GLEON 2025

# Book of Abstracts

## GLEON All-Hands Meeting

### February 17-February 21

### Lake Toba, Indonesia

**Co-hosted by National Research and Innovation Agency of Indonesia (BRIN) and Deltares with support from local institutions and communities**

GLEON

global lake ecological observatory network

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## Exploring Machine Learning for Predicting Complex Water Quality Variables in Lakes

**Daniel Mercado Bettin[1],**
Eleanor Jennings[2], Elvira de Eyto[3], Valerie McCarthy[4], Rafael Marcé[1]

[1]Spanish National Research Council
[2]Dundalk Institute of Technology
[3]Marine Institute
[4]Dublin City University

Accurately predicting water quality variables in lakes, such as organic matter (OM), is critical for effective ecosystem management under changing climate and anthropogenic pressures. This study explores the use of machine learning (ML) models, specifically Random Forest and XGBoost, to predict OM concentrations based on atmospheric, hydrologic and soil predictors derived from reanalysis datasets (e.g., ERA5). Initial analysis has been done in two lakes, where air temperature and soil moisture were used to build and validate the models. Preliminary results demonstrate the models' ability to capture the non-linear relationships between predictors and OM dynamics, highlighting their predictive performance across different seasonal and environmental conditions.

While these initial findings are promising, we aim to expand this work by collaborating with researchers and water managers to test and validate the methodology across diverse lakes. Sharing data from various regions will allow us to assess the models' robustness, generalisability, and potential limitations when applied to different ecological contexts.

We invite collaborators willing to contribute water quality data or expertise to refine these predictive tools. Together, we can improve our understanding of water quality dynamics and provide reliable, scalable solutions for lake monitoring and management.

## Freshwater zooplankton diel vertical migration and carbon flux under varying levels of planktivory: A mesocosm-based approach

**Anna G. Schmidt[1],**

Christian Dilewski[2], Harrison DuBois[3], Lars Ganzert[2], Tiare Huízar Hernández[4], Elžbieta Kazanavičiūtė[5], Amelia McReynolds[1], Sabine Wollrab[2], Gülce Yalçın[6], Hans-Peter Grossart[2], Stella A. Berger[2], Jens C. Nejstgaard[2], Jason D. Stockwell[1]

[1]University of Vermont
[2]Leibniz Institute of Freshwater Ecology and Inland Fisheries
[3]Northeastern University
[4]University of Kaiserslautern-Landau
[5]Lancaster University
[6]Middle East Technical University

Zooplankton often exhibit diel vertical migration (DVM) in lakes, whereby they reside in deeper waters during the day to avoid fish predation and migrate to surface waters at night to feed on phytoplankton. Zooplankton are expected to exhibit more pronounced DVM behavior in lakes with higher predation risk from planktivorous fish. However, zooplankton trait-based groups differ in their evasion capabilities, which may drive diverse behavioral responses to planktivory. Zooplankton DVM behavior contributes to the downward transport of organic carbon to deep waters and sediments in the ocean, but DVM-mediated carbon flux has not been quantified in freshwater systems. We manipulated densities of planktivorous fish in 14 large enclosures (9 m diameter x 20 m deep) at the LakeLab in Lake Stechlin, Germany for six weeks in spring 2023 to investigate differences in DVM behavior of zooplankton functional groups, and to quantify impacts of DVM on carbon cycling. DVM was quantified using AI-supported high-resolution in situ video (MDPI). Preliminary results indicate stronger migration responses for larger individuals and taxa with weaker evasion capabilities. We use zooplankton respiration and fecal pellet production models, combined with physical parameters and particulate and dissolved carbon concentrations, to investigate how DVM drives carbon flux dynamics through changes in respiration and excretion across time and space. Our results will contribute to better understanding impacts of fish community changes on zooplankton behavioral dynamics and roles in lake ecosystem function.

## New insights into diel $CO_2$ fluxes from lakes across the world

**Elvira de Eyto[1]**
DC-Flux consortium[2]

[1]Marine Institute
[2]Various

As carbon dioxide concentrations in the atmosphere rapidly increase, interest in the functioning of individual ecosystems as important carbon sinks and sources grows. We now know that aquatic ecosystems, in particular inland surface waters, play a significant role in the global carbon cycle, being substantial emitters of $CO_2$ and other greenhouse gases to the atmosphere. . Here, we seek to expand the spatial and temporal diversity of $CO_2$ flux data from inland waterbodies, using a common fieldwork protocol. Sampling took place at 21 lakes and reservoirs around the world between 2016 and 2018, with 41 sampling campaigns in total, measuring $CO_2$ flux ($FCO_2$) at circa 4-hour intervals over a full diel (~24 hour) cycle. $FCO_2$ ranged from -75.79 to 105.84 mmol $m^{-2}$ $d^{-1}$. Eleven campaigns recorded only negative $FCO_2$, nineteen recorded only positive $FCO_2$ while $FCO_2$ in the remaining 11 campaigns switched between negative and positive over the diel cycle. There were three distinct patterns of diel $FCO_2$, determined by the nutrient status of the waterbody and the windspeed. Work is ongoing in finalizing this analysis.

