower light/temperature tolerance limits to understand the winter appearance. The photosynthesis of the integrated samples was measured with the ¹⁴C method at 8 temperatures (2, 5, 10, 15, 20, 25, 30, 35°C). For the P-I measurements the samples were incubated at nine different light intensities in the range of 0-1320 $\mu\text{mol m}^{-2} \text{s}^{-1}$ PAR for 2 hours at each applied temperature. Above 150 $\mu\text{mol m}^{-2}\text{s}^{-1}$ light intensity the photosynthetic activity was above 20°C the highest, but at the lowest light intensities the photosynthesis was the most intensive in the temperature range of 2-5°C. This low temperature range is similar to the *in situ* temperature in the euphotic layers of Lake Stechlin in winter. The photoadaptation parameter (I_k) and the maximum photosynthetic rate (P_{max}) correlated positively with the temperature between 2-30°C. The I_k was on each temperature low, which enables the development of *A. flos-aquae* DCM in summer periods, and the active photosynthesis of overwintering populations at decreased light intensities under ice cover. The applied low temperatures (2 and 5°C) are the lowest experimental conditions ever, and the results of the P-I and P-T measurements provide novel information about the physiological plasticity of *A. flos-aquae*.

This research was implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors, 2CE243P3)

Impact of eutrophication and climate change on the development of cyanobacteria in a deep southern subalpine lake (Lake Garda)

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This contribution will consider the research carried out in the LTER (Long-Term Ecological Research) station of Lake Garda, in the framework of the project EULAKES. Major focus in interpreting phytoplankton changes in this specific typology of waterbodies is directed towards nutrients and climatic dynamics. During the last 35 years, Lake Garda underwent a significant increase of phosphorus in the water column, from ca. $10 \mu\text{g P l}^{-1}$ to $18\text{-}22 \mu\text{g P l}^{-1}$. At the multi-decadal scale, the increase of the trophic status had a positive impact on the growth of Cyanobacteria. At the seasonal and annual scale, the development of this algal group was strongly controlled by specific modes of atmospheric circulation, which controlled the extent of spring vertical water mixing and surface nutrient fertilization. At the seasonal scale, and comparing the results obtained also in the other deep sub-alpine lakes, the results indicated a positive relationship between the development of the more abundant and eutrophic-sensitive algal groups and the interaction between trophic status and water temperature. Finally, this contribution will discuss the implications due to the development of toxic cyanobacteria in water management and risk assessment.

Impact of cyanotoxins: implications for management and water utilisation with particular reference to Lake Garda

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The presence of toxic cyanobacteria in freshwaters represents a risk for human health. Some cyanobacteria produce secondary metabolites which are endowed with toxicity for liver, kidneys, nervous system. Humans can be exposed to toxins through several routes: ingestion of contaminated drinking water, dermal contact, inhalation of aerosols. Kind and severity of the health problems following exposure to toxins are greatly variable and are dependent on the nature of the toxins (more than 120 different cyanobacterial toxins are reported in the scientific literature). The World Health Organization since 2003 has been developing specific guidelines for helping authorities to assess and manage risks related to cyanobacteria both in drinking waters and in recreational waters. Many countries have implemented own guidelines based on cyanobacteria monitoring and toxin determination. One major limitation of the existing guidelines is that they provide a single limit for all cyanobacteria, and a single limit for all toxins; if this approach can be considered protective, it doesn't give the real picture of the situation. A reliable risk assessment requires primarily a complete profiling of the cyanobacterial toxins. In the frame of the EULAKES project we are applying this approach to Lake Garda, which is a very important resort for touristic/recreational activities, besides being an important source of drinking water.

Environmental issues and local governance in EULAKES project

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Lakes are among the most observable areas where human nature interactions take place. These interactions vary from a single use, such as recreational, drinking water resource, to a more complex multipurpose use. Changing by time the protection of natural assets or the utilisation of natural resources got more attentions. In recent decades the strategies to balance the use and protection of resources are advanced. As the size of the lake gets bigger, the complexity of such strategy is increasing. Facing with new phenomenon such as climate change, these strategies get even more complexity. Lake regions have a long tradition and a well established infrastructure for scientific research. However, research connecting global and local forces of change, such as climate change, started only recently.