## Benthic Algal Metacommunity Resilience: Synthesizing Meta-Analysis, Long-Term Data, and Experimental Assessments

**Tommy Shannon[1],**
Evelyn E. Gaiser[1]

[1]Institute of Environment and Department of Biological Sciences, Florida International University, Miami, FL, USA

Understanding the landscape-scale patterns and drivers of benthic algal conditions is critical for modeling and managing aquatic ecosystems. Here. we synthesize findings from a meta-analysis, a long-term dataset, and an experimental manipulation that collectively assess the capacity and mechanisms by which benthic algal metacommunities can maintain their community structure and ecosystem functions during disturbance events. We find that, by and large, algae are resilient to most "pulse" disturbances but are nonresilient to many "press" disturbances, instead adapting to new conditions via altered species and functionality. We also find that metacommunities are most resistant to disturbances to which they are historically exposed and pre-adapted, and that recovery is facilitated by factors including disturbance refugia, dispersal, and a return to pre-disturbance ecosystem conditions. Finally, we find that algal metacommunities are co-regulated by local and landscape-scale ecosystem factors, but that landscape-scale environmental alterations and spatial processes are the dominant regulators of landscape-scale metacommunity regulation.

## Enzymatic latch based modeling framework to predict carbon dynamics and storage in mangrove wetlands

**Ya-Hsin Liu**[1]
Jeng-Wei Tsai[2]

[1]Department of Forestry, National Pingtung University of Science and Technology, Pingtung, Taiwan
[2]Graduate Institute of Bioresource, National Pingtung University of Science and Technology, Pingtung, Taiwan

Blue carbon ecosystem provides a promising natural-based resolution to mitigate the crisis of climate change. However, the carbon (C) storage ability show temporal and spatial variations, which results in uncertainty for reaching the goal of net-zero carbon emissions by using blue carbon approaches. 60–90% of C was stored in sediments of mangroves. However, natural and artificial disturbances, such as droughts or deforestation, might dry up and aerate the sediment, accelerate microbial decomposition of labile organic matter (LOM), and thus declining the long-term blue C storage. Refractory organic matters (ROM), such as humus, is more beneficial for long-term C storage. Microbial enzyme latching mechanism (ELM) will be applied to illustrates the key microbe population, their functional gene and metabolic pathways that drives the changes in total carbon (TC) level, C processing and ROM/LOM ratio in the sediment by field investigations and mesocosms bioassays. Structural Equation Model will be applied to clarify the causal-relationship and thus to build a C dynamic model to predict long-term C storage in mangrove blue systems with different root structures between contrasting seasonal rainfall patterns. Research findings contribute to algorithm of coastal blue carbon investigation as well as the knowledge basis for developing the coastal blue carbon trading markets.

## Using digital twin approach to map temporal dynamics of primary production in an intertidal system

**Qing Zhan**[1]

[1]Royal Netherlands Institute for Sea Research

Coastal aquatic systems are hotspot for biodiversity and provide various ecosystem services to society. Accurate quantification of Primary production is required for determining the system carrying capacity. However, intertidal systems, subject to tide dynamics on one side and inland water discharges on the other side, are often extremely variable both in space and and time, making estimation of primary production a challenging task. The recent emerging digital twining tools may help us on this aspect. This research adopt a EU virtual research infrastructure to develop a reproducible workflow that aims at integrating the data and models needed for assessing primary production in Dutch Wadden Sea. Preliminary results will be shown on this poster. Upon publishing of corresponding research, the data and models will also be made following FAIR principle (Findable, Accessible, Interoperable, and Reusable).

## Estimating buried allochthonous organic carbon across the land-to-ocean aquatic continuum

**Daniela Henry P**[1]
Rafael Marcé[1], Núria Catalán[1], Biel Obrador[2]

[1]Center for Advanced Studies, Spanish National Research Council, Blanes, Spain.
[2]University of Barcelona, Department of Evolutionary Biology, Ecology and Environmental Sciences, Barcelona, Spain.

The transport and reallocation of organic carbon (OC) along the land-to-ocean aquatic continuum (LOAC) are crucial yet poorly understood components of the global carbon cycle. Allochthonous OC, displaced from terrestrial ecosystems through erosion, is transported through various aquatic environments, including floodplains, lakes, reservoirs, and coastal ecosystems. Along this pathway, substantial amounts of OC are retained and buried in sediments. However, significant uncertainties remain regarding its distribution, interactions among ecosystems, and the quantification of OC sinks and sources. Addressing these gaps requires integrative models that explicitly incorporate key processes, such as sedimentation and burial, which are often oversimplified or treated statistically.

This study introduces a novel, process-based modeling approach to estimate allochthonous OC dynamics along the LOAC at a global scale, with a spatial resolution of 0.0625ºx0.0625º and a yearly time step. Unlike traditional approaches, this model explicitly represents sedimentation and burial across all aquatic ecosystems simultaneously. Our findings quantify the relative contributions of these ecosystems to global OC retention and burial, while highlighting the critical importance of their connectivity.

In conclusion, we emphasize the need to incorporate these ecosystems and processes into Earth system models to improve our understanding of OC burial and its role in the global carbon budget. This work represents a foundational step toward bridging knowledge gaps and improving predictions of OC cycling along the LOAC, and providing a versatile and powerful tool for exploring diverse global scenarios.

## Modeling of $CO_2$ and $CH_4$ Emissions in Inland Waters - Global problems need global efforts

**Yike Li**[1]
Fatima Tamboosi[2], Lisette N. De Senerpont Domis[2, 3, 4, 5]

[1]Netherlands Institute of Ecology
[2]Department of Aquatic Ecology, Netherlands Institute of Ecology, Wageningen, The Netherlands
[3]Aquatic Ecology and Water Quality Management group, Wageningen University & Research, Wageningen, The Netherlands
[4]Faculty ITC, Department of Water Resources, University of Twente, Enschede, The Netherlands
[5]Faculty EEMCS, Department of Pervasive Systems, University of Twente, Enschede, The Netherlands

Inland waters are significant natural sources of greenhouse gases (GHGs) such as carbon dioxide ($CO_2$) and methane ($CH_4$). Modeling these emissions enhances understanding of internal and external drivers and supports mitigation strategies through scenario analysis. This review synthesizes application domains, model types, model performances and the global representation of $CO_2$ and $CH_4$ modeling studies for inland waters published in the past 10 years. Our results reveal an uneven representation of water body types and application domains in modeling carbon emissions. Reviewed studies primarily targeted wetlands and inland waters in cold and temperate climate zones of the Northern Hemisphere. However, small water bodies (like ponds, streams) and inland waters in tropical zones and climate zones in the Southern Hemisphere are underrepresented. Bottom-up approaches dominate the reviewed studies, with process-based models being the most common, particularly for wetlands. We highlight that present modeling studies for inland water carbon emissions seem not able to represent carbon emissions globally and accurately. One the one hand, present modeling efforts fail to reflect the high carbon emissions and the projected severe climate change patterns in the Global South. On the other hand, evaluation of performance metrics recorded for models capturing $CO_2$ and $CH_4$ emissions in inland waters shows high uncertainties. In addition, researchers from the Global South are also underrepresented in research publications on modeling inland water carbon emissions compared to researchers from the Global North, making climate change a global problem, but not a global effort.

## Future Oxygen Dynamics In Diverse Global Lakes

**Lipa G. T. Nkwalale[1]**
Karsten Rinke[1], Johannes Feldbauer[2], Jorrit Mesman[3], Tuba Bucak[4], Tom Shatwell[5], Daniel Mercado-Bettin[6], Robert Ladwig[4]

[1]Department of Lake Research, Helmholtz Center for Environmental Research - UFZ, Magdeburg, Germany
[2]Technische Universität Dresden, Dresden, Germany
[3]Uppsala University, Uppsala, Sweden
[4]Department of Ecoscience, Aarhus University, Aarhus, Denmark
[5]Department of Environmental Engineering and Applied Computer Science, Technische Hochschule Ostwestfalen-Lippe, Lemgo, Germany
[6]Centre for Advanced Studies of Blanes (CEAB), Spanish National Research Council (CSIC), Blanes, Spain

The long-term impacts of climate change on lakes worldwide are expected to significantly alter both water quantity and quality, leading to changes in thermal regimes, ecosystem functioning, habitats, and biogeochemical cycling. While recent advances in global-scale models have projected rising surface water temperatures and extended stratification periods, these models often overlook key aspects of water quality and are limited by their focus on single mechanistic approaches, leading to uncertainties. Additionally, most existing ecological models lack the transferability needed for global-scale applications, as they are tailored to specific lake systems. In this study we use a multi-model approach in which three lake models were forced by five different climate model projections to simulate future changes in the stratification duration and hypolimnion temperature patterns of 73 lakes (2015 – 2100) under three Shared Socioeconomic Pathway (SSP) scenarios: SSP1-2.6, 3-7.0, and 5-8.5 using data from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). We apply a deep-water dissolved oxygen (DO) depletion model, projecting future hypolimnion DO concentrations at the end of summer stratification for the 73 lakes. Our projections quantify future declining DO levels, especially under SSP-3.70 and 5.85, on a global scale due to rising hypolimnion temperatures affecting depletion rates and longer stratification periods. Mitigation strategies should be considered to preserve ecosystem functioning.

## Annual cyanobacterial blooms that produce geosmin and MIB are occurring earlier in Clinton Lake, Kansas

**Megan Hamersky[1],**
Ted Harris[1], Chris Frazier[1], Thomas Coole[1]

[1]Kansas Biological Survey

Taste and odor compounds, such as geosmin and 2-methylisoborneol (MIB), are primarily produced by cyanobacteria, though they can also originate from soil bacteria. While these compounds are not toxic, they are the leading causes of unpleasant tastes and odors in drinking water. Water treatment facilities often receive numerous customer complaints about these issues before becoming aware of elevated levels of taste and odor compounds in the water. Treating these compounds is costly, making continuous treatment impractical. Therefore, it is essential to develop methods to predict when geosmin and MIB are likely to increase. To better understand the factors that trigger spikes in taste and odor compounds, we analyzed an 18-year dataset from Clinton Reservoir. This dataset includes weather data from a nearby location along with geosmin and MIB levels recorded from 2006 to 2024. Additionally, we examined recent data (2023 and 2024) with higher-resolution weather information and expanded water quality metrics. Our findings indicate that taste and odor compounds have been appearing earlier each year, with geosmin potentially emerging as early as March and MIB as early as February. For the larger dataset, seasonality appears to be the most significant predictor, though it accounts for only about 10% of the variability in compound levels. In the recent dataset, key factors influencing taste and odor compound levels vary, with average water temperatures, water elevation, and seasonal transitions (summer and winter) playing crucial roles.