Furthermore, although the volume of scientific research focused on various aspects of lakes is significant, results of this research are rarely applied to answer policy questions; typically research is not even designed to be relevant for policy. EULAKES project was initiated to bridge this gap between science and policy formulation, thus the partnerships in each country were established to equally involve scientific organisations and organisations playing role in lake management.

The project realised the need, not only for strengthening research on impacts of climate change in lakes, but also for connecting its results to lake management. Forward looking implementation of existing monitoring systems (WP3), integrated vulnerability and risk assessment (WP4), as well as the pilot actions (WP5) provide the scientific background for the discussions on the joint transnational strategy and a new model of environmental governance (WP6).

Strategy formulation develops through multi-stakeholder participation employing an integrated approach and with the results from the systematic scientific process. The participation of a wide range of stakeholders is essential in order to review existing knowledge, assess policy implications and options, and to engage affected stakeholders in constructive dialogue about lake governance. Therefore, the project aims to engage stakeholders in:

- developing lake information systems (EULAKES model) designed to help identify, understand and track issues critical for climate change and sustainable development;
- identifying and analyzing adaptive strategies and policy initiatives;
- formulating and implementing lake governance initiatives to capture regional environmental benefits, and increase social and ecosystem resilience in response;
- synthesizing learnt lessons and sharing them with relevant local, national and international audiences by implementing the project's educational campaign (WP2).

Existing disconnect between the scientific research and policy decision making and planning will be overcome by integrating the measures to address vulnerability and adaptation through the EULAKES model. Lake governance will be improved through various strategic planning tools both at regional and local levels.

All these activities are focused to enhance the skills in the communities to build voluntary agreements for the future of the lake territories' regions.

POSTER

Air and Water Temperatures at Lake Neusiedl –Past, Presence and Future

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INTRODUCTION

Higher temperatures are supposed to be unavoidable companions of future environmental conditions in the Lake Neusiedl region. The search for more evidence was the starting point to take a closer view on temperatures of air and water.

MATERIALS AND METHODS

Monitoring data of ZAMG¹, HISTALP², and eHYD³ were used to investigate the last 3 decades, and scenario outputs of Züger & Knoflacher (2011)⁴ were the basis for the future prospect estimations.

RESULTS

The increase of temperature was more pronounced for water than for air. The increase of water temperature was significant for all seasons (according to Mann-Kendall-test; per decade increase of 0.76, 0.99, 0.49, 0.44°C resp. for spring, summer, autumn, winter) in the last 30 years, but not so for air temperature (significant only in spring and summer (increase per decade +0.60, 0.70°C resp.)).

A close relationship between air and water temperature could be observed. The coefficient of determination R^2 for these two parameters was between 0.9 and 0.8 for spring, summer, and autumn, but only 0.05 for winter. During winter obviously the insulation by ice and snow cover inhibited the influence of air on water temperature.

It was shown that air temperature changes for the Lake Neusiedl region are expected to be about -0.4°C in spring, +0.7°C in summer, +1.15°C in autumn, and +0.7°C in winter for the 30 year mean 2011/2040 above the basis 1971/2000. Mean increases of 1.6°C for spring, about 4.2°C for summer, approximately 3.7°C for autumn, and 3.75°C for winter in the period 2071/2100 were estimated.

Using these scenario outputs and assuming that the relationship between air and water temperatures will not change, possible water temperatures were derived (method b). Another approach was the extrapolation of the trend over the years (method a). The water temperature values provided by using method b) were lower than by method a).

CONCLUSIONS

- The increase of water temperatures of Lake Neusiedl during the last three decades was more pronounced and steeper than that of air temperatures for all seasons except winter.
- Water temperature was strongly determined by air temperature except in winter.
- Near future water temperatures were estimated by extrapolating the trend of the last three decades.
- Another approach to derive future water temperatures was based on air temperature scenario outputs and the use of the current relationship between air and water temperature.

¹ HISTALP: <http://www.zamg.ac.at/histalp/content/view/35/1/index.html>

² ZAMG: <http://www.zamg.ac.at/klima/jahrbuch/>

³ eHYD http://gis.lebensministerium.at/eHYD/frames/index.php?&146=true&gui_id=eHYD

⁴ Züger, J. & Knoflacher, M. (2011): Regional climate change scenario – Scenario selection and preliminary results. Deliverable 4.2.3 EULAKES