## Sewage lagoons provide seasonal refuge for birds and an ecosystem service for birders

**Dean M. Bobo[1],**
Matt S. Schuler[2], James A. Rusak[3], Emily R. Nodine[4], Benjamin M. Kraemer[5], Max Glines[6], Edward Millar[7],Stephanie J. Melles[8]

[1]Department of Ecology, Evolution, and Environmental Biology. Columbia University. New York, NY, USA
[2]Biology Department. Montclair State University. Montclair, NJ, USA.
[3]Department of Biology. Queen's University, Kingston, Ontario, Canada
[4]Environmental Studies. Rollins College. Winter Park, FL, USA
[5]Leibniz Institute for Freshwater Ecology and Inland Fisheries, Berlin, Germany
[6]Department of Biological Sciences. Rensselaer Polytechnic Institute. Troy, New York, USA
[7]Environmental and Applied Science and Management Program. Toronto Metropolitan University. Toronto, Ontario, Canada
[8]Department of Chemistry & Biology. Urban Water Research Centre. Toronto Metropolitan University, Toronto, ON, Canada

Sewage lagoons are known birder hotspots where novice and advanced birders alike can observe regionally rare waterbird species. These artificial settling or waste stabilization ponds are designed to treat raw human sewage, and they can contain emergent wetland vegetation. Conventional wisdom suggests that sewage lagoons provide more productive habitat for birds feeding on aquatic invertebrates than neighbouring natural areas, albeit with a heavier load of pollutants, detergents, and bacteria. However, a question remains: Do sewage lagoons provide ecosystem services that are good for birds overall, or are they merely good for birders? We used monthly eBird 'hotspot' data from Jan 2010 to Dec 2019 and the locations of wastewater treatment (WWT) plants with lagoons throughout Ontario (n = 131) to examine seasonal bird species richness at WWTs and near-by (>1500 m) hotspots (nonWWTs). Linear mixed effect models were used to evaluate temporal trends in species richness, controlling for seasonal fluctuations, differences between WWT and nonWWT localities, observation effort, and other potential confounders. Our findings suggest that species richness was higher at nonWWT sites despite high seasonal variability and an increase in number of species observed over time. Even so, birders generally observed more bird species for less effort at WWT than nonWWT sites. More specifically, winter and shoulder seasons had more bird species per unit effort at WWT lagoons than the breeding season, suggesting that lagoons provide warmer conditions and better foraging opportunities during seasonal stopovers and cold conditions. Overall, sewage lagoons seem to be better for birders than birds.

## Sick and sinking

**Lisa Morales**[1]

[1]F.A Forel, University of Geneva, Geneva, Switzerland

Diatoms are key drivers of carbon export in aquatic systems due to their large, dense cells that promote sinking. Asterionella formosa, a dominant species in temperate lakes, may contribute significantly to carbon fluxes to lake sediments during its spring bloom. However, this process is influenced by chytrid parasites infection. While these fungal parasites can terminate blooms by infecting diatom cells, their impact on Asterionella's sinking rates, aggregation dynamics, and carbon content remains unclear.

This study aims to experimentally determine how chytrid infection alters the sinking behavior and carbon content of Asterionella. We hypothesize that chytrid infection could either enhance carbon export by promoting aggregation and increasing the sinking rates of Asterionella's colonies or reduce it by depleting infected cells of their carbon content before they reach the sediment. Using controlled laboratory experiments, we will measure sinking velocity, aggregate formation, and carbon content in infected vs. non-infected cells. This approach is inspired by the SETCOL method and Klawonn et al.'s (2023) sinking aggregates characterization. Our findings will provide insights into how parasitism influences carbon cycling in lakes, particularly in the context of climate change, where warming may alter host-parasite interactions.

## An image-based pipeline to assess phytoplankton near-real time dynamics and provide early warnings of harmful algal blooms in Lake Geneva

**Mathilde Dugenne**[1]
Mridul K. Thomas[1], Irene Muscas[1], Bastiaan Ibelings[1]

[1]Department F.-A. Forel for Environmental and Aquatic Sciences, Faculty of Sciences, University of Geneva

Lake Geneva provides essential services for local communities, serving as a source of drinking water, recreational and touristic activities, and supporting local fisheries. Early on, these services have been threatened by massive proliferations of phytoplankton (algal blooms), which discolored the lake, clogged fishermen nets or produced nauseous gas. Despite longstanding efforts to reduce these proliferations, Lake Geneva still suffers from sudden outbreaks of diverse phytoplankton groups, including potentially toxic species. To understand what conditions (meteorological, hydrological, and/or biological) favor the blooms, we started monitoring phytoplankton communities in the vicinity of the Lac Léman exploration platform (LéXPLORE), a unique collaborative platform designed for autonomous sampling. Using various imaging instruments, our team ultimately aims at developing an AI-based image classification tool to assess the near-real time dynamics of phytoplankton groups, provide early blooms detection, and support the development of decision tools for Lake stakeholders

## Lakes across New Zealand show differential rates of warming in response to climate change

**Whitney Woelmer[1]**
Margaret Armstrong[1], Mat Allan[2], Cady Burns[1], Buddhika Mahaarachchige[1], Matthew Prentice[1], Olivier Raven[1], Martin Sarkezi[1], Deniz Özkundakci[1]

[1]Te Tumu Whakaora Taiao Environmental Research Institute, University of Waikato, Hamilton, New Zealand
[2]Waikato Regional Council, Hamilton, New Zealand

Lake surface water temperature (LSWT), a key regulator of numerous lake ecosystem processes, is changing globally. Despite this, LSWT trends are highly spatially variable, and remain underexplored in New Zealand (NZ). NZ, in particular, provides a unique opportunity to understand LSWT changes in a country with relatively low anthropogenic pressure and a vast representation of ecoregions and climatic gradients. Using remotely sensed LSWT data from 2013 to present, we estimated trends in LSWT across >600 NZ lakes. We found NZ lakes are warming overall at a mean rate of 0.11±0.31 °C/decade. However, regional warming trends were highly variable, with northern lakes experiencing greater warming than southern lakes. Warming trends were significantly different across seasons, with lakes in autumn having the fastest and most variable warming trends, and lakes in spring exhibiting a slight cooling trend. Trends in LSWT were significantly related to observed trends in climate variables, with both air temperature warming and extreme wind gusts having a positive relationship with LSWT, and precipitation rates exhibiting a negative relationship with LSWT. Lake morphology further explained variability in observed trends in warming, with large and deep lakes exhibiting lower and more consistent rates of warming than small and shallow lakes. Our work provides the first estimates of NZ LSWT trends in response to climate change and contributes to our global understanding of climate change impacts on lakes. Ultimately, knowing temperature trends across broad regions helps managers anticipate ecological changes, potentially mitigating ecological degradation and prioritizing conservation actions in vulnerable lakes.

## Variable responses of continental-scale lake and reservoir surface area to land cover and climate change

**Max R. Glines[1]**
Paul C. Hanson[2], Kathleen C. Weathers[2]

[1]Cary Institute of Ecosystem Studies, Millbrook, NY, USA
[2]Center for Limnology, University of Wisconsin-Madison, Madison, Wisconsin, USA

Lakes and reservoirs across the globe support a large portion of freshwater biodiversity, provide access to drinking water, and play an important role in biogeochemical cycles. The quantity and quality of these freshwater resources are influenced by climate and land cover change, but the current literature focuses mainly on northern temperate lakes. Expanding the understanding of these interactions beyond the northern temperate region has important implications for biological processes at continental to global scales. Here we compare and contrast variability in lake and reservoir surface area for 674,963water bodies at spatial scales ranging from continental to global in relation to anthropogenic change. We show that the influence of land cover and climate in regulating lake and reservoir surface area varies across and within continents. Additionally, reservoirs display seasonal and long-term fluctuations in surface area that are distinct from those of natural lakes. Overall, total reservoir surface area has increased across all continents since 1984, while lake surface area was more variable across continents. Our results demonstrate the importance of scale in analyses of interactions at the terrestrial-aquatic interface, and add to ongoing efforts to understand continental-scale biology.

## Controls on light availability for submerged macrophytes in the Coorong, a eutrophic shallow lagoon

**Daniel Chilton[1]**
Christopher Keneally[1], Tyler Dornan[1], Robert Reid[1], Justin Brookes[1]

[1]School of Biological Sciences, The University of Adelaide

Light is fundamental to the growth and reproduction of submerged aquatic plants. Light attenuates with depth and by the concentrations of water column constituents (suspended sediment particles, phytoplankton and chromophoric dissolved organic matter). Light availability can be a limiting factor for submerged aquatic plant growth, reproduction, distribution and abundance when these constituents increase. This study investigates the drivers of light attenuation and its impacts on a submerged macrophyte community in the Coorong, South Australia. A field sampling campaign was conducted seasonally (summer, autumn, winter, spring) at five sites spanning the length of the Coorong South Lagoon in 2022. Measurements of water quality, light attenuation, water level and local wind conditions were taken. All water quality constituents significantly contributed to light attenuation with the largest mean contribution coming from total suspended solids (70.14%), followed by coloured dissolved organic matter (13.31%), chlorophyll a (8.65%) and the water itself (7.95%). Variations in water quality and light attenuation were driven by wind speed and seasonal fluctuations in water level. Predicted light availability at the sediment surface was significantly lower in autumn and summer than winter and spring, coinciding with low water levels and high concentrations of water quality constituents. The timing of these changes in predicted light availability and water level coincide with the annual life history traits of the submerged macrophyte community. This study highlights the importance of light availability on the growth of submerged macrophytes in the Coorong.

## Parametrising Methane Emissions and Uncertainty in a Stratified Reservoir

**Kamilla Kurucz[1],**
Matthew R. Hipsey[1] , Cayelan C. Carey[2] , Peisheng Huang[1]

[1]Centre for Water and Spatial Science, UWA School of Agriculture and Environment, The University of Western Australia, Australia.
[2]Department of Biological Sciences, Virginia Tech, Blacksburg, Virginia, USA.

Freshwater systems are major sources of methane (CH4) emissions, with reservoirs believed to have higher net emission rates compared to other water bodies, although these rates remain highly uncertain. In this study, we developed a parsimonious reservoir CH4 model to explore CH4 dynamics under a variety of ecological conditions and get an accurate picture of the magnitude of CH4 emissions from a eutrophic drinking water reservoir. To achieve this, we extended a 1-D reservoir hydrodynamic model to include a simple methane production and release module. We incorporated the key processes related to CH4 dynamics, including methane production in the sediments, oxic methane production, methane oxidation, diffusion, and ebullition. The model was coupled with an independent Parameter ESTimation software package to optimize its performance and assess the predictive uncertainty of methane emission rates. The model showed promising performance in capturing the magnitude and spatiotemporal variability of methane emissions via both ebullition and diffusion. Of the two pathways, ebullition was found to be more effective in emitting methane, with only a small proportion of bubbles dissolving in the water column. Oxygenating the hypolimnion was found to affect the magnitude of diffusion from the sediments but was not able to suppress the sediment bubble flux. The model's ability to simulate seasonal variability along with pulse emissions due to mixing and pressure changes makes it an effective tool for GHG accounting applications, management scenarios and forecasting.

## How does phytoplankton community cope with climate change?

**Barbara Leoni[1],**
Veronica Nava[1], Morena Spreafico[1], Flavia Dory[1]

[1]University of Milan-Bicocca

Climate change and increasing nutrient concentrations are two major threats to lake ecosystems. Further, warming is exacerbating the symptoms of eutrophication in freshwaters. Facing both environmental challenges simultaneously is more urgent than ever to preserve and recover water quality and protect the remaining biodiversity. Here we used long-term observational data to investigate the phytoplankton response to the interaction between temperature and nutrient variations in a deep mesotrophic subalpine lake (L. Iseo, Italy). This study illustrates that phytoplankton in deep subalpine lakes will experience severe changes in the upcoming years, and that complete mixing events may constitute a threshold for community transformation. Our results stress the importance of better integrating climate change in mitigation strategies to preserve ecosystem structure and functions.

## The role of plastic pollution in shaping freshwater ecosystem metabolism and functional traits

**Veronica Nava**[1],
Sudeep Chandra[2], Barbara Leoni[1]

[1]Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milano, Italy
[2]Global Water Center and Biology Department, University of Nevada, Reno, Nevada, USA

Plastic pollution is increasingly acknowledged as a growing threat to freshwater ecosystems, yet its effects on key ecological processes remain underexplored. In particular, the role of plastic surfaces and their associated microbial communities (the 'plastisphere') in shaping biodiversity, functional traits, and metabolic functions is not well understood. The extent of these impacts may vary depending on the ecological state of a system, but comparative studies across ecosystems are still scarce. This study investigates how biofouled plastics influence ecological processes in aquatic environments with different trophic conditions and geographic locations. Through a series of controlled semi-natural experiments, we assessed metabolic shifts, biodiversity patterns, and broader implications for water quality. Our findings indicate that plastic surfaces serve as substrates for active microbial communities that contribute to fundamental ecosystem functions. We observed changes in nutrient cycling, with shifts toward either heterotrophy or autotrophy depending on environmental factors. These results suggest that plastics can exert significant ecological effects, altering system metabolism and influencing biogeochemical cycles more than previously anticipated.

## An ecosystem modelling platform to assist Aotearoa New Zealand lake management – LERNZmp

**Tadhg Moore[1],**
Chris McBride[1], Mathew Allan[2], Moritz K Lehmann[3], Matthew J Prentice[4], Whitney Woelmer[4], Maggie Armstrong[4], Deniz Özkundakci[4]

[1]Limnotrack, Hamilton, New Zealand
[2]Waikato Regional Council, Hamilton, New Zealand
[3]Starboard Maritime Intelligence, New Zealand
[4]Te Tumu Whakaora Taiao Environmental Research Institute, The University of Waikato, Hamilton, New Zealand

The Lake Ecosystem Research New Zealand modelling platform (LERNZmp) integrates data from Regional Councils, NIWA, Freshwater Ecosystems of New Zealand (FENZ), and Land Information New Zealand (LINZ), alongside satellite remote sensing, to enable scenario simulations for up to 1,500 lakes. The platform hosts meteorological inputs for lake models from the Copernicus ERA5 reanalysis data. Nutrient load estimates were also generated using the CLUES model for catchments with sparse data, ensuring consistent nationwide coverage. Comprehensive bathymetric maps were digitised for 173 lakes. Two R packages, Aquatic Ecosystem Model Ensemble (AEME) and AEMEtools, were developed to simplify the modelling workflow. These tools standardise input and output processes, facilitate model calibration, and integrate geospatial and meteorological data sources. Local, regional and national-scale modelling studies have a common workflow with consistent input datasets and reproducible outputs and can be accessed through the platform.

## Remotely Sensed Water Transparency of Indonesia's Large Lakes

**Fajar Setiawan**[1]
[1]Research Centre for Limnology and Water Resources, Indonesian National Research and Innovation Agency (BRIN)

The lack of a comprehensive water quality database makes it challenging to evaluate lake conditions objectively. Investigating long-term changes in lake water quality requires time-series data, which is currently unavailable for most Indonesian lakes. In this context, remote sensing data archives, combined with a robust estimation model, offer great potential for retrieving historical water quality information, providing a valuable alternative for monitoring and assessing lake conditions over time. The water transparency data generated from Landsat 5-TM and 7-ETM+ using a selected water transparency estimation model were used to analyze long-term water quality trends in 35 Indonesian lakes larger than 10 $km^2$. The results show that water transparency has significantly decreased in eight lakes, increased in 13 lakes, and remained unchanged in 14 lakes. To improve water quality data availability, we should combine remote sensing-based water quality estimation with in situ data collected through citizen science monitoring to address data scarcity. Engaging more observers will enhance local awareness and contribute to more effective lake management and conservation efforts.

## The Impact of Eco-Enzyme Addition on Phosphate and Hydrogen Sulfide ($H_2S$) Dynamics in Endorheic Volcanic Lake Batur

**Sulung Nomosatryo[1],**
Fachmijany Sulawesty[1], Arianto Budi Santoso[1], Tjandra Chrismadha[1], Fajar Setiawan[1], Rosidah[1], Dian Oktaviani[1], Fajar Sumi Lestari[1], dan Eva Nafisah[1]

[1]Research Center for Limnology and Water Resources, National Research and Innovation Agency (BRIN), KST Soekarno, Jalan Jakarta-Bogor KM 46, Cibinong, Bogor 16911, Indonesia

Eco-Enzyme (EE), garbage enzyme, known as a "magic solution," is promoted in Indonesia for enhancing lake water quality. This study evaluates EE's effectiveness in Lake Batur, focusing on phosphate speciation, phytoplankton abundance, and hydrogen sulfide dynamics. We treated surface water samples from eutrophic Lake Batur and distilled water (control) with various EE formulations. Results showed a significant decrease in pH and an increase in soluble phosphate concentrations. A temporary rise in phosphate concentration and phytoplankton abundance was noted within three days, followed by a sharp decline. Geochemical modeling suggested that in the surface waters of Lake Batur, phosphates naturally precipitate with calcium to form hydroxylapatite. Additionally, the alkaline conditions of the lake water facilitate the predominance of sulfide speciation in its ionized form. However, EE adding could release phosphate back into the water through hydroxylapatite dissolution, driven by low pH. Additionally, the pH decrease shifted ionized sulfide to its more toxic unionized form (unionized H2S), posing risks to aquatic life. Our findings indicate that EE may not effectively improve lake water quality, highlighting the need for balanced management strategies to ensure ecological health and sustainable restoration.

## Microplastic Occurrence and Abundance in Lake Singkarak, Indonesia

**Cynthia Henny[1],**
T. Suryono[1], D. Rohaningsih[1], N. Setiadewi[1], A. Waluyo[1], A. B. Santoso[1]

[1]Research Center for Limnology and Water Resources-Research and Innovation Agency of Republic of Indonesia (BRIN)

Lake Singkarak is a tectonic lake and one of the most important lakes in Indonesia. The lake is the habitat of an endemic fish that is of significant value to the local community. In recent years, the lake has been receiving an increasing quantity of waste, notably plastic debris, from its river inflow and catchment runoff. As a result, Lake Singkarak has been acknowledged as one of the most critical lakes in need of restoration. It is probable that the lake is being contaminated by microplastics. Although the research on the occurrence of microplastic in rivers and coastal areas in Indonesia is receiving increased attention, there is a lack of studies that monitor microplastic pollution in lakes. The hydropower dam and the implementation of a sluice in the main lake outlet to regulate outflow could block plastic debris discharge, resulting in a higher accumulation of microplastics in the lake. The study's objective was to ascertain the initial occurrence and the quantity of microplastics in the surface water of the lake and river inflow. The highest abundance of microplastics in the lake's surface water was 9 particles/$m^3$ in the lake inlet area of the main river and the lowest abundance was 2 particles/$m^3$ in the main lake outlet area. It is not surprising that the river outlet contains the greatest concentration of microplastics in comparison to river inflow. Foams and fragments, white and clear in color, size of 300 μm were the dominant types of microplastics observed. Polypropylene was the most frequently identified polymer thus far. It implies that the lake could serve as a microplastic sink, particularly for high-density MP types, due to the significant amount of plastic that is constrained in the lake's surface and bottom. It is crucial to prioritize the reduction of plastic garbage input sources from the river in order to prevent the further contamination of Lake Singkarak with microplastics.

## Great Basin Western United States Saline Lakes : Estimating Chlorophyll-a, TSS and CDOM via MODIS and VIIRS

**Kimberly Casey[1],**
Ryan O'Shea[2], Nima Pahlevan[3], Dorothy Hall[4], Lara Jansen[5]

[2]NASA GSFC, SSAI
[3]NASA Headquarters
[4]NASA GSFC, ESSIC
[5]ORISE, USEPA

Terminal saline lakes present unique hydrologic conditions and optical properties with divergences from freshwater, estuarine and oceanic water characteristics. Here we use new and existing terminal saline lake in situ data to extend chlorophyll-a, total suspended solids and colored dissolved organic matter estimations and retrieval algorithms via the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) and the NASA/NOAA Visible Infrared Imaging Radiometer Suite (VIIRS) missions. This new MODIS and VIIRS algorithm monitoring allows daily characterization for many important inland high-salinity water bodies. Earth observation monitoring is key to understanding lake trophic status and biological productivity both in the Western U.S. and other saline lake sites globally. Aquatic algorithm development is useful to the named missions as well as the plethora of current and forthcoming remote sensing missions.

## Self-Made Equipment for Automatic Methane Diffusion and Ebullition Measurements From Aquatic Environments

**Jonas Stage Sø[1]**
Kaj Sand-Jensen[2], Theis Kragh[1]

[1]University of Southern Denmark
[2]University of Copenhagen

Freshwater ecosystems are believed to account for about half of global methane emissions, but this estimate is uncertain due to few measurements in some geographical regions and most important for our purposes, large local variations. We propose a simple, cheap (<200€), and effective solution to the urgent need for equipment that can provide accurate data on methane emission at high spatial and temporal resolution for many days, across many ecosystems and regions, and with limited inspection. A low-cost metal oxide semiconductor sensor, placed in a floating chamber equipped with an air pump to flush the chamber's headspace at regular intervals, provides frequent and accurate high-resolution measurements of diffusive and ebullitive methane emissions from lakes and rivers. We made several improvements that yield more useful data and enable the setup to operate for several days without visual inspection. To test the accuracy of the equipment, we compared its measurements of methane emission to parallel measurements by an expensive, commercially available laser sensor. The correspondence was excellent (R2 ≥ 0.94) and the deviation of measurements was minimal at fluxes within ranges encountered in the field. Furthermore, we present an R-package (FluxSeparator), which associates the large sensor-generated data sets with diffusive and ebullitive flux activity. We propose that our sensors could be used for collaborations across the GLEON network, thus creating a better understanding of the methane and carbon dioxide emissions from freshwaters.

## New GLEON lake observatory: Sau Reservoir

**Rafael Marcé[1],**
Biel Obrador[2], Daniel Mercado[1], Mireia Bartrons[3], Daniela Henry[1], Núria Catalán[1]

[1]Centre for Advanced Studies (CEAB-CSIC)
[2]Universitat de Barcelona (UB), Spain
[3]Universitat de Vic (UVic), Spain

Sau Reservoir, located in Spain, has been a cornerstone of water quality monitoring since its first filling in 1964. A pioneering site for eutrophication studies in reservoirs, it was one of the first inland water ecosystems formally linked to climate change impacts in an IPCC report. Over the years, it has become a reference in global limnological research, particularly within GLEON collaborative projects. Despite its significant contributions, Sau Reservoir has not been formally introduced to the broader GLEON community, a gap this contribution aims to address. By highlighting its long-term monitoring and key role in understanding the interactions between eutrophication and climate change, we seek to reinforce its importance as a critical research site and promote further collaboration within the network.

## New Sites: Midwest US Reservoirs

**Rebecca L. North[1],**
Ted D. Harris[2]

[1]School of Natural Resources, University of Missouri, Columbia, Missouri, USA
[2]Kansas Biological Survey, University of Kansas, Lawrence, Kansas, USA

The US Midwest has five new GLEON buoys! In Missouri and Kansas, GLEONites can have access to continuous, online data from lake water quality monitoring buoys, deployed year-round in five reservoirs. Table Rock Lake and Marceline reservoirs (Missouri) and Marion Reservoir (Kansas) have new water quality data buoys including: a CB-450 data buoy cellular telemetry and EXO3 multi-parameter sondes with sensors for temperature, conductivity, dissolved oxygen, turbidity, pH, ORP, chlorophyll (proxy for phytoplankton biomass), and phycocyanin (proxy for cyanobacteria). Each reservoir has two EXO3s, one in the epilimnion, and one in the hypolimnion. Bethel Lake (Missouri) and Clinton Lake (Kansas) have a Hobo and NexSens weather station. With the NexSens telemetry hardware, data is pushed to the cloud to a secure website called WQData LIVE. In addition, each reservoir has HOBO temperature sensors from surface to bottom in one meter increments, and in Missouri, there are photosynthetically active radiation (PAR) sensors from one meter below the surface to 3 m depth in each reservoir. The MU Limnology Lab will provide QAQCed data to interested users. We are thrilled to complement GLEON buoys with more reservoirs and year-round, continuous data